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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Investigate Methods of Improving Production Throughput in a Shipyard

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

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**INVESTIGATE METHODS OF IMPROVING
PRODUCTION THROUGHPUT
IN A SHIPYARD**

**FINAL PROJECT REPORT
NSRP PROJECT SP-8-92-4
Industrial Engineering Panel SP-8**

**This Report is submitted by:
NATIONAL STEEL AND SHIPBUILDING COMPANY
San Diego, CA**

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Executive Summary

Throughput is the rate or the cycle time at which a ship can be manufactured combined with the total cost of manufacture. The goal is to simultaneously decrease the cycle time and total manufacturing cost for any given ship.

World wide commercial shipbuilding has set production cycle durations in both Asia and Europe which are considered to be the World Class Standards. For ships of various types (tankers, bulk carriers, RoRo's 200,000 tons to 350,000 tons) production cycles from the beginning of fabrication to delivery are 8 to 16 months. When first ship design is included, the cycle time will be 14 to 27 months. The ARPA discussions of 11-16-93 set these at 12 months and 14 months respectively.

It is admittedly difficult to directly compare naval ship throughputs with those for commercial ships, however, we can see that cycle times are dramatic and the processes that are employed by world class commercial yards are highly developed and very efficient. The fundamentals of cycle time reduction appear to be applicable in both cases.

Throughput is the result of Design, Engineering, Planning, Materials, Production Systems and Methods, and Facilities Utilization — the complete Ship Manufacturing System. Engineering, Planning, and Production must be commingled in such away as to provide the shortest time cycle, lowest cost, highest quality, and best facility utilization — the best plan for manufacturing a given ship at a given facility.

This project was focused by the ECB at the time of approval and ranking to address production, as opposed to marketing, design, or some other function. Thus this project Investigate Methods of Improving Production Throughput in a Shipyard was intended to provide practical methods which can be effectively applied at various levels of the Production Process in order to: a) Reduce the total production cycle time for a ship, and b) Reduce production costs. The first and very vital point to be made and understood is that throughput is a process. The process can be defined and evaluated in total or in part. As a result, this project and the final report focus on four key approaches:

- Ž Total Process Evaluation
- Ž Independent (Elemental) Process Evaluation
- Ž Process Integration
- Ž Continuous Process Improvement

These approaches were applied in the development of four specific methodologies:

- Process Effect Measurement
- Process Improvement
- Process Systems Application
- Global Change of the Total Process

Development use, and general application of these methodologies is presented in this report. The conclusions drawn by the project are derived from these applications, resource data, and other industry experiences.

The project conclusions are:

Shipyard Engineering has the largest single effect and impact on production practice. [Reference is also made to the SP-8 project Concurrent Engineering. Report issued January 1995.]

- 1 Planning and Material are the next two functions which impact production practice.
 - 1 Production methods and practice depend upon design, planning strategies, material availability, facilities, and the profound knowledge of the production organization.
 - 1 It will take five to seven years for a complete change from current throughput levels to world class levels.
 - 1 If those process functions which most unfavorably impact production throughput can be identified and systematically corrected, up to 50% reduction in production cost and 33% reduction in production cycle are predictable.
 - 1 Making the changes to the global and sub-set processes in order to accomplish these reductions requires a total company effort. All levels must breakdown the barriers between historically functional departments and do away with narrow ownership territories.
- All the systems that control the processes must be re-examined for integration and speed of proper and effective action. These may require Re-engineering.
 - Team work skills and employee empowerment are needed and will require commitment and training.
 - Most importantly, the guidance and total commitment of top management are mandatory.

Introduction

This project was focused by the ECB at the time of approval and ranking to address production, as opposed to marketing, design, or some other function; and, thus the project title: Investigate Methods of Improving Production Throughput in a Shipyard.

This specific guideline was used both by NASSCO management and the project staff in selecting, developing, and applying the methodologies that evolved from this undertaking. That does not mean that the project does not identify and make relevance to functions other than production, since certainly engineering and materials have profound effects upon production throughput, but simply that the project looked at throughput from the perspective of production.

A combination of Industrial Engineering technologies (both classic and new), the work of Dr. Deming, NASSCO practical applications, and the work of a number of neo-business systems authors has gone into this project.

Process Effect Measurement is fundamentally an IE application which can be easily applied to any number of yard processes for clearer understanding of problems and the measured contributing factors.

Process Improvement relies heavily on the Deming applications which NASSCO is utilizing. This is a constantly evolving method application and will have taken on change by the time the report reaches the reader.

Process System Application is based upon good systems practices, shipbuilding parameters, and NASSCO specific requirements. Presentations to various NSRP groups and industry representatives indicated great interest.

Global Change of the Total System is a comprehensive collection of resource data. Any one of the ten sources researched can stimulate a separate NSRP project. It is this particular method(s) that offer the greatest potential for decreasing cycle times and manufacturing cost on a grand scale.

The report is presented in six parts so that anyone part can be used separately for project work or reference. The first part gives an overview and some detail to the collection of work. Each method is discussed in detail in four sections, and the appendix contains the balance of project specifics.

Project Report

"It is insanity to do the same thing over and over
and to expect that the results Will change."

- Albert Einstein -

CHANGE is what the World Class Commercial Ship Market is demanding of us. We as an Industry want to change, we have recognized that opportunity and necessity are one in the same. The following are in the forefront of our thinking:

- ¶ Recognition that our U. S. Industry must move from where we have been to something different.
- Recognition of a commercial world ship market.
- ¶ Recognition of “World Class” as a Product Measurement for Quality, Delivery, and Price.
- ¶ Recognition that competition sets the pace of change.

However, the RATE of CHANGE should concern us.

- l We are not known for our ability to embrace change.
- l Our culture and history has been heavily influenced by our customer(s),
- l Rather than we having a heavy influence over our customers through a free marketing approach to ship design, manufacture, and sale.
- l And, the speed with which we need to address this “end for end change” is pressing our total industry and individual yard abilities.

THROUGHPUT is at the heart of the issue. THROUGHPUT is the rate or time cycle at which a Ship can be Manufactured combined with the total cost of manufacture. THE GOAL is to simultaneously decrease the cycle time and total manufacturing cost for any given ship. THROUGHPUT is the result of Design, Engineering, Planning, Materials, Production Systems and Methods, and Facilities Utilization-the complete Ship Manufacturing System. Engineering, Planning, and Production must be commingled in such away as to provide the shortest time cycle, lowest cost, highest quality, and best facility utilization-the best plan for manufacturing a given ship at a given facility.

Production “Throughput Improvement was intended to provide practical methods which can be effectively applied at various levels of the Production Process in order to: a) Reduce the total production cycle time for a ship, and b) Reduce production costs. The first and very vital point to be made and understood is that throughput is a process. The process can be defined and evaluated in total or in part. As a result, this project and the final report focused on four key approaches:

- 1) Total Process Evaluation
- 2) Independent (Elemental) Process Evaluation
- 3) Process Integration

4) Continuous Process Improvement

The following is a summary of the four methods developed and provides an overview of each. A detail section is provided for each method in the subsequent sections of the report.

Process Effect Measurement

The first of three specific methods to be developed was directed at the On-Board Outfitting experience on three ships (AOE's). NASSCO elected this initial effort since Outfitting possessed the greatest number of issues, and therefore the best potential for improvement. Since there were three ships of a type to provide experience, and the outfitting was rather complex and testy, this was an ideal opportunity to develop a process evaluation method capable of determining those elements which contribute most to opportunities for process improvement.

The resulting method can be used to evaluate any process or sub-process in any yard.

The initial key to this method is a model, which defines in elements all the inputs and outputs of the subject process. Therefore 100% of the process (at a pre-defined level) is addressed. The second key is the study and the associated techniques, which are vital to the validity of the resulting data. And the third is the analysis which will rank the elements as to lowest or highest contributors to the process performance.

In this NASSCO application, the seven critically effective process elements were identified out of a total of 23 elemental inputs. These seven represented 80% to 95% of the total process effect and therefore became those activities where management could devote the greatest immediate effort. However, this method application also provided trade specific effects, allowing the individual trade and ship managers to focus on the main performance issues relative to their responsibilities.

The data and analyses derived are a data base for future reference, while the model has been applied to a number of other yard processes including the second method which is discussed next.

Process Improvement

The second method was developed as a natural continuation of the first method, Process Effect Measurement, the interests of outfitting management and the current NASSCO company-wide Deming Program for continuous process improvement.

The On-Ground Outfitting process was selected for developing this method whereby a combination of On-Block management and staff, production trades, cross function managers from Engineering, Purchasing, Production Control, Planning and Scheduling, and a Manufacturing Engineering representative could be interactive in addressing process performance issues. This would work at two levels: 1) The On-Block Manager, staff,, and On-

Block Trades Supervisors, with others as required, meeting regularly as a Process Improvement Team (PIT); and 2) the cross fictional group as previously mentioned as a Resource Team to address those issues outside of the influence of the PIT.

This method in the case of NASSCO focuses on a combination of project learned applications and modeling, and the Deming Program Tools methodology as developed by the company. Other yards would not be restricted to any of these parameters but might well benefit from the approach that has been developed. This is an ongoing activity and shall no doubt evolve with time and experience. The cautions, which were heeded by the project staff and On-Block management, were to not get ahead of the Deming training program and to not be redundant to any other existing efforts.

Process Systems Application

The third method was an important combination of a NASSCO initiated program and a Project effort. This method simply stated is systems application. In this case, an improved system for integrating outfit planning. This is the Integrated Production Planning and Scheduling system (IPPS).

The initial work in this method had a beginning in another NSRP project, and evolved from concept to function. While a detailed explanation is not necessary here (this is covered in detail later), a simplified overview is this:

- This system looks at outfitting as a totally integrated scheduling effort beginning with whatever stage of construction introduces outfitting work and ending with system test and compartment completion.
- It stresses interpretation of master build strategies to a detail plan.
- Integrates material and vendor planning.
- Defines critical path(s), and provides a production feed back loop.
- And, improves the planning base for future ships.

Application of this system is ongoing since it feeds on continuous process improvement as both driver and product. The early returns show the following accomplishments and potential

- Master Build Strategy Adherence
- Production Cycle Time Reduction (59%)
- Cost Reduction (15%)
- Material Planning Integration
- Process Teams Utilization and Interactive Trades Planning
- Integrated Sequencing of Total Work Scope
- Definition of Critical Paths
- Feedback of Production Problems
- Data Base Establishment for Future Hull Planning

Global Change of the Total Process

The project was also directed to look into outside sources; those industrial activities beyond the shipbuilding horizon. This was done in parallel to the three specific methods applications.

This was addressed at one level only, the intention of an industry to compete in the world market. The staff looked to information from several sources: organizations that have made the necessary change or seek to make the necessary change, and methods for accomplishing the necessary change.

It is important to note that benchmarks from the Pacific Basin and Europe were used to describe world class commercial shipbuilding as a base of reference for our industry. Please also note that global in this context means corporate or company, and represents that level of doing business or systems which involve the CEO and senior executive management of a given organization.

The effort has revealed a number of fundamental truths. The level of expectation must be equaled by the level of commitment. The ultimate in attacking process, systems, and organizational change is Reengineering. The extreme form of this is totally redesigning how business is done. Some may for good reason not want to commit to the extreme. However, if attempting cultural change without realizing that the new radical nature of methodology is inherent to the process, may only guarantee failure. There is possibly too much information available, in a practical sense; and therefore selectivity shall be necessary for identification, selection, and action. The project does supply a bibliography and synopsis to assist with this.

It appears that there is no choice but for the industry to change; the competitive gap is great, time is critical. This project shows that each yard can pick what will work best, and there is” much from which to choose. The inevitable need is a 100% (up from) commitment.

The key principles in all successful world class methods applied globally are

SYSTEM
PROFOUND KNOWLEDGE
QUALITY

In the judgment of this collective work, the best methods emphasize

Process Analysis
Leadership
Long Term Commitment
Empowerment

And, stress the elimination of micro management and tampering.

Each yard has a Shipbuilding System which functions at all levels upon The Profound knowledge, individually and collectively, of the members of the yard organization, the yard data base, and outside information. Quality suggests the degree of success of that system and knowledge in producing a ship. If not measured by the system, it is certainly measured by the customer, the effectiveness of the system, and the throughput. This is another way to describe

the *process*. If the yard throughput is not satisfactory, is not on a World Class level, then improving the *global process* is necessary.

Process Analysis will be the main tool, the Measurement Method developed by the project is part of this Industrial Engineering technique. This must be applied on a rather grand scale for global systems, and a lesser scale for the operational systems levels. This can tell how the system functions, what *contributes* most to any failure to attain performance, and lead to process improvement. However, if the very best in *leadership* is not provided from the top down, the maximum change shall not take place. Additionally, *leadership* must be found, instilled, developed, and *allowed* at every level of the organization. In this manner, a total organization can become *empowered to seek* and attain continuous improvement. This process is a big investment and must be established with nothing less than a *long term, up front commitment*. Experience, in some well documented cases, has shown that failure occurred with victory in sight not due to the method selected nor the organizational involvement, but rather a lack of management commitment.

Global Change and World Class Throughput

If we truly intend to attain World Class Throughput, our yards must manufacture *ships*. Design for manufacture, Engineer for manufacture, Plan for manufacture, Procure for manufacture, and Facilitate for manufacture dedicating total yard systems to this end. Do we build ships, construct ships, or manufacture ships? World class shipbuilding manufactures Ships.

Defining the word *Manufacture* in itself is difficult since it is evolutionary by nature. One applicable set of current definitions is:

To make or process (a raw material) into a finished product, especially by means of a huge-scale industrial operation. Originally defined as to make by hand, now meaning to make by machine or an industrial.

While being textbook correct, these are simply not adequate definitions if one wants to understand the degrees of difference between a *construction system* and a *manufacturing system*. Certain key words are needed:

Systems, standards, technology, systems and process integration, throughput, and profound knowledge.

It is necessary to not be concerned with the definition but with the nature of what makes the definition evolutionary. This project research suggests that the competitive demands and changes required to meet those demands are the real defining terms for the *manufacture of ships*.

Global shipbuilding strategies developed by companies in both Europe and the Pacific Basin have been accomplished primarily through three actions:

- 1) Determine what classes of ships to produce based upon:
 - Facility
 - Market
 - Experience
- 2) Pre-Design and Engineer these basic product(s).
- 3) Completely develop a manufacturing plan.

The second strategy is to create a ship manufacturing process where

- 1 Any ship in the yard class is manufactured;
- 1 To appropriate standards;
- 1 Using the same, similar, or equal production methods from class to class, ship to ship;
- 1 And, the same integrated manufacturing system for:
 - Engineering
 - Planning
 - Procuring, and
 - Controlling

The technology and practices required to create ship manufacturing systems are not new; NSRP projects have been developing much of the necessary information over the life of this research program, while other methodology is constantly emerging.

The principles involved in the creation of the Manufacturing System are

- 1 Understand the economics of the change
 - Changes must be made concurrently and not serially
- 1 Electronic process (computer system) must be universal and concurrent
- 1 Capital spending must be concurrent and integrated to the whole
- 1 A World Class Manufacturing System is highly disciplined, which prompts the question; “Does this Railroad (your shipyard) run on time?”

The throughput factors upon which the successful system must be developed are

- 1 Manufacturing Strategy
- 1 Schedule Attainment
- 1 Individual Work Package Schedule Maintenance
- 1 Shop/Supplier Schedule Maintenance
- Individual Production Methods
 - A Vehicle for Continuous Change and Improvement.

Summary

This project has addressed the problems of Improving Production Throughput in several ways. First, by seeing throughput as a process that has global and local, and therefore, intermediate effects and issues. Second, by providing methodologies which address the various levels of the shipyard organization and relative responsibility. Any process can be improved by

removing the constraints which effect best performance. This project provides working, tested examples of process **measurement**, continuous improvement, and application. At the same time, it addresses Global Change issues.

We must keep in mind that removing local and intermediate constraints is necessary. However, if global constraints are not removed **no** throughput improvement will be accomplished.

PROCESS EFFECT MEASUREMENT:
An Industrial Engineering Methodology
applied to On-Board Outfitting
in order to enhance
Ship Production Throughput

A subsection Report for
NSRP project SP-S-92-4
PRODUCTION THROUGHPUT IMPROVEMENT

Presented by
NATIONAL STEEL AND SHIPBUILDING COMPANY
San Diego, CA

S u m m a r y

It was stated earlier that this project was concerned with process evaluation in order to identify potential areas for improvement. A method for evaluating and measuring a process, as found in fundamental ship production, was developed, applied and the results utilized in order to determine contributing elements to longer production cycles and costs.

The application in this instance was On-Board Outfitting, however, the methodology has potential in evaluating any shipbuilding or repair process. The key to this technique is the understanding of process versus functional evaluation and modeling of the same. Functional analysis, such as flow process study and charting, work analysis, and failure analysis, has a long history and is by no means invalid. However, in recent years this has been placed in a subordinate role to techniques of process analysis since it is vital to know what areas of a process require improvement prior to applying detail specific and costly methods. The abiding concept is that Production Throughput Improvement (PTI) is a process and can be defined and evaluated in total or in part. AU modern methods used in improving manufacturing cycles are based on process evaluation which tends to avoid the pitfalls of the traditional multi-function and more often separate functional analyses for problem solving. These latter methods perpetuated functional barriers and isolation of operations rather than total process improvement.

Previously stated, the four interacting relationships that make up the PTI program are

- 1) Total Process Evaluation-Total process improvement can only be accomplished by looking at the whole.
- 2) Independent (or Elemental) Process Evaluation-It is often necessary do to the size and extent of the total to look at some part thereof, (this is the mission of this kind of method application), and then
- 3) Process Integration-Put improvements to the various parts together in order to make the necessary improvement(s) to the total process.
- 4) Continuous Process Improvement-Once the process improvement is started and institutionalized it is necessary to maintain a constant program of improvement.

And, the project objectives are to:

- 1) Develop methods to measure, identify, and support Production Process Improvement. (The specific intention of this development.)
- 2) Relate the process improvements to the Total Production Cycle. (The extended results of this method application.)

3) Identify those processes or process elements which are failing to attain Best Production Throughput. (The conclusions of the study).

These are fully met by developing and utilizing this measurement technique.

The On-Board Outfitting process was selected since this activity is very complex on many ships and required something new in the way of a measurement method. The key differences between this and some previous studies were two-fold. First, the process approach was introduced as opposed to a task measurement method. Second, a quantizing measure was introduced in place of a qualification measure. This aspect is most vital to the idea of process improvement, since quantifying is needed in order to assess and measure the relative need for improvement. What needs to be improved and in what priority?

This methodology is based on the need to determine what is wrong in the process and to what degree, rather than assigning blame. In short, processes have common ownership, and therefore common and mutual reason for improvement. This promotes a positive engagement with areas requiring change, rather than the defensive nature associated with function or departmental blame.

You will find the study method easy to learn and adapt to the particular needs and objectives of most any yard. However, a dedication to Industrial Engineering practices and methods is extremely necessary for accuracy and validity of the resulting data and the conclusions derived therefrom. The estimated cost to duplicate a study of this magnitude, now that the method has been developed, will be between \$50,000 and \$75,000 at the level of engineering skills required. The results can direct management to focus on the most important process issues. Once completed and documented, this type of study can provide

Identification of selective areas for corrective action. (The classic 80:20 Rule, where 80% of the cost or time improvement impact can be found in 20% of the contributing elements.)

Formulation of proposals for Throughput Improvement to management

CEO and other executives.

Production executives.

Ship, trade, and line managers and supervisors.

A benchmarking database for future reference. (Continuing process improvement.)

Process Effect Measurement

Introduction

This study was the result of several important actions. Firstly, the executive management for production was consulted as to what initial limits and concerns were foreseen that might be needed to keep the project effort focused. And secondly, a survey was conducted throughout the production, trade, ship, and support management to determine the concerns that they had in focusing on improvement of cycle time and cost. Both of these efforts were conducted without the advantages of a well organized and Thought out” approach to Process Analysis and Improvement. That was developed as the early study work was performed and continued to evolve throughout the project.

Outfitting was the close to unanimous result of initial actions. The study approach was worked out and presented to executive management for approval. A presentation was made to the ship and trade management group and their inputs and support was solicited. These two steps proved to be very vital in the study and results process and are absolutely recommended.

Each trade and ship superintendent and manager was briefed on an individual basis, asked for comments, recommendations, and approval of the plan. Throughout the study period, contact was made with each manager on a regular basis so that problems could be worked through-and there were some problems. The main issue was the time needed for the study interviews. This ran about 1 to 2 hours per study and involved approximately 200 studies. However, by having had the managers involved from the start, and having gained their understanding and support, these and other issues were relatively easy matters to resolve.

Further to the course and communication of the work an interim study assessment was conducted with each affected manager. In this manner, they could see real results and benefits to their organizations, ask questions, and give input. This was most helpful and again, absolutely recommended. The study period ran 2 months, the preparation period (engineers had to be trained in the study process) required 1 month, and the analytical work took 1 month. Depending on the experience of the project manager and staff engineers, the size of the yard, and extent of the process to be studied, an estimated project cycle would run 5 months or less.

The choice of yard process to be evaluated, Engineering, Steel Production, Outfitting Production, Planning, Procurement and Material, or other does not matter; this method can be applied. The emphasis is critical to the following:

- 1) Executive Management must be involved in the initial selection and approve of the plan.
- 2) Operating management must be made a key part of the plan, with ownership of the objectives and the results.

- 3) The staff must be totally trained in the Industrial Engineering study technique. This is the most vital factor in the quality of the results.
- 4) The analytical process must be equally applied with statistical qualification of the basic data.
- 5) The conclusions must be viewed objectively and actively, so that change *and process improvement* will result.

Otherwise, *why do it at all?*

THE STUDY: The study and methodology are explained in the sequence which follows. The lead page (in several instances) describes the graphic which follows. This was done in order that the reader could view the full size of form, chart, or data. Copies can be easily made as well.

Outfitting Study Model

The model represents On-Board Outfitting as a process. There are three major inputs to the process which are further broken down into 23 individual elements. There are also six different types of outputs which represent the final results of the process. The 'three types of inputs are

- i. Inputs-These are the fundamental items needed to support production.
- ii. Controls & Constraints-These are the items which control and regulate production.
- iii. Operations-These items represent the actual on-board production process.

PROJECT: SP - 8 - 92 - 4
PRODUCTION THROUGHPUT
IMPROVEMENT
OUTFITTING STUDY MODEL

CONTROLS & CONSTRAINTS

What controls or constrains the process?

- Schedules
- Planning Sequence
- Work Transfer
- Material Delivery
- Tooling RQMTS
- Shop MAT'L RQMTS
- Inspection System

INPUTS

What is needed to perform the work?

- Eng Drawings
- Eng ECN's
- Material Selections
- Work Package
- Work Force
- Trade Supervision
- Ship MGT

ON BOARD OUTFITTING
PROCESS

OUTPUTS

What is the result of the process?

- Time to Completion
- Hours Charged
- Material Wasted
- Quality
- Rework
- Owner Satisfaction

OPERATIONS

Describes all Operations needed to be Performed:

- Material Control
- Equipment Control
- Installation
- Other Trade Support
- Other Zone Support
- Vendor Support
- Technical Support
- Subcontractors
- In Process Q/C

PTI Project Principles

Input Measurement

This study concentrates on measuring the input elements of the production process. Current systems only monitor the outputs of the process. While the outputs are important, using those to control the process is a lot like trying to drive by looking only through the rear view mirror.

Effectiveness Rating

This study seeks to quantify the level of performance of the elements and the process. This is done by using a scale of one to ten to rate the effectiveness of any particular element, with a one being the best. During the course of the study no attempt is made to fix this rating scale to any output measurement. Instead, a 1 was considered as the best that can be done, given current resources, and a 10, the worst.

Element Isolation

The study seeks to isolate each element and consider the performance of each element on an individual level. This is necessary in order to evaluate all elements of the process. You do not want to know if any particular element was the best or the worst, but rather if that element is an effective contributor to the process.

Zone Focus

The study seeks to evaluate the process from the bottom up. In the NASSCO study, focus was on production foremen and working foremen, and each study was limited to the evaluation of a particular zone. Prior to conducting the study, the subject zone was toured with the interviewee. In this way, the interviewee was better focused on the particular zone and the evaluation of elemental effectiveness was more insightful.

Study Guide (Next four pages)

This guide was used in conducting the Study to ensure continuity among the individual studies. The answers to the individual questions, or sub-elements, were not recorded, but were used to help evaluate each element. As such, this document provides the definition for each element. It should be noted that many elements are not what the name would imply. For example, Test & Trials is not a measure of the performance of the Test & Trials organization. It is instead a measure of the impact of the Test&Trials organization upon the on-board outfitting process.

The questions were designed to keep the study as factual as possible. To this end, these questions are both historical and tied to specific events. An example is the Material Delivery element under Controls & Constraints. The question is focused on what did occur in that specific zone. We were not interested in the individual's feelings about the system, but rather, was the material received when needed.

Study Guide by Component, Element, and Sub-Element

- I Inputs-Fundmmental Items needed to support production
 - A Engineering Drawings
 1. Were the drawings clear and understandable?
 2. How clear was the dimensioning?
 3. How well did they match drawings from other blocks?
 4. How well were systems integrated on the drawing?
 5. How well did vendor drawings match NASSCO drawings?
 - B Engineering ECNs
 1. What percentage of the work was affected by ECNs?
 2. Were ECNs issued before/during/after production?
 3. What was the response time on PIRs? Was it acceptable?
 4. How well were you supported by your liaison?
 - C Material Selections
 - L Did the material selection support production?
 - 2. How was the quality of vendor supplied materials?
 - 3. Did vendor supplied materials support production schedules?
 - D Work Package
 1. Was the work package of a manageable size?
 2. Did the work package have all the information you needed /wanted?
 3. Did the work package break down /sequencing support production? How accurate was it?
 - E Work Force Ability/Training
 1. What was the ratio of trainees to journeymen for the crew working on this zone?
 2. How did the experience level of your crew affect job performance?
 3. Are additional worker training programs needed?
 - F Trade Supervision Ability/Training
 1. Did you have proper training for using the various production systems?
 2. Did the trade superintendent have the experience and skills needed to manage effectively?
 3. Did they support you when needed for this zone?
 - G Ship Management Ability/Training
 1. Did production managers have the skills and experience required?
 2. Did the area manager set clearly established production goals?
 3. How well did the area manager coordinate production efforts with the subcontractors?
 4. Did the management structure help or hinder the production effort?
 5. Did the managers clearly understand the job requirements?

Study Guide by Component, Element, and Sub-Element

- II Controls & Constraints-Items which control and regulate production
 - A Schedules
 - 1. Was the level of detail scheduling appropriate?
 - 2. How frequently was the schedule changed and how did that affect production?
 - 3. Were schedules reasonable, flexible, and attainable?
 - 4. Did you have input in making the schedule?
 - B Planning Sequences
 - 1. Was the work sequencing clear and logical?
 - 2. Was the work sequencing coordinated with other efforts (trades / subcontractors)?
 - 3. Did you have any input into making the work sequencing?
 - c Work Transfer
 - 1. How much of the tasks could have been done On-Block (SOC-5)?
 - 2. What was the quality of work completed by On-Block (SOC-5)?
 - 3. Was the work transferred from On-Block (SOC-5) accurate?
 - 4. How well was material transferred from On-Block (SOC-5)?
 - 5. What lines of communication existed with On-Block (SOC-5)?
 - D Material Delivery
 - 1. Did you get material when needed?
 - 2. Was material delivery complete, accurate, and on time?
 - 3. Was any material damaged when received?
 - E Tooling and Equipment Requirements
 - 1. Did you have the quality and quantity of tools required to do the work?
 - 2. Would the work have been easier with more and/or better tools?
 - 3. Were special requirements recognized and coordinated appropriately?
 - F Shop Material Requirements
 - 1. Did production receive shop manufactured materials on time?
 - 2. Was there a timely response to special needs?
 - 3. How was the quality of shop manufactured materials?
 - G Inspection System (Test & Trials)
 - 1. How was this affected by the test and trials requirements?
 - 2. How well were test and trials requirements incorporated into your zone schedules?

Study Guide by Component, Element, and Sub-Element

- III Operations-Items of the actual production process
 - A Material Control (On Site)
 - 1. How often was material lost, damaged, stolen, or borrowed?
 - 2. Did you have a place to store material?
 - B Tool Control (On Site)
 - 1. What was the average wait for equipment from the tool room?
 - 2. Did you have special equipment available at the job site?
 - 3. Did you have delays due to equipment problems?
 - c Installation
 - 1. Did work go smoothly?
 - 2. How much modification was required for assembly?
 - 3. Did work require field changes during production?
 - D In-Process Quality Control
 - 1. Were quality standards defined and understood?
 - 2. How many discrepancies were the result of poor quality workmanship?
 - 3. At what level does quality control take place?
 - E Other Trade Support
 - 1. Were other trades responsive to your needs?
 - 2. Did you have delays or rework due to other trades?
 - 3. Was there good cross-trade communication?
 - 4. At what level were the trades coordinated?
 - F Other Area/Zone Support
 - 1. Was work coordinated among adjacent zones?
 - 2. Did work in other zones cause you delays or rework?
 - G Vendor Support
 - 1. Did you require vendor support to accomplish work?
 - 2. Were vendor support requirements coordinated into the work effort?
 - H Technical Support
 - 1. Did you have all the technical support and information you required?
 - 2. Was technical support available and complete?
 - 3. Was all the necessary background information supplied?
 - I Subcontractors
 - 1. Was subcontractor work coordinated into the overall work package?
 - 2. Did you have any delays or problems due to subcontractors?
 - 3. Could subcontractor work have been done in-house?
 - 4. Could subcontractor work have been done at a different stage of production?

Study Guide by Component, Element, and Sub-Element

- I v Outputs-Final results of production
 - A Time to Completion
 1. Was the work completed on schedule?
 2. why?
 - B Hours Charged
 1. Did you meet the manhour budget?
 2. why?
 - C Material Wasted

How much material was lost, damaged, or otherwise wasted?
 - D Quality
 1. What do you think of-the final quality of work?
 - E Rework
 1. Did you perform any rework?
 2. What was the rework due to?
 3. How much did rework impact cost and schedule?
 - F Owner Satisfaction
 1. Was the customer satisfied with the work performed?

NSRP SP-8-92-4: Final Report

Rating Form (Next two pages)

This is the form used in conducting the study. As noted earlier, all elemental ratings were assigned by the PTI Engineer conducting the study. The form also includes a considerable area for remarks. This allowed for the collection of qualitative data to supplement the quantitative evaluation.

The ratings are based on a score of one to ten. A rating of ten represents the worst and one the best that could be done.

ON BOARD OUTFITTING STUDY

SHIP: Zone _____ Space _____	INTERVIEWEE: Trade Class _____ Title _____	DATE: / / 93	ENG
--	--	------------------------	------------

Rating Key: A=Missing, B=Late, C=Incorrect, D=Incomplete: 1-10, 0, N/A, CNE

COMP	ELEMENT	Rate ** 1-10	REMARKS
INPUT	Eng Drawings		
	Eng ECN'S		
	Material Selections		
	Work Package		
	Work Force		
	Trade Supervision		
	Ship MGT		
CONTROLS & CONSTRAINTS	Schedules		
	Planning Sequence		
	Work Transfer		
	Material Delivery		
	Tooling RQMTS		
	Shop MAT'L RQMTS		
	Inspection System		
	Material		
OPERATIO	Control		
	Installation		
	Other Trade Support		
	Other Zone Support		
	Vendor Support		

OPERATIONS <small>(continued)</small>	Technical Support		
	Subcontractors		
	In Process Q/C		
OUTPUTS	Time to Completion		
	Hours Charged		
	Material Wasted		
	Quality		
	Rework		
	Owner Satisfaction		

NOTES:

Rev. 23 10-8-93

FINAL QUESTIONS:

- 1] What reduction in manhours would be a possible under the best conditions?

- 2] What reduction in cycle time would be possible under the best conditions?
 (Schedule) _____, (Actual) _____, (Best Effort) _____.

- 3] What was your biggest Single Problem?

- 4] What was your next biggest Single Problem?

Logged by:

Date / /93

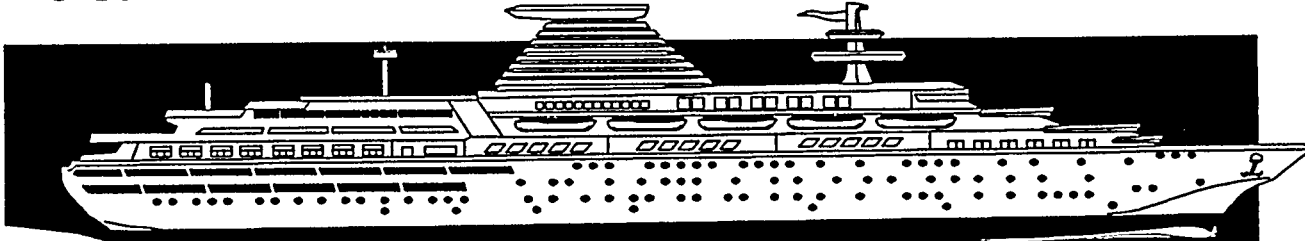
Individual Study Make-up (Next page)

This chart shows the total number of studies conducted, and the distribution of these studies across three ships and five trades.

Abroad cross-section of zones was taken. The zones selected did have to meet some criteria. Since we intended to compare the performance of the three ships, we wanted to study the same or similar zones on each ship. We also wanted to study zones from a historical perspective. This limited our choice of zones to the 01 level and below, and zones which were at least 50% complete.

Statistically, the number of studies taken is enough to support a 95% accuracy within the study itself for most all elements.

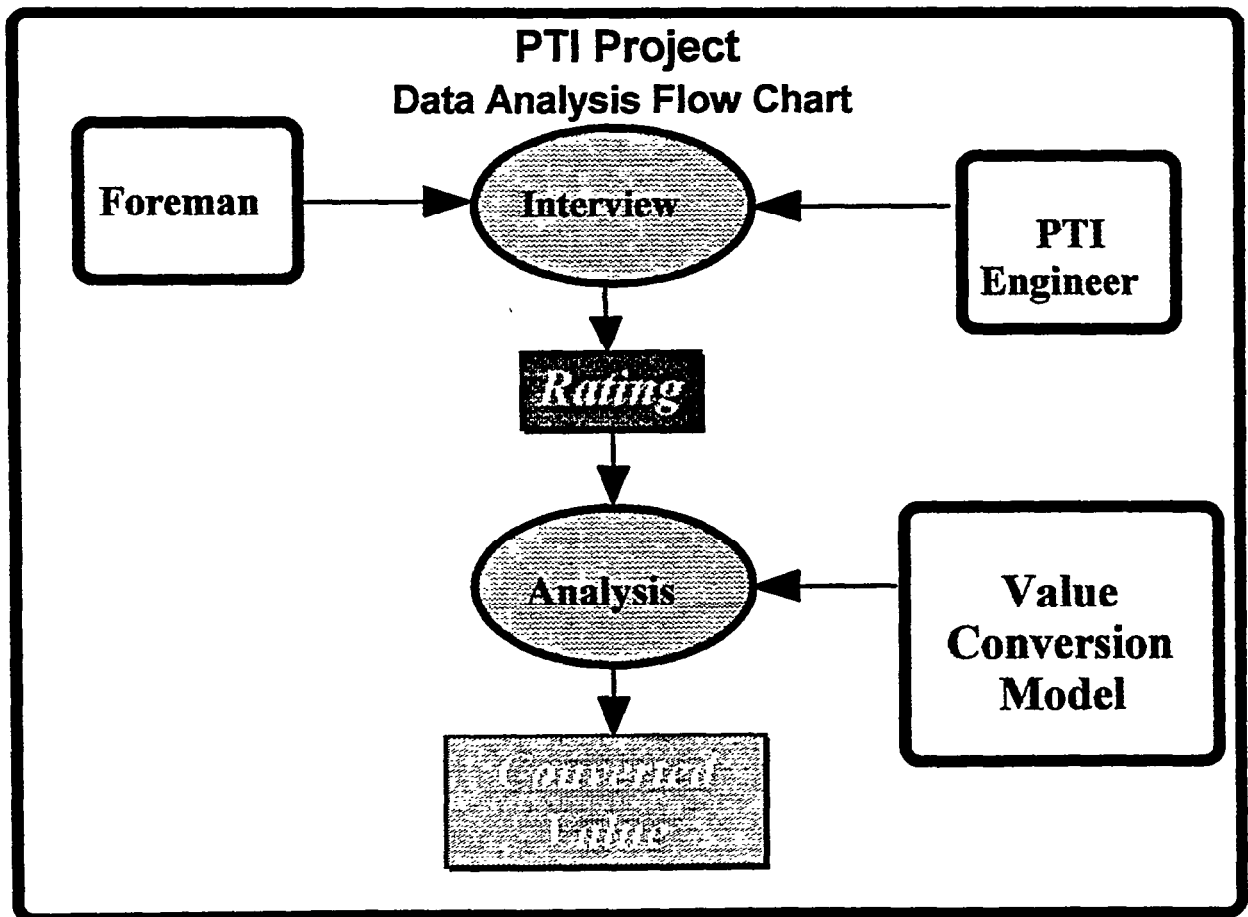
PTI Project Studies



SHIP	Pipe	Machinery	Sheetmetal	Electrical	Steel	TOTAL
Shlp 1	1	3	6	1	2	13
Shlp 2	23	9	18	29	19	98
Shlp 3	20	9	13	20	24	86
TOTAL	44	21	37	50	45	197

Data Analysis (Flow Chart)

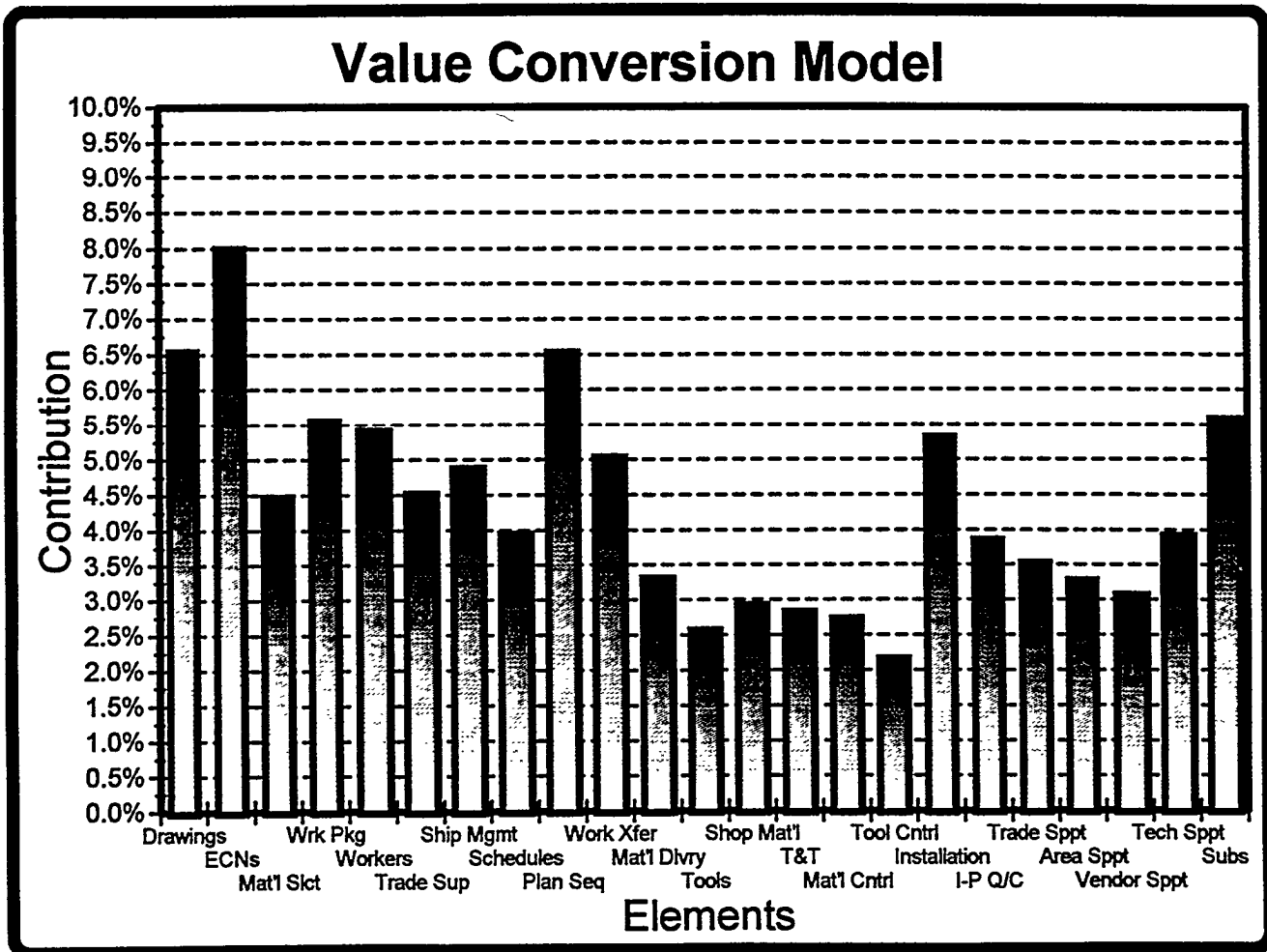
This chart gives an overview of how the data was handled. The results each interview produced is a series of ratings for each element. As mentioned before, **each element in the study was evaluated in isolation**. However to properly analyze the process, we needed to consider the relative importance of each element. It is intuitively obvious that some elements of importance will have a larger effect upon the process than others. To perform this rating, a value conversion model was created. The ratings were filtered through this model to give a converted value representative of both the effectiveness and relative importance of each element. All data presented is at the converted values.



Value Conversion Model

This model represents the relative contribution of each element to the total On-Board Outfitting Process. This model was created by using a matrix to chart both the networked effect of each element upon the others and the direct effect of each element upon the outputs of the process. These effects were quantified and the scores equated to a percentage of the total process.

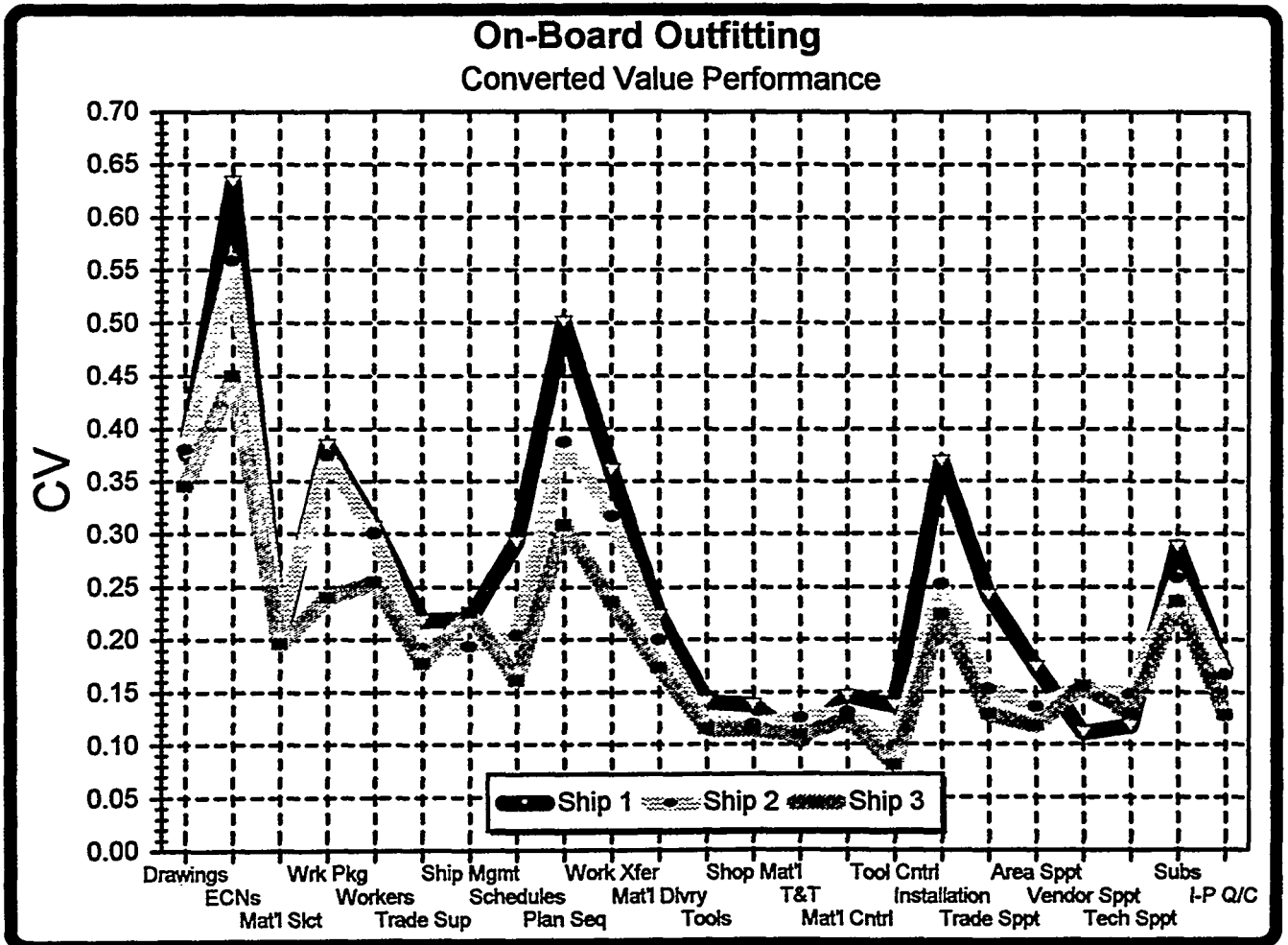
The Converted Value (CV) is used from this point on for all analysis.



CV Performance

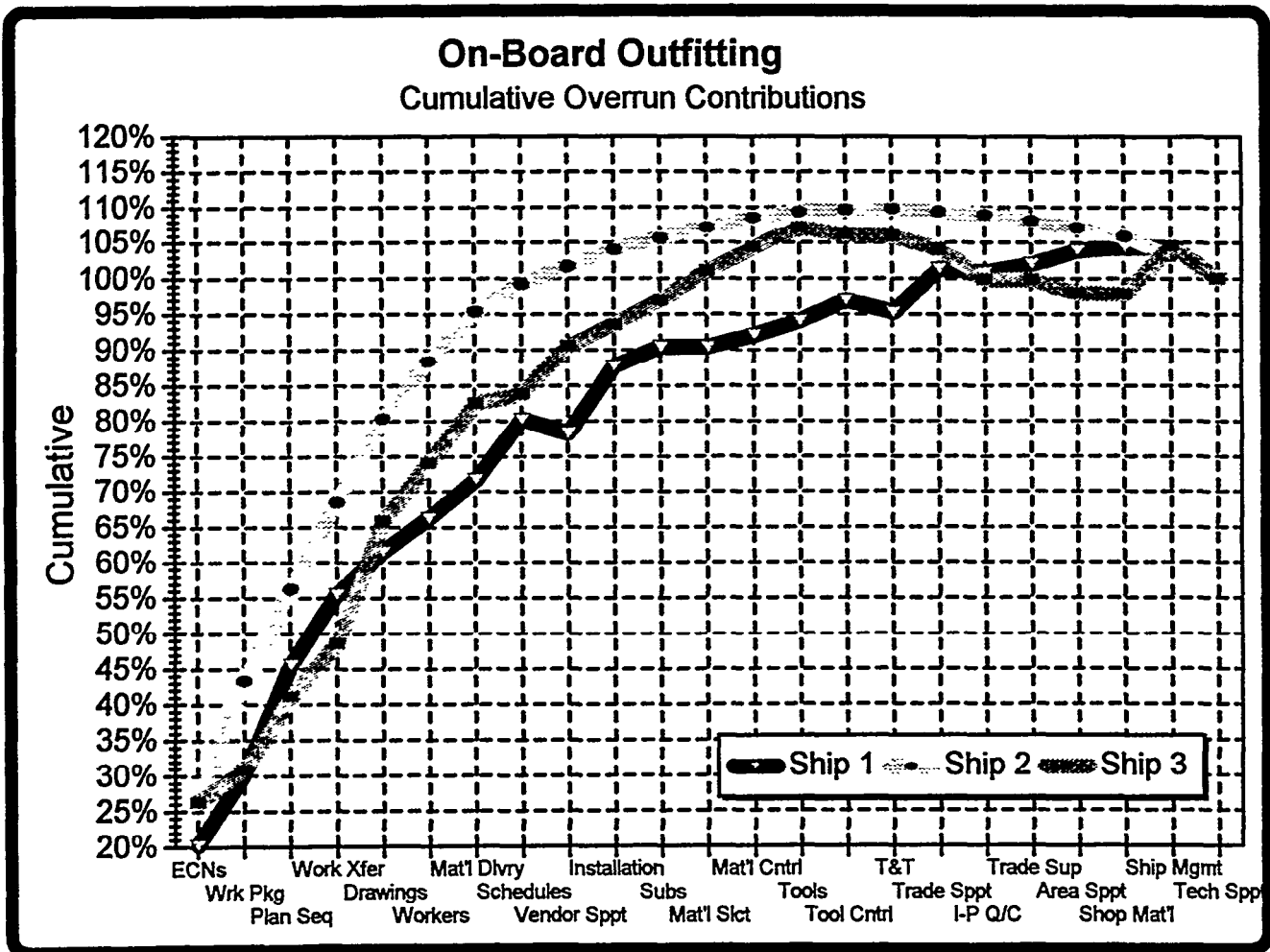
This graph plots the elemental performance of each ship on a straight CV scale. The improvement of the basic performance level can be seen in most elements. However, in several areas, performance can be further improved.

In most areas, the profile of the line has not changed. This implies that what improvement has been made is the result of a learning curve on progressive ships and not significant process change. A notable exception to this is the Work Package element. This element remained at essentially the same level on Ships 1 & 2, but showed a dramatic improvement on Ship 3 when the system was changed. It can also be seen that this element still needs to improve to meet the budgeted level of Ship 3.



Cumulative Deviation Contributions

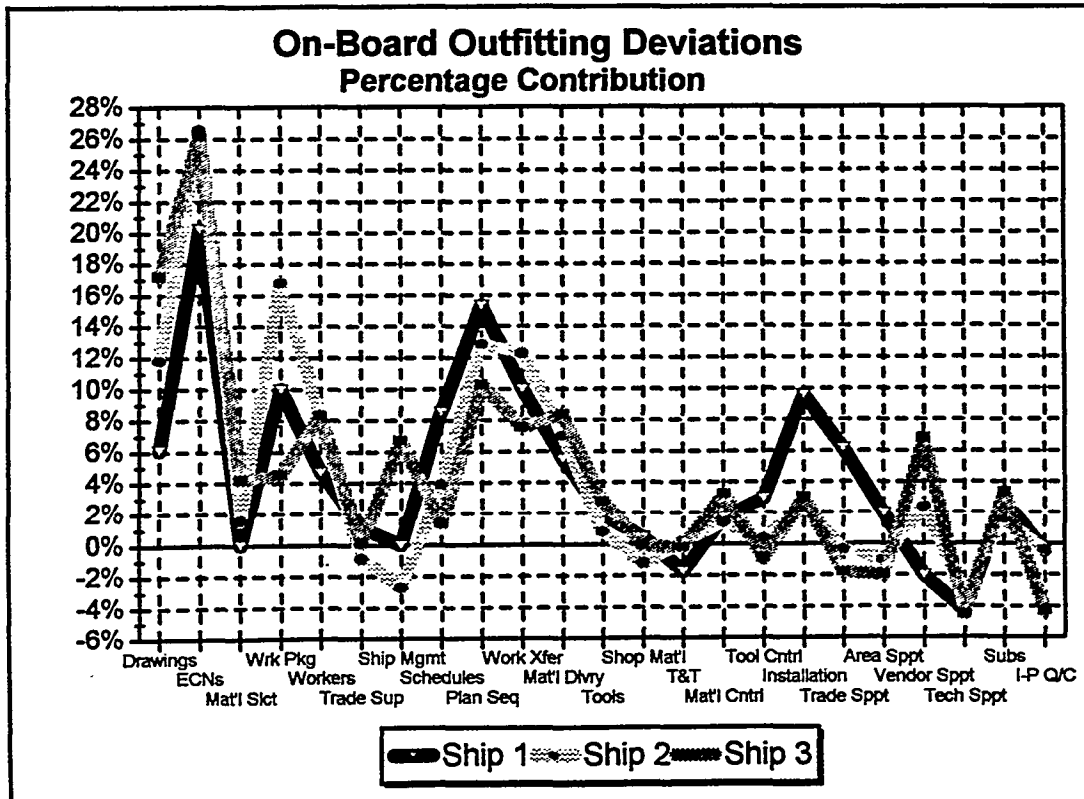
The cumulative effect of the deviation can be examined by plotting the percentage contribution of each element. These curves represent the combined effect of each elemental deviation. One important thing to note is that the profile of the curve is largely determined by the first seven elements. This corresponds to a rule-of-thumb, the "20:80 relationship". That is, approximately 20% of the inputs account for 80% of the output. To maximize the effect of any improvement, it is, in this case 30%, or seven out of 23 elements, upon which efforts should be concentrated to deal with 80% to 95% of the needed process change.



Deviation Percentage Contribution

This graph shows the percentage contribution of each element to the total deviation for each ship. It highlights the relative importance of the failure to meet the budgeted level of performance. It is important to keep in mind that the effect of the decreasing budget is included. This graph also shows the shifting concerns of the foremen. Since this graph shows percentage contribution, the sum of the percentages for each ship is 100%. Because of this, each line tends to act as a piece of string of fixed length. As some areas decrease, others will increase correspondingly.

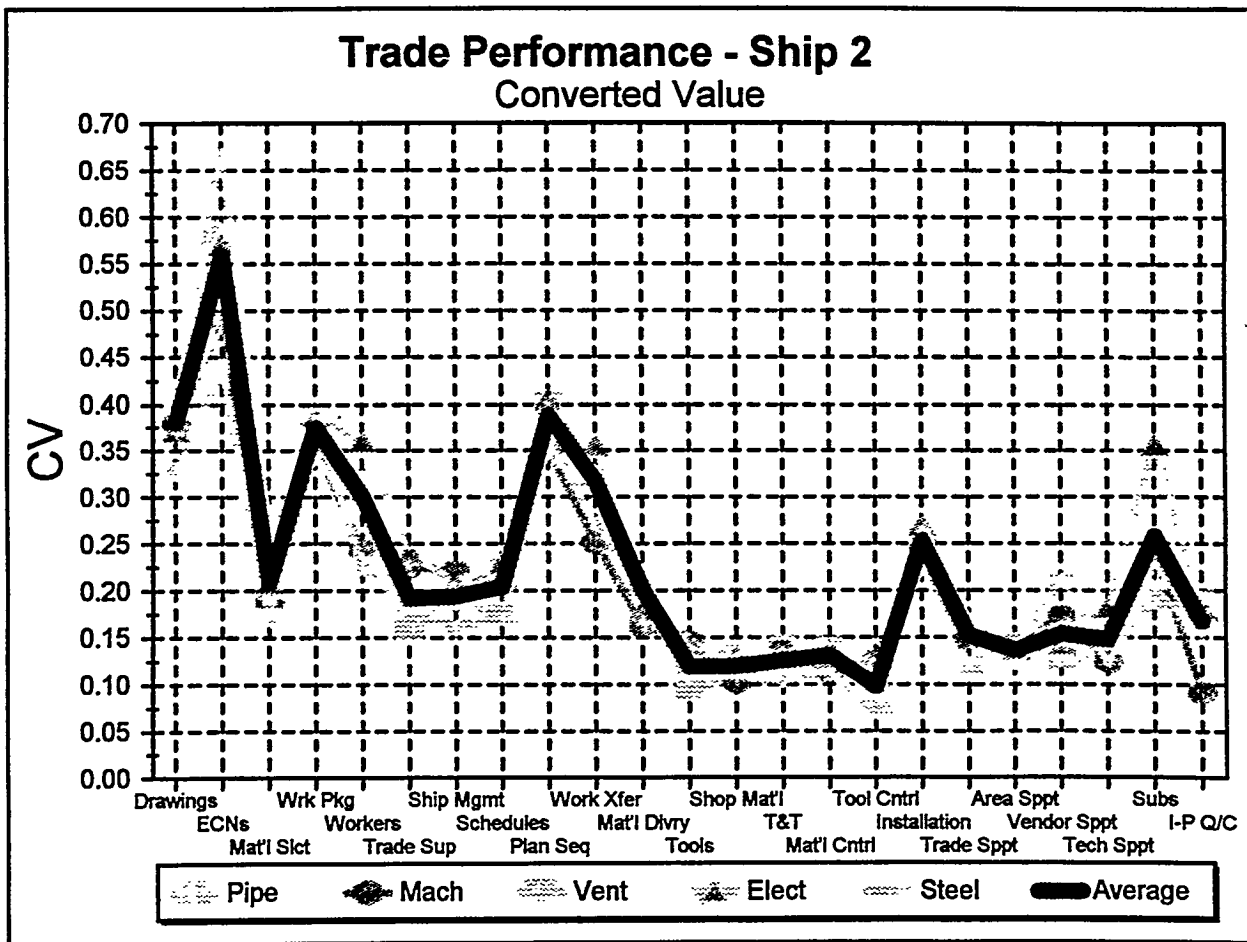
As an example, consider the drawings element. On previous graphs we have seen that although the performance level has increased, the deviation has remained the same. On this graph, we see that this deviation has become increasingly more critical. As some of the other major concerns are addressed, the drawings become an ever larger relative problem. Another likely factor to consider is that Ship 3, more so than the other ships, is being built by the drawings rather than to the ECNs.



Trade Performance-Ship 2

This chart compares the elemental CV performance of each trade on-board Ship 2. Also shown is the average CV performance for all trades on that ship.

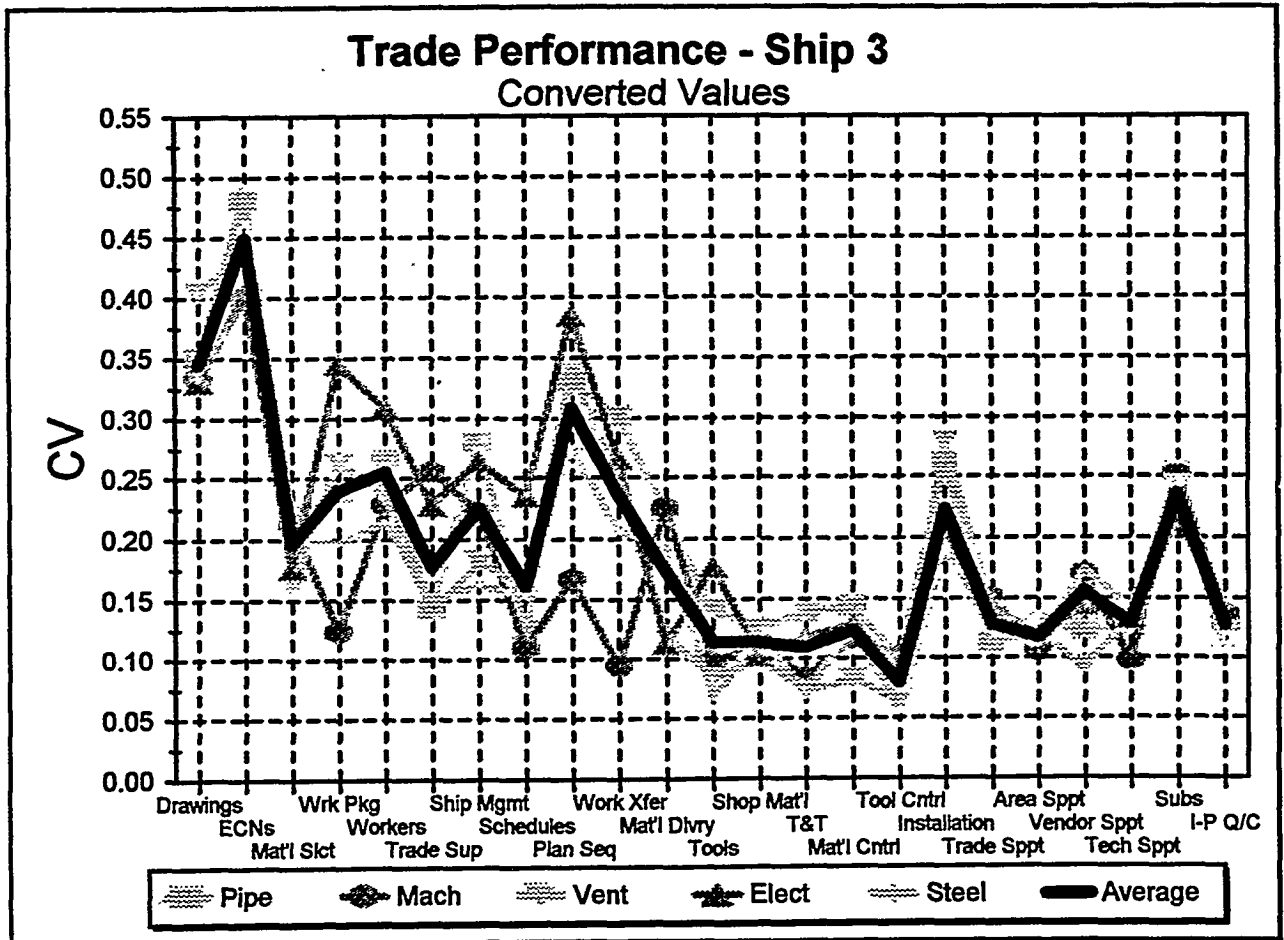
It is interesting to note that the profiles of each trade performance are very similar. It appears that on this ship, the dominant factors common to the whole process largely overshadow the particular effects of the process for each trade.



Trade Performance-Ship 3

This chart compares the elemental CV performance of each trade on-board Ship 3. Also shown is the average CV performance for all trades on that ship.

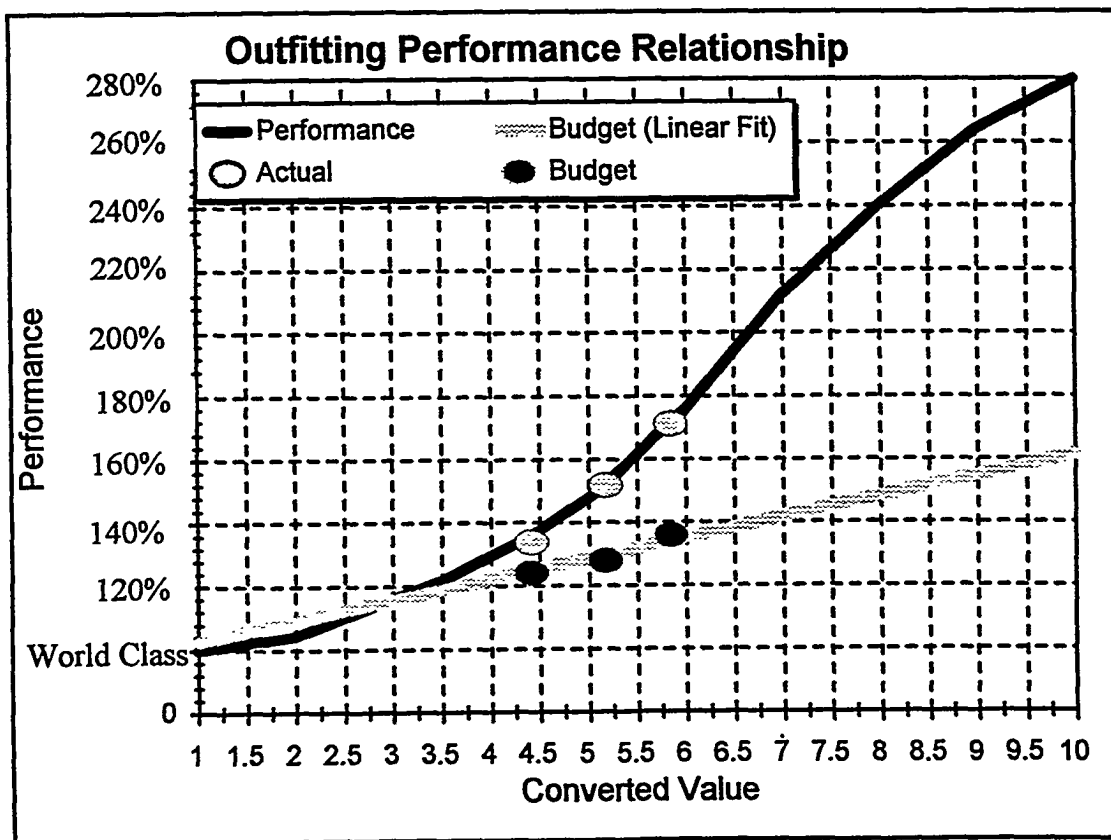
As compared to the trade performance on Ship 2, two basic changes can be seen in this chart. First, the overall CV performance has improved. Second, the variations in performance due to the particular characteristics of each trades' process have become more evident. It appears that as the effect of some of the global constraints has been reduced, the local constraints of each trade become relatively more important. There is however, still a large degree of correlation amongst the trades.



Outfitting Performance Relationship

This graph shows the empirical relationship we found between the average converted value of each ship and the total manhours spent on On-Board Outfitting by the five trades interviewed in our study. The oval markers represent points of our actual data. The derived relationship between the converted value and the relative degree of World Class Performance is shown as the line with the gray markers. The gray markers represent the budgeted performance for each ship. This graph shows that there has been a measurable improvement in performance between each ship in the series. However, the budget has also dropped with each ship, and the rate of performance improvement has not been sufficient enough to meet the budget.

A second use of this graph is to determine the budgeted performance level of each ship. The budgeted performance is taken at the point where the gray line intersects the budgeted manhours.



Conclusion

The Process Model and Study are two initial steps which are critical to this method. These must represent 100% of the process to be evaluated. However, the Elements must all be defined at the same level of the process. One element can not be global and another local. For example, company Policy and employment form data are not “level elements”.

The second critical step is the making of the individual studies, industrial engineering evaluation, and rating. This must be performed consistently, isolated to the element in question, and without bias. Training is recommended, along with an initial trial study period.

The data should be developed and processed immediately, with interim review of the data. Make certain that the study technique does not have high degrees of variation. Work to a statistical level of accuracy of 90% to 95% in the number of studies made.

Keep the managers and participants informed and give them intermediate briefings, get their feed back and ideas. When the final data has been developed, make them part of the team for comment, recommendation, and even action commitment (where this is within their responsibility and authority).

Take the results and recommendations to organizational management, and share it with all “stake holders”. It is everyone’s process and all should be concerned with improving it.

PROCESS IMPROVEMENT:
A Cross Functional Process Changing Methodology
applied to On-Ground Outfitting
in order to enhance
Ship Production Throughput

A subsection Report for
NSRP project SP-8-92-4
PRODUCTION THROUGHPUT IMPROVEMENT

Presented by
NATIONAL STEEL AND SHIPBUILDING COMPANY
San Diego, CA

Process Improvement

This method was developed as a natural continuation of the Process Effect Measurement method. Critical process elements had been identified and the effects of On-Ground Outfitting were among these. This was identified as the Work Transfer Element.

Other important factors concerning this vital production function were:

- Ground Outfitting is the bridge between Steel and On-Board outfitting.
- Connects to the major internal suppliers Materials, Planning, and Engineering.
- Is an ideal area for production innovations.
- Works closely with the new NASSCO activity of Manufacturing Engineering and can draw readily on this resource.
- Is 1/5th the cost of On-Board work
- Is 1/3rd the cycle time of On-Board work

The current NASSCO company-wide Deming Program for continuous process improvement also played a vital role in the concepts and structure of this method. This program provided the principles, background training of the participants, application techniques and analytical methods, and the common structure named the Process Improvement Cycle. Because of the interaction of the PTI project and the Deming program it is very desirable to discuss both contributing activities simultaneously. Where it is necessary to identify the two sources, this has been done. The staff has made the assumption that the Deming Philosophy and history are generally known and therefore only project related background detail is supplied.

Structure

At the core of this development is the idea of combining (through a team activity) the skills and knowledge of On-Block management and staff, production trades, and cross function managers from Engineering, Purchasing, Production Control, Planning and Scheduling. This would work at two levels: 1) The On-Block Manager, staff, and On-Block Trades Supervisors, with others as required, meeting regularly as a Process Improvement Team (PIT); and 2) the cross functional group as previously mentioned as a Resource Team to address those issues outside of the influence of the PIT.

Approach

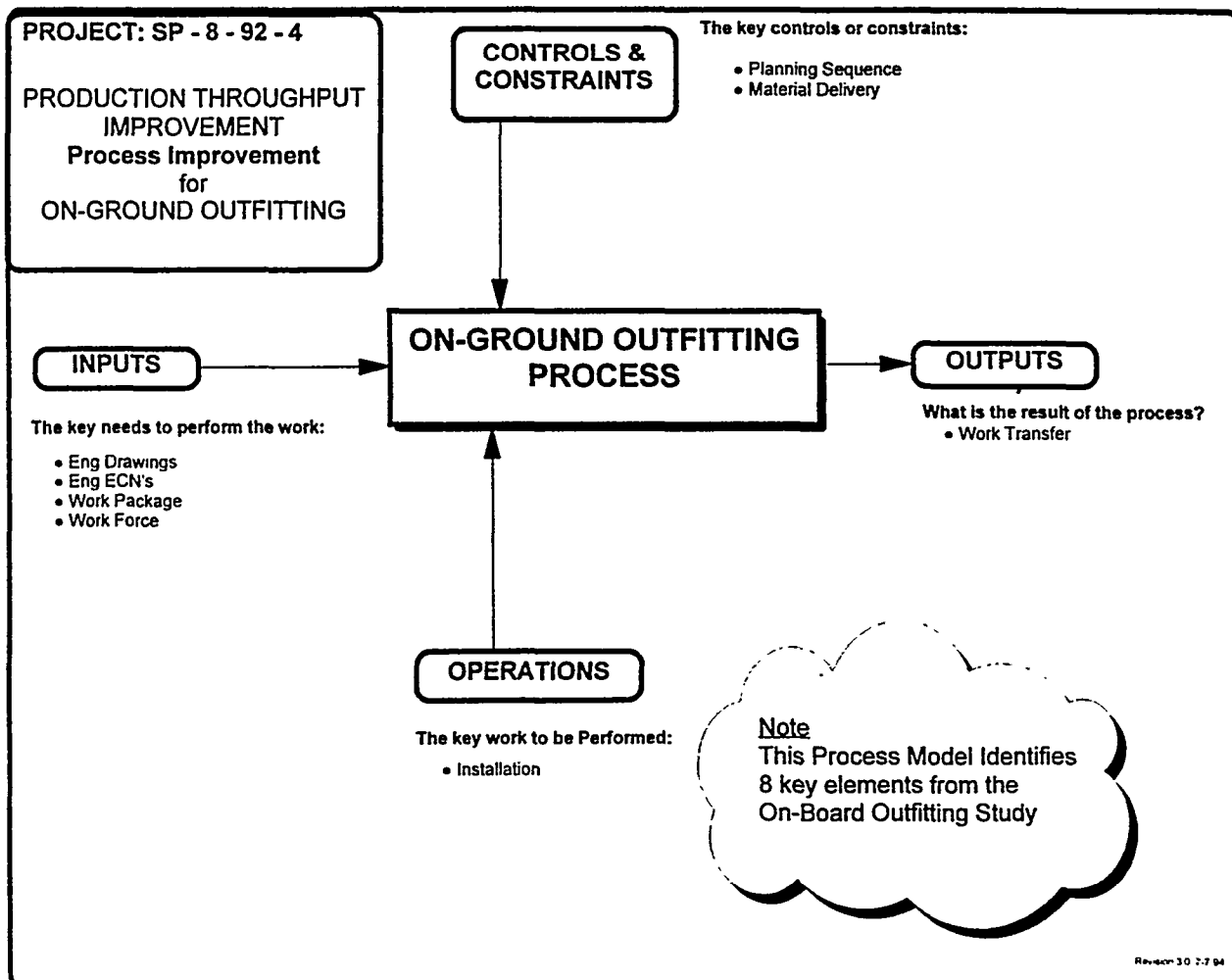
This method is vital to the dynamics of process change and improvement. But, it is not generally applicable to the global (corporate or company wide process), and therefore should be used in dealing with the local and intermediate organizational levels (where a great percentage of improvement must be identified and acted upon). Further, the actual procedures to be used, meetings, subject selection, task development, etc. will be specific to the shipyard doing the process improvement. NASSCO has an on-going program developed around the Deming philosophy and it made only good sense to work to this model, even though it required some delay in full initiation due to conflicts in training and other program issues. The production management and project staff did not see this as an insurmountable problem, since continuous process improvement is exactly that under the Deming philosophy and lasts for the life time of the shipyard.

It is important to understand how the Deming principles and the project methodology were worked together.

PTI Project Source

The project had developed a method for identifying and measuring process elemental performance and therefore a relative need for improvement. In this case, the sub-process of On-Ground Outfitting was measured at a contributing level of 8 to 12% of 100% of the On-Board process failure. Again it is most important to note that “fault” or “causing the problem(s)” simply have no application or proper use here. As Will be seen, the On-Ground Outfitting Process has contributing elements within and outside of the control of the Manager, staff, and trades. And therefore, there should only be a dedication to improvement and no energy wasted on “fault’.

The project also had developed a model that would describe the input and outputs of any process. This was utilized here and is a most important part of the method. Develop this model in draft as the first step. This will be a working instrument in the next steps of the method.



Consultation with the production manager immediately responsible is necessary at the outset. The Manager must see the good, want to take the leadership, and be knowledgeable with techniques. Once this is the situation, the executive to whom the Manager reports, must be consulted, briefed on the objectives, and permission requested. *In the Deming atmosphere, this is not a difficult process, since everyone is speaking a common language concerning process improvement.* Also, during this process, the model must be presented, discussed, and generally agreed upon. This is extremely important, because it describes the process to be improved and forever be a tool to be used in tasks ahead.

Next, in whatever order the core group (the executive, the Manager, and key players) determines, consultations must be conducted with the managers and executives from the cross functional organizations and their commitment obtained. Again, present and discuss the model for understanding and agreement.

Then, conduct the consultation of the potential participants (in this case the trades). This *action is also vital. These are the people with the real problems, usually looking for needed improvements, and often frustrated with the "system". They Will most likely have "pet" issues which need to be aired. This is a great way to open and conduct these initiating contacts.*

Some principles to this method are these:

- Ž Prepare a complete briefing for tie group in advance.
- Ž Open a discussion and get the groups thoughts on the table.
- Ž Walk through the model.
- Ž Develop the consensus for action and *commitment to the process improvement.*

Then, assuming that this is a new program experience, preferably a skilled and experienced staffer must approach each participant individually and get their input to the model (so that this is accurate and complete) as well as their recorded key comments and ideas. Answer all questions, or get back after researching where necessary. The model will require about three revisions when done by a skilled experienced person. *Get it right no matter what it takes!*

Deming Sources

This section contains both direct quotations and indirect references form various works and writings of Dr. Deming, and full credit is extended to these various sources.

For the purposes of understanding what underlies this method application, two perspectives require extended discussion. First, an overview and second, specific tools.

Overview: Deming (the influence and works of W. Edwards Deming) as relates to this project is primarily a philosophy and set of guiding principles rather a detailed methodology. Dr. Deming's Management Philosophy is based on the now famous "14 points" and it is worth listing and describing these, but first, let us focus on a simple and important to understand concept.

The business process, in both internal and external relationships, is based upon "supplier", "customer" relationships, understandings, and agreements (contracts).

Every company is not only made up of its own organization for conducting business, but also contains suppliers and customers. Therefore, each part of the company organisation must function with supplier and customer connections. his most often is an internal company association, but nevertheless, totally applicable. In shipbuilding, engineering produces a product used by planning, purchasing, and production purchasing procures for production planning provides work packages and schedules for production and production manufactures a ship and delivers this product to the customer *thus the ever present "supplier customer relationship"*.

Once this is understood, skills can be developed in defining these relationships at any company or process level, reaching understandings and agreements on services and products, and continuing improvement of the processes which support the relationship. This is *a fundamental principle of this project developed method*

As a preamble to listing Deming's 14 points, it needs to be recalled that Deming initially targeted and worked in the quality arena and originated the *Operational Definition of 'Quality' as:*

Furnishing products or services which are complete, accurate and timely, and which meet the requirements mutually agreed to by the supplier and customer.

This will be the connection for this project purpose of the Demng fundamental principles, quality, and the philosophy as set forth in the 14 points. TQM and other quality oriented methodologies are left for another project.

The key ingredients of Deming's 14 Points are:

- Create Constancy of Purpose
- Adopt, the New Philosophy
- Build Quality into the Product
- Build Long Term Supplier Relationship
- Improve the Process Constantly
- Institute On-Job Training
- Institute Leadership throughout Management
- Drive out Fear
- Breakdown Organizational Barriers
- Eliminate Slogans, Exhortations, Etc.
- Eliminate Quotas, Substitute Leadership
- Remove Barriers that Rob Employees of Pride of Workmanship
- Institute a Program of Education and Self-Improvement
- Put Everybody to Work Transforming the Company

Specific Tools

Mathematicians, Statisticians, Industrial Engineers, and others have developed many techniques and methods over the years. This project is testament to the fact that new developments are emerging and shall continue to do so in the future. Each of these is intended to assist in the analysis of simple or complex situations (in this case process improvement) in order to identify elements requiring change, develop answers, and synthesize these into the larger or whole process. NASSCO is doing exactly that as an on-going extension of Deming.

Briefly, certain techniques have been developed and training conducted in order to provide initial skills. (In many cases, both for this project and application in any shipyard, leadership and facilitation skills training most likely will be useful and needed.)

The training program in this situation was based upon the Shewhart/Deming Cycle: Plan, Do, Study and Act. This was transformed into a specific package intended to provide a comprehensive understanding of the Process Improvement Cycle (see Appendix, page 109), and provide training in specific techniques. These included:

- Process Improvement
- Customer/Supplier Relationships
- Deployment Flow Charting
- Data Collection
- Pareto Charts and Histograms
- "Brainstorming"
- CheckSheets and Fishbone Diagrams
- Decision Making
- Team Dynamics

Function

This specific method is designed to function a certain way in the initial phase, tailored to the nature of the organization, the inputs of the responsible executive, the status of the training program the complexity of the issues, and inputs of the participants. (This project work suggests that a good *team participation* program, while requiring a *discipline of purpose and procedure*, should not have a *restrictive form of function*. Management must create the *vision of purpose and philosophy of change*, provide the vehicle and let the people function. The *empowered* people must provide status of progress and be receptive to guidance while shouldering and maintaining responsibility.)

There are a number of team projects and programs taking place outside of the project influence which function quite differently but which have the common overall *purpose and procedure*. Each varies in mission, scope, structure, function, and duration all exist to improve the process.

The PIT (Process Improvement Team) will meet every two weeks. They use an agreed agenda and each member works from the assignment for which they volunteer or are assigned by the leader. There will be several phases for this PIT. In the early phases it will be desirable to have certain technical participation, such as manufacturing engineering, material control, or planning, on a regular basis. As new, more mature phases evolve, resources will be identified and invited in as required.

Once a specific issue is developed to the point of a desired action and that action is within the organization control and responsibility of the On-Block Management or Outfitting Executive the ordinary procedures of approval and initiation are followed. The PIT, however, is responsible to follow the progress, measure the results, and report status until the action has become totally *institutionalized*. (It may be justifiably seen that in reality, a PIT should not have many of these easy projects, organizationally self-contained, since these can be dealt with in staff meetings or other normal departmental functions. But, do not doubt for a moment, that the use of the tool and the *techniques* for process improvement can have a profound impact on the quality of project development and implementation that would not be possible otherwise. Even the easy ones can be enhanced. It must be noted that a team association is not needed for an opportunity to apply the *tools*. *These are* intended for every day use as well.)

Where an issue is cross functional the PIT must look to the cross functional group or Resource Team for support. (It is true that invariably in most large organizations like shipyards these are the issues, which when resolved, improve *throughput*.) Digressing, the PIT will call upon various resources and invite these individuals to participate and assist with issues, and in the case of the Resource Team (PRT) invite individuals to do the same. However, the PIT does not involve the PRT in total until the issue is fully developed to the action level. This forces focus on the quality of the team work as well as the quality of time use. (In this or any team program *efficient use of time* is vital and must be attended as part of the total process improvement program.)

Why the Team Process?

The team process has a number of contributions to make. Let us keep in mind that the industry needs to undergo rapid, deep, *cultural change*. Companies will need vehicles for carrying out *global, intermediate, and local* actions that result in early and then continuous improvement. Individuals do not manufacture ships, this is done by groups of people. If these people can function as a team and improve upon that team work then they can transform selective, successful team experiences into ever expanding process effectiveness.

The advantages and importance of Team Programs are these

- Accomplish Process Improvements
- Maintain the *Global Purpose* at all organizational levels
- Work within a discipline relative to the *purpose*
- Focus profound knowledge in problem solving
- Realize individual and group success
- Learn by improving
- Develop the larger sense of *process*
- Maintain the spirit of *teamwork and mutual trust*

These kinds of things cannot take place unless the mission is clearly identified, the preparatory work is done thoroughly, and the effort is properly “championed”.

Yes, this method will have some cost, in some yards a significant cost. It is however an investment, not unlike those associated with shipbuilding facilities or trade skills training, which are equally vital to this industry.

PROCESS SYSTEMS APPLICATION:
Throughput is Improved by Changing
the Systems which we employ,
here is an example of an
Integrated Production Planning System

A subsection Report for
NSRP project SP-8-92-4
PRODUCTION THROUGHPUT IMPROVEMENT

Presented by
NATIONAL STEEL AND SHIPBUILDING COMPANY
San Diego, CA

Process Systems Application

Introduction

This method was developed as a *joint venture* between the efforts of NASSCO prior to and during the life of this project. NASSCO, through the initial work of Rich Neuman, had initiated and was working to develop the Integrated Production Planning and Scheduling System (IPPS).

This system had its concept in the need to more closely and adequately plan Outfitting, both integrated with Steel Assembly, for earliest On-Ground Outfitting, and Test for completion driven systems, decks, areas, zones, and compartments. PTI identified additional concerns through the measurement studies and was able to assess contribution and impact relative to the Work Package and Planning Sequence elements of the studies. Further, the insights gained through the various interviews, at all organizational levels, provided information not before collected.

The previous system for outfitting planning was structured independent of Steel, in the sense that no integration of production was attempted and no strategy was worked. The Master Schedules and work performance windows were the connection between the various production stages. Test was scheduled based on the Master Schedule demand, and trade completion “realities”. The interaction of material and work was in large pallets where stage of construction and time durations were difficult to manage.

This impacted the completion phase on construction and caused work to “focus” at late stages of production and test. Thus *constraints to process throughput* were easily identified and the need for rectification was not only identified, but also measured.

This section will walk through the methodology as reported to the SP-8 Panel in New Orleans in October 1994. This is an expansion of that presentation, which was developed as a summary of the events and activities leading to the current (October 1994) status of Integrated Production Planning Systems of the NASSCO On-Board Outfit Planning Section.

Dave Webb, was integral in both the Outfit Planning group and on this PTI project team to develop this presentation and section of this report. Mr. Webb’s presentation was very well received by the Panel as attested that at least two shipyards asked if it could be given to their staff at a future date.

This section of the report will represent the SP-8 presentation with some brief comments as to local activity and changes from past practices.

CHART 1 Outfit Planning Historical Problems

EBM—Engineering Bill of Material, the basis of the parts structuring logic for each ship.

A one dimensional system with no capacity for dynamic scheduling.

LMS-Labor Management System the system utilized to meet customer requirements for labor expenditures.

A system designed to provide a stable labor reporting baseline to the customer, and therefore not to be used to adjust production schedules because of hold-ups caused by late material, manpower shortages etc.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

**"Outfit Planning
Historical Problems"**

- **STATEMENT OF HISTORICAL PROBLEMS**
 - **18 MONTH WINDOWS**
 - **EBM / LMS**
 - **NO SEQUENCING DISCIPLINE**
 - **ONE PLANNER PER PRODUCT**
 - **LITTLE MATERIAL CONTROL**
 - **NO TESTING OR SUBCONTRACTING**

CHART 2 Outfit Planning Goals

These goals are a summary of over six years of dedication and changes within outfit planning.

This summary is based upon the integration of systems and people changing the process of planning.

Much work is still ahead, but we have proven results to justify the needed additional commitments and resources.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

"Outfit Planning Goals"



- Ž PRODUCTION THROUGHPUT IMPROVEMENT
- Ž SUPPORT MRP II IMPLEMENTATION
- Ž CONTINUOUS EXPANSION AND IMPROVEMENT OF
THE INTEGRATED PLANNING BASE AND TEAM EXPERTISE
- Ž IMPROVED SEQUENCING OF TOTAL WORKSCOPE
- Ž DEFINITION OF CRITICAL PATH [OR PATHS]
- Ž IMPROVED QUALITY OF INFORMATION PROVIDED TO
MATERIALS ORGANIZATIONS
- Ž PROVIDE FLEXIBILITY PLANNING FRAMEWORK
- Ž ACCOUNT FOR PRODUCTION PROBLEMS
- Ž FORMAT FOR 'ROLLOVER' FROM HULL TO HULL ON
MULTI-SHIP CONTACTS

CHART 3 Production Stages of Construction

This chart clearly shows the requirements of both concurrency and integration. It also shows the historic barriers.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
"Production Stages
of Construction"

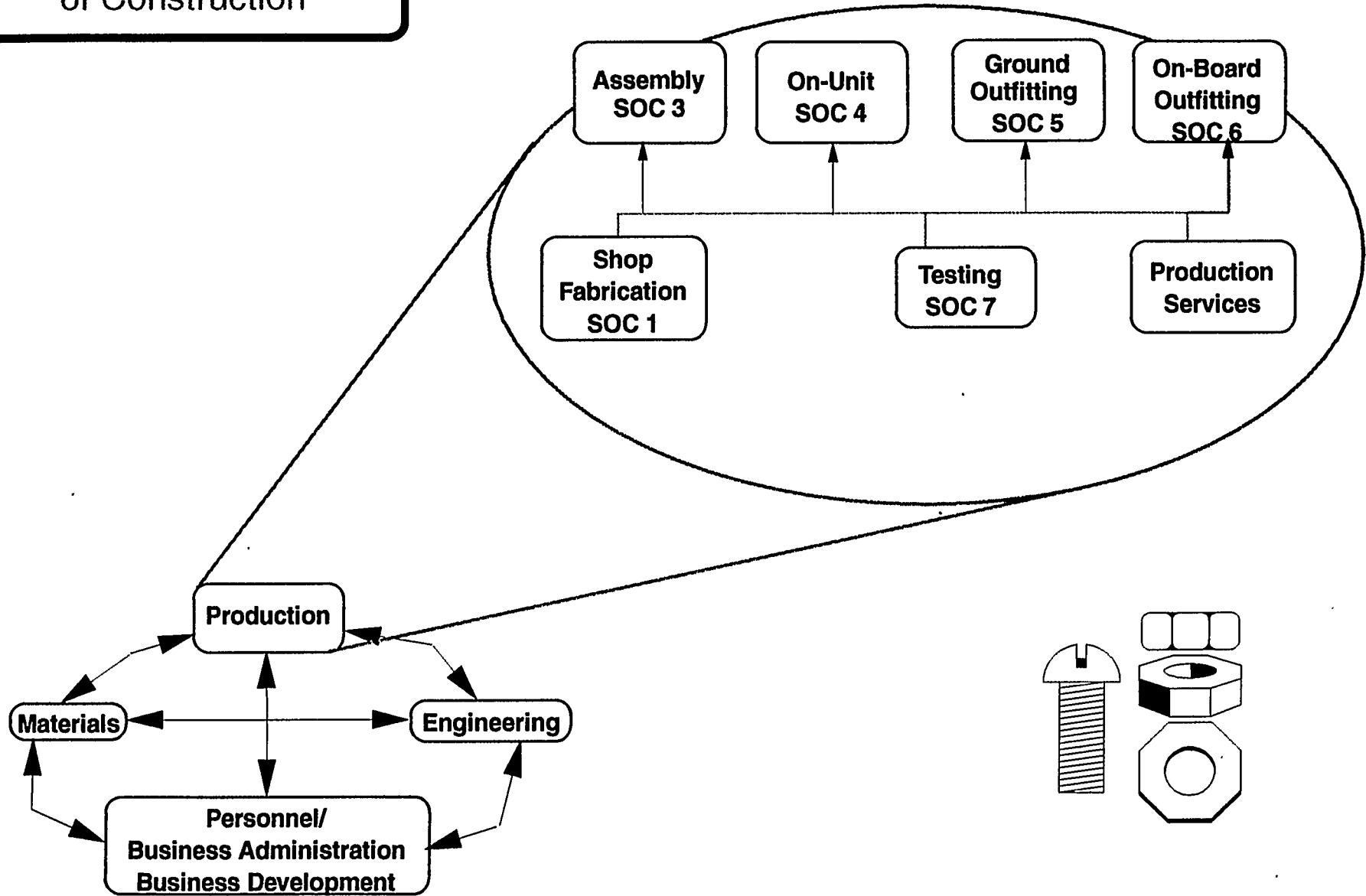


CHART 4 Planning system “Outfitting Model”

The main objective of Integrated Production Planning and Scheduling is to ensure that all systems being used by Materials, Planning, Engineering and Production have the capacity to exchange information and therefore provide a medium in which a critical path can be produced. See A Discussion of Critical Path in the Appendix, page 105.

The On-Block and On-Board strategies, which provide the basis of the schedule networks, are generated by Outfit Planning after close consultation with Production. The strategies are then reviewed, agreed upon and signed off by Production. The activities produced by the strategies are loaded into the project management software, Open Plan, which provides each activity with a schedule. Each activity, accompanied by its corresponding schedule, are loaded into MacPac.

MacPac is the material system now being utilized at NASSCO. The planners palletise all the material loaded by Engineering and then hook each pallet to its appropriate activity. The Planners also provide each pallet with a schedule which falls within the dates loaded from Open Plan. MacPac then uses these dates to drive demand for each pallet.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
Planning System
"Outfitting Model"

● **Master Scheduled Major Milestones**
i.e. Start of Construction,
Launch, Delivery etc.
● **Erection Schedule**

● **Open Plan On - Board Schedule Network**

On - Board Integrated Strategies

● **Open Plan On - Block Schedule Network**

On - Block Integrated Strategies

MacPac Top of Bill of Material + Schedule

Engineering Bill of Materials

Pallets for SOC 3, 4, 5, & 6

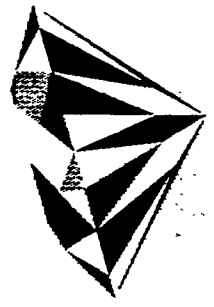


CHART 5 Open Plan Model

Open Plan is a project management software. It was chosen by NASSCO after being recommended in an NSRP project performed from within the company. The activities generated by the On-Block and On-Board strategies are loaded into Open Plan. The activities are then formed into a network by loading predecessor and successor relationships for each one. The network is then constrained by loading key master schedule dates against certain activities, such as, block erections, tests and trials, compartment close-outs etc. Open Plan will then process this information and provide a schedule for each activity within the constraints provided. Two sets of dates are generated. The early start and finish dates give the schedule as far left as possible, the late start and finish dates give the schedule as far right as possible. The difference between these two sets of dates provides the float.

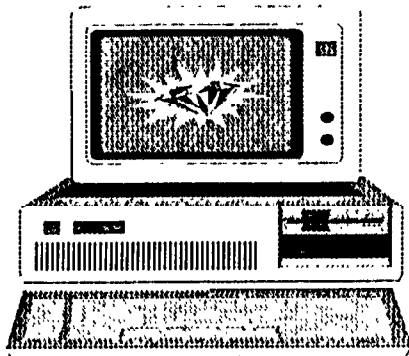
PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
IPPS
"Open Plan Model"

Tools Utilized: Software

Open Plan

Input

- Major Milestones & Erection Schedules
- Activities created by Strategies
- Relationships between activities & Major Milestones



Processing

Outputs

- Top of Bill of Materials Schedule
- Schedule constraints for Outfit Pallets

Controls/Feedback

Pallet Progress Information

CHART 6 Planning System “Mac Pac-Model”

One of the major advantages of MacPac over NASSCO'S old material system EBM, is that it is independent of the Labor Management System. This enables pallet dates to be adjusted to reflect reality, without altering the L.M.S. baseline. MacPac also provides better material visibility by generating a dispatch report that notifies each department with a responsibility for providing material exactly when and what it should be building. MacPac accomplishes this by back-scheduling from an installation need date, or pallet start date, using predetermined offsets that have been input by each support department respectively.

Another advantage MacPac has over E.B.M. is its ability to rollover information between hulls on a multi-ship contract. As adjustments were necessary on previous contracts a rollover of pallets could never be accomplished without a significant clean-up effort. MacPac utilizes a hull affectivity system that enables a change to be made for one hull, but not for follow ships. For example, a piece of material that is palletised to an SOC 5, On-Block, workpackage is not going to be available and therefore must be transferred to a SOC 6, On-Board, workpackage for the first ship. However, the material will be available for follow ships and the cost effective SOC is stage 5. MacPac enables you to make the change for the first ship, without changing pallets for follow ships.

The key to the proper utilization of MacPac is the manipulation of pallet schedules to reflect real life production needs and material availability, therefore providing increased material control. Open Plan provides the large portion of this dynamic scheduling information.

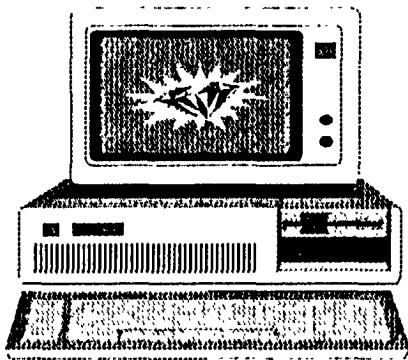
PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
IPPS
Planning System
"Mac Pac-Model"

Tools Utilized: Software

Mac Pac

Input

- Engineering Bill of Materials
- Top of Bill schedule provided by Open Plan
- Product control material availability, estimates & adjustments



Processing

Outputs

- Outfit Planning Workpackages
- Pallets of Material

Controls/Feedback

**Pallet Progress Information
inputted into Open Plan**

CHART 7 Process Team Development

By using the strategies that production has participated in and signed off on, the planners have an excellent framework that gives them a guideline from which they can set their pallets in the sequence that production requires them. Previously no such framework was provided, therefore planners experience or best guess was used.

The strategies also provide guidance on pallet schedules and durations.

The fundamental difference between Integrated Planning and previously used methods is the amount of work accomplished up front by small teams of engineers, planners and production supervision. Concurrent Engineering has started to be used on new contracts and has produced some excellent manufacturability issues. One of these areas has been in the definition of Interim Products. An Interim Product is a portion of the ship, usually” Unit, Block or Zone. The Concurrent Engineering team, working closely with production have developed a Work Breakdown Structure, or Interim product list that is geared towards manufacturability and ease of installation.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
IPPS
"Process Team Development"



Ž PROCESS TEAM DEVELOPMENT AND TASKS

- INTERIM PRODUCT DEFINITIONS
- REQUIREMENT AND UTILIZATION OF FUNCTIONAL SPECIALIST IN PROCESS ANALYSIS AND MAJOR STRATEGY DEFINITIONS
- UTILIZATION OF LESSONS LEARNED FROM SHIP TO SHIP ON GOING

CHART 8 Build Strategy Applications

On previous contracts the Build Strategy was developed by Steel Planning and Master Planning. Steel Planning devised the block breakdown using structural and facilities constraints as a guideline. Master Planning developed the Zone breakdown by using easily defined boundaries to split-up portions of outfitting work. For example, a typical Zone would be a certain deck level running between two major steel bulkheads.

By utilizing the Concurrent Engineering team the build strategy on our newer contracts has seen some adjustments. The Block breakdown, while continuing to respect structural and facilities constraints, now takes into account how to maximize On-Ground outfitting.

The Zone breakdown has changed significantly. Although most Zones are still defined by geographic location an attempt has been made to isolate areas that contain similar work content, i.e. Tank Zones. Other Zones have been created to account for large scopes of work that cross many geographical boundaries, but should not be broken down that way, i.e. Cable Pull Zones.

By utilizing these methods to create the build strategy NASSCO has realized the following benefits:

- Increased focus on specific scopes of work
- A strategy for every Interim Product.
- An increased awareness and understanding from production of the reasoning behind each Interim Product.
- A clearer definition, provided to planning via the strategies, of sequence required for similar work scopes, i.e. a tank and a cargo space will each have their own Interim Product number and strategy, as opposed to previous contracts where they might have been in the same geographic Zone.

An increased awareness and early input into build structure definition lays an important foundation at the start of any contract, particularly in the pursuit of meaningful critical path analysis. However problems such as material shortages etc. can still disrupt the program but impact analysis is more readily obtained.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application
IPPS

"Build Strategy Applications"

- **BUILD STRATEGY**
 - **STRATEGY**
 - **STANDARD ZONES**
 - **FUNCTIONAL ZONES**
 - **TANKS**
 - **VERTICAL ZONES**
 - **CABLE PULL ZONES**
 - **TEST / SHIP SYSTEMS**
 - **DELIVERY**

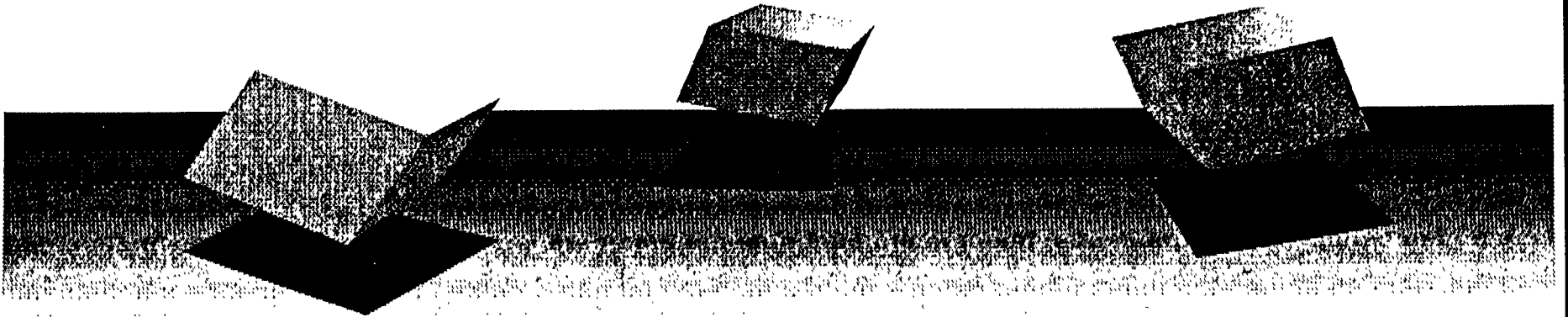


CHART 9 Summary-Basefine Status

This chart represents the evolution of the methods and systems used by Outfit Planning. The department has evolved from assigning material to blocks and zones to producing high level strategies, critical path and impact analysis and detail installation workpackages.

A key milestone in this progression was the formation of a process team made up of Planning and Production personnel. NASSCO was struggling to come to grips with the comet sequencing required to outfit the complex AOE class ships. This team was formed at a time when construction of the AOE 8 was about to begin, and lessons learned from the two previous ships needed to be incorporated into the plan.

Also at this time NASSCO was in the early stages of formulating a plan to implement a new materials system, MacPac. It became clear that in order to utilize MacPac's superior material control capabilities a high level framework for each Interim Product, which dictated sequence, would be required. The information being generated by the process team provided an excellent starting point for the high level strategies.

The strategies required for first of class vessels require a slightly different approach. The Outfit Planning strategists solicit help from production supervision who have experience working similar areas on previous ships. Although no two ship classes are the same, similarities in areas such as the engine room or berthing spaces always exist. For the purposes of high level strategies this method has proved successful.

Commitment from numerous departments is necessary to produce meaningful strategies, which involves a lot of time and effort. This time and effort spent early on in the planning evolution will hopefully save many more hours in the future. If management fails to resource this effort or allows production to deviate from the agreed upon sequence without just cause or communication with Planning, then these efforts will prove to be less effective.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

"Summary-Baseline Status"

PLANNING LEVEL	SHIP TYPE						
	AOE				SLNC		
	6	7	8	10	SLC	SLNC	MATSON
1.)EBM	√	√	√	X	X	X	√
2.) LMS	√	√	√	√	√	√	√
3.) Process Team (old NSRP Project	X	X	*	√	√	√	X
4.) Open Plan - Strategies	X	X	X/√	√	√	√	X
5.) MRP II Mac/Pac D	X	X	X	√	√	√	X
6.) Integrated Open Plan Rev/Mac/Pac D	X	X	X	√	√	√	X

Legend

- X Not Utilized
- √ Utilized
- * Steel laydown only
- ** 30 Zones only

CHART 10 Summary of Ongoing Implementation

This chart summarizes the ongoing efforts to utilize integrated planning and gives the areas in which substantial improvements are expected.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

**"Summary of Ongoing
Implementations"**

- **DETAIL STRATEGIES BY
THE TEAM [INFLOW PROCESS CHARTING]**
 - **INTEGRATED SYSTEMS FOR INTEGRATED PLANNING**
 - **MODELLING / CRITICAL PATHING**
 - **REPORTING / TRACKING /SCHEDULING MILESTONES**
 - **CONTINUOUS PROCESS IMPROVEMENT**
 - **SCHEDULE ATTAINMENT**
 - **MATERIAL PRODUCTION CONTROL DISCIPLINES**

CHARTS A - E Detail Analysis via Zones

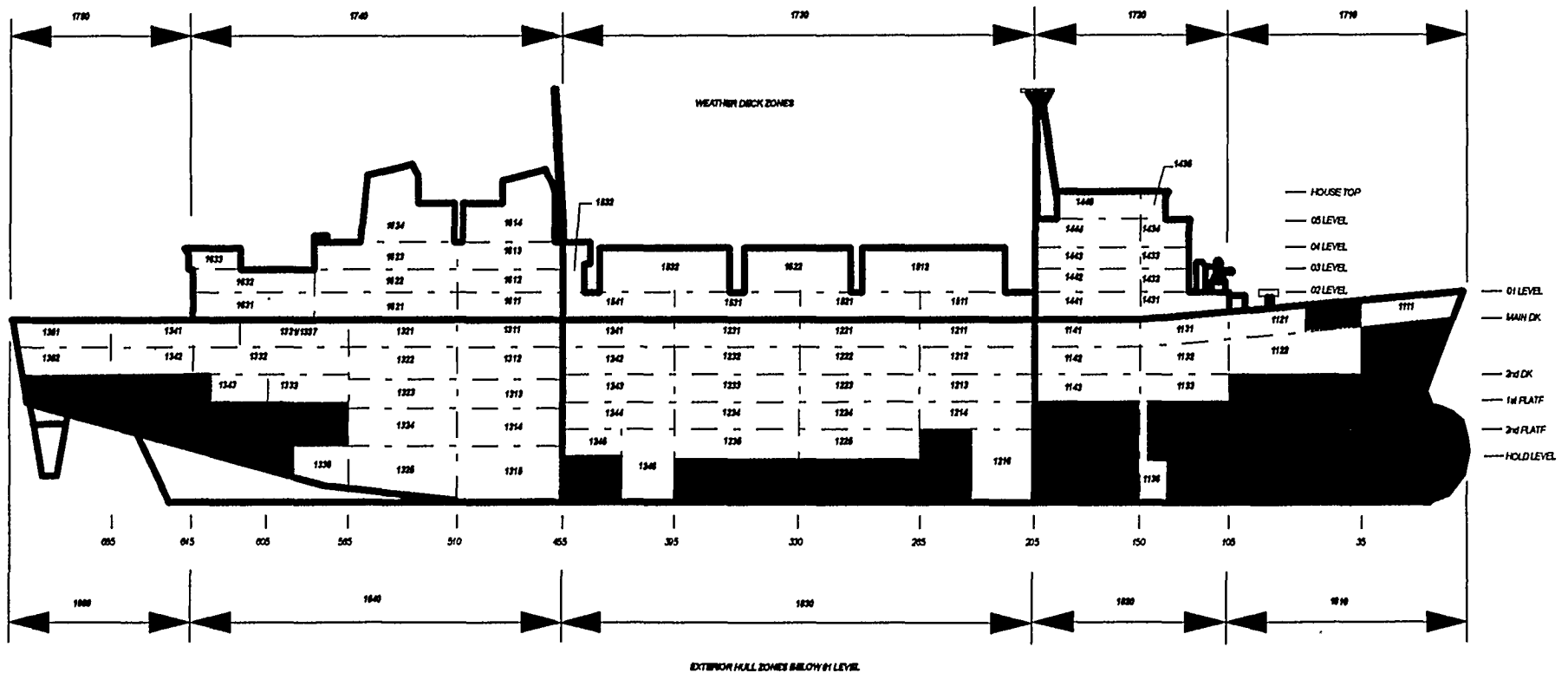
Work Breakdown Structure for On-Board has in the past consisted of Zones. The Zones were defined as geographical spaces split by deck level and major transverse bulkheads. Driven by difficulties encountered on previous hulls in workpackaging material and maintaining sequence the Zones are now split into the following categories (and Charts):

- (A) Standard Zones-same criteria as previous hulls, split by deck level and major transverse bulkheads.
- (B) Tank Zones-all structural tanks are a stand alone Zone. Provides increased visibility to production on work scope contained within tank and makes scheduling of compartment completion for each tank easier.
- (C) Vertical Zones-consists of spaces such as ladder wells and elevators. All work contained within vertical space is in the same time instead of being split into each horizontal zone that it passes through as on previous hulls.
- (D) Functional Zones-work that does not break down easily using geographical boundaries but represents a logical grouping of work
- (E) Cable Functional Zones-breaks down main and area main cable into the sequence in which it can be pulled. This sequence is predicated on Block erection and the presence of both source and destination for each cable.

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AOE 10 ZONE/FUNCTIONAL ZONE DEFINITION

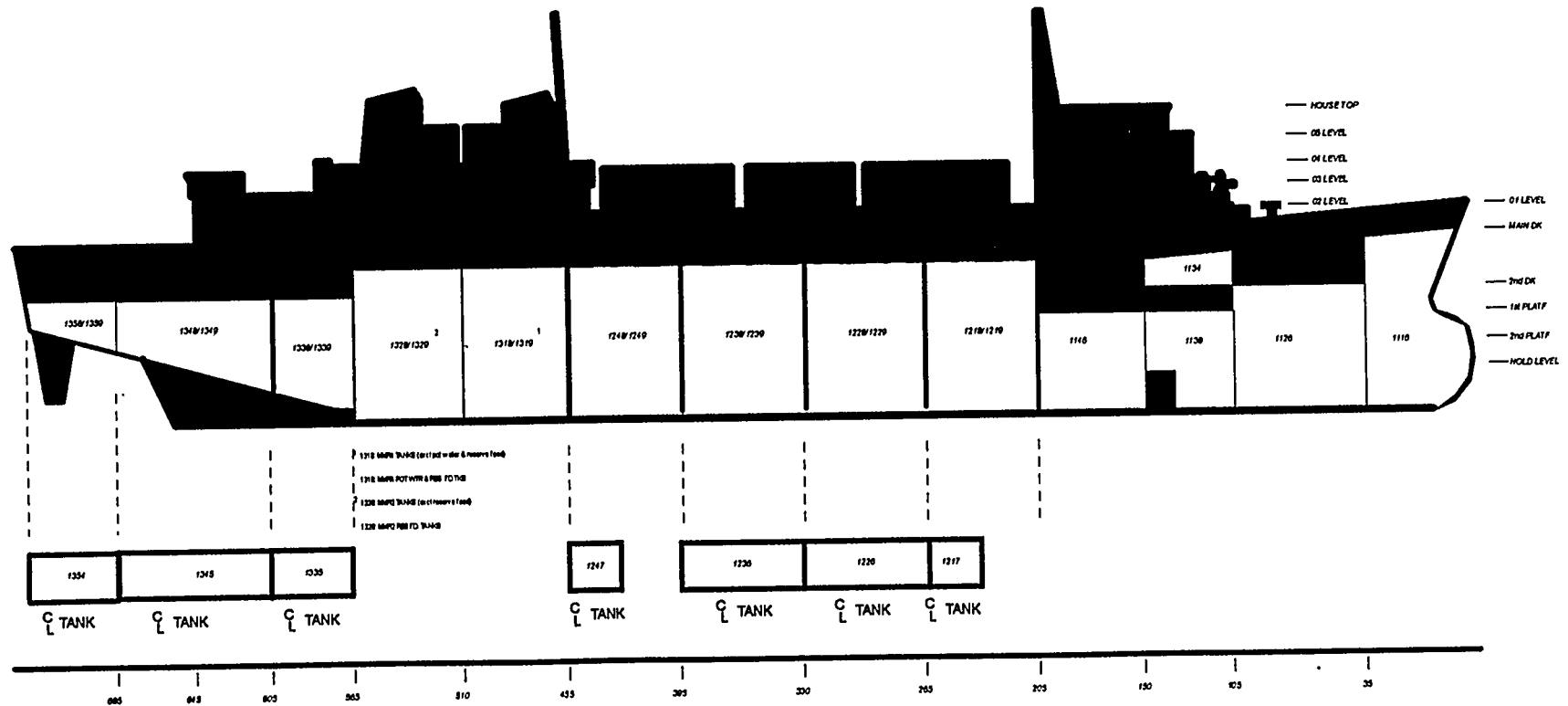
STANDARD ZONES



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Process Systems Application

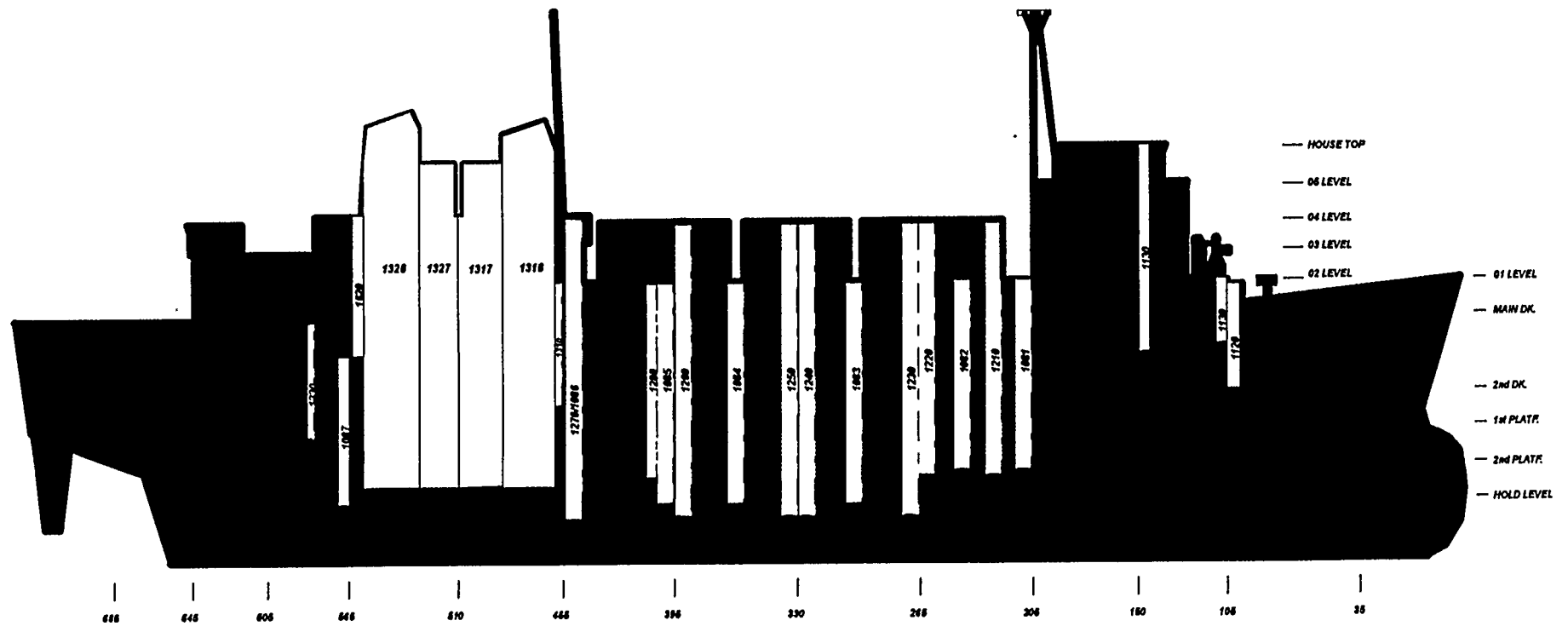
AOE 10 ZONE/FUNCTIONAL ZONE DEFINITION

TANK ZONES



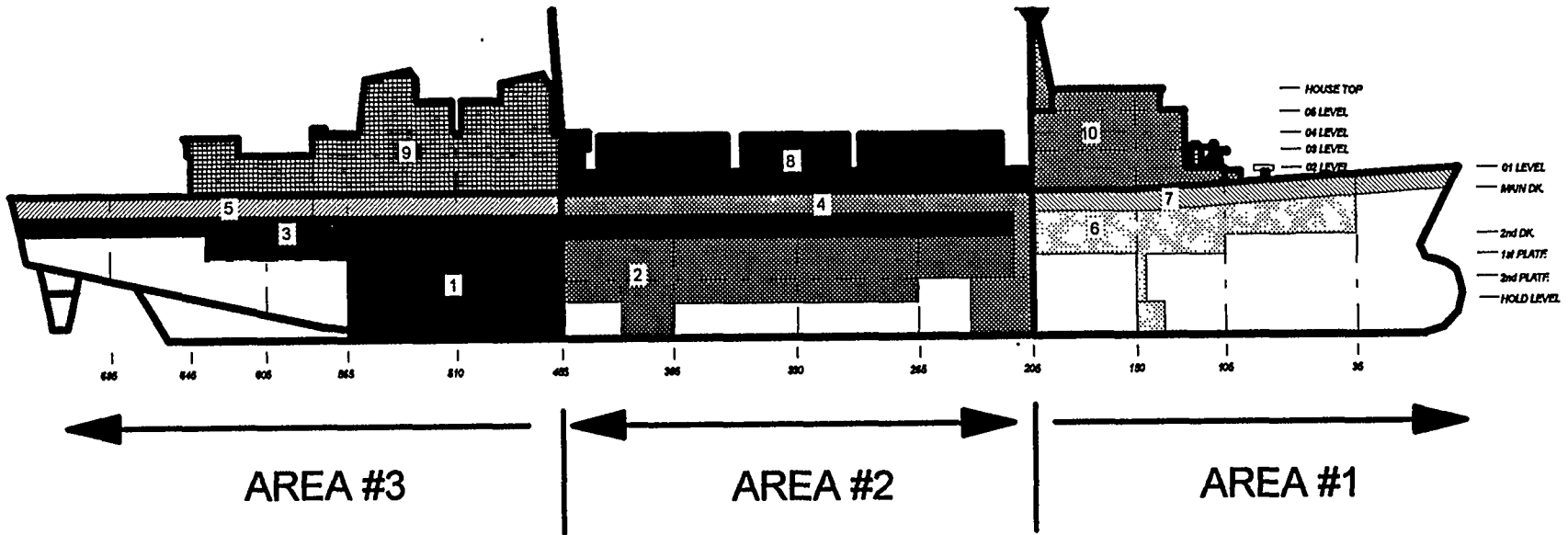
AOE 10 ZONE/FUNCTIONAL ZONE DEFINITION

VERTICAL ZONES



PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

AOE 10 ZONE/FUNCTIONAL ZONE DEFINITION CABLE FUNCTIONAL ZONES



Functional Zone 1050
 Main Cable Pull #1
 Main Machinery Spaces

Functional Zone 1051
 Main Cable Pull #2
 Cargo Stores and Dunnage
 Below 2nd Dk & CO PR

Functional Zone 1052
 Main Cable Pull #3
 Fr 205-Aft, 2nd Dk
 & Below 2nd Dk Aft of MMR's

Functional Zone 1053
 Main Cable Pull #4
 Fr 205-455, Main Deck
 and JP 5 PR *

Functional Zone 1054
 Main Cable Pull #5
 FR 455-Aft, Main Deck

Functional Zone 1055
 Main Cable Pull #6
 Fr 205-Fwd, Below Mn Dk
 & Aux PR *

Functional Zone 1058
 Main Cable Pull #7
 Fr 205-Fwd, Main Deck

* Note: Include Access Trunk

Note: Elevator cabling is structured to the elevator zone rather
 than the area cable functional zone.

Functional Zone 1057
 Main Cable Pull #8
 Fr 205-455, 01 Lvl and Above

Functional Zone 1058
 Main Cable Pull #9
 Aft House

Functional Zone 1059
 Main Cable Pull #10
 Fwd House

★ Functional Zone 1060
 DEGAUSSING CABLEING

The main cable pull functional zones are derived from the sequence in which cable pull occurs. Cable pull through these zones is cumulative. Specific pulls are packaged to the highest main cable pull functional zone in which the circuit appears, i.e. a circuit going from the MMR (Area #1) through the main deck midbody (Area #4) to the Aux Pump Room (Area #6) would be packaged to Functional Zone 1055 - Cable pull #6.

The area cable pull functional zones represent pulls that have both source and destination within the given area

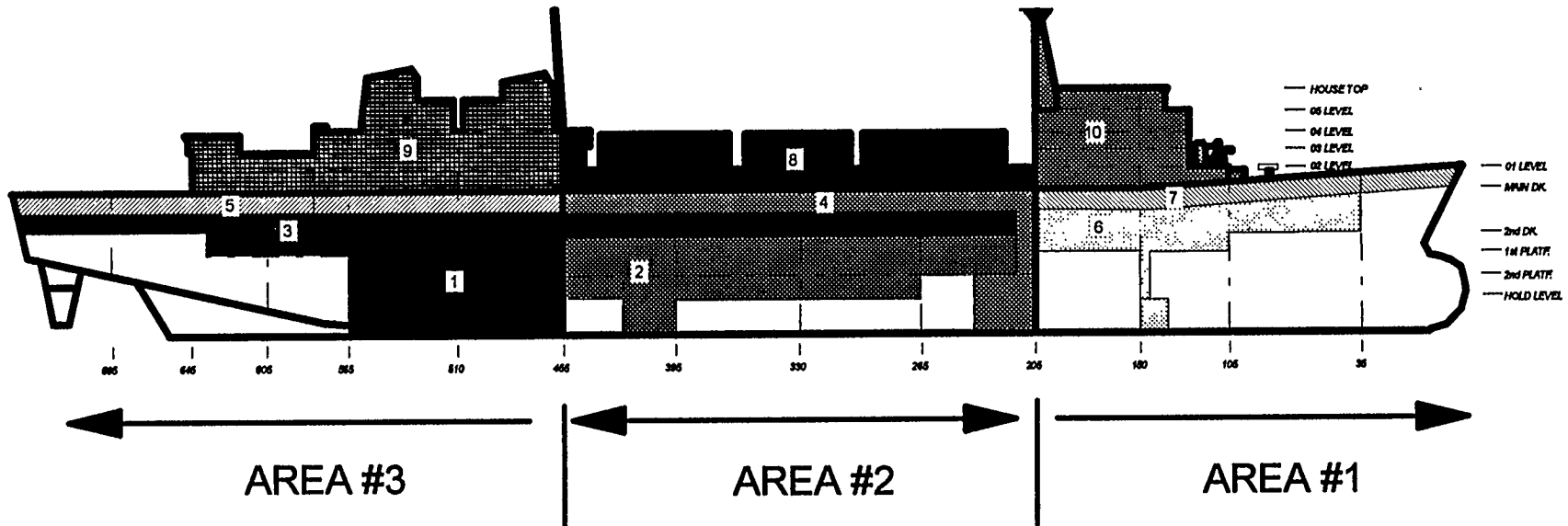
★ Functional Zone 1061
 AREA MAIN CABLE-AREA #1
 Frame 205, Forward

★ Functional Zone 1062
 AREA MAIN CABLE-AREA #2
 Frame 205 to Frame 455

★ Functional Zone 1063
 AREA MAIN CABLE-AREA #3
 Frame 455, Aft

AOE 10 ZONE/FUNCTIONAL ZONE DEFINITION

CABLE FUNCTIONAL ZONES



- Functional Zone 1050
Main Cable Pull #1
Main Machinery Spaces
- Functional Zone 1051
Main Cable Pull #2
Cargo Stores and Dunnage
Below 2nd Dk & CO PR
- Functional Zone 1052
Main Cable Pull #3
Fr 205-Aft, 2nd Dk
& Below 2nd Dk Aft of MMR's
- Functional Zone 1053
Main Cable Pull #4
Fr 205-455, Main Deck
and JP 5 PR *
- Functional Zone 1054
Main Cable Pull #5
FR 455-Aft, Main Deck
- Functional Zone 1055
Main Cable Pull #6
Fr 205-Fwd, Below Mn Dk
& Aux PR *
- Functional Zone 1056
Main Cable Pull #7
Fr 205-Fwd, Main Deck
- Functional Zone 1057
Main Cable Pull #8
Fr 205-455, 01 Lvl and Above
- Functional Zone 1058
Main Cable Pull #9
Aft House
- Functional Zone 1059
Main Cable Pull #10
Fwd House
- Functional Zone 1060
DEGAUSSING CABLEING

* Note: Include Access Trunk

Note: Elevator cabling is structured to the elevator zone rather than the area cable functional zone.

The main cable pull functional zones are derived from the sequence in which cable pull occurs. Cable pull through these zones is cumulative. Specific pulls are packaged to the highest main cable pull functional zone in which the circuit appears, i.e. a circuit going from the MMR (Area #1) through the main deck midbody (Area #4) to the Aux Pump Room (Area #6) would be packaged to Functional Zone 1055 - Cable pull #6.

The area cable pull functional zones represent pulls that have both source and destination within the given area

- Functional Zone 1061
AREA MAIN CABLE-AREA #1
Frame 205, Forward
- Functional Zone 1062
AREA MAIN CABLE-AREA #2
Frame 205 to Frame 455
- Functional Zone 1063
AREA MAIN CABLE-AREA #3
Frame 455, Aft

Actual Planning System Output for a Zone

The standing practice for Zone Scheduling is produced by Master Planning and basically provides large windows for each product category to accomplish its outfitting. This is then used by the detail planners as a guideline with which to schedule the pallets. All pallets have to have schedules that fit into the window provided.

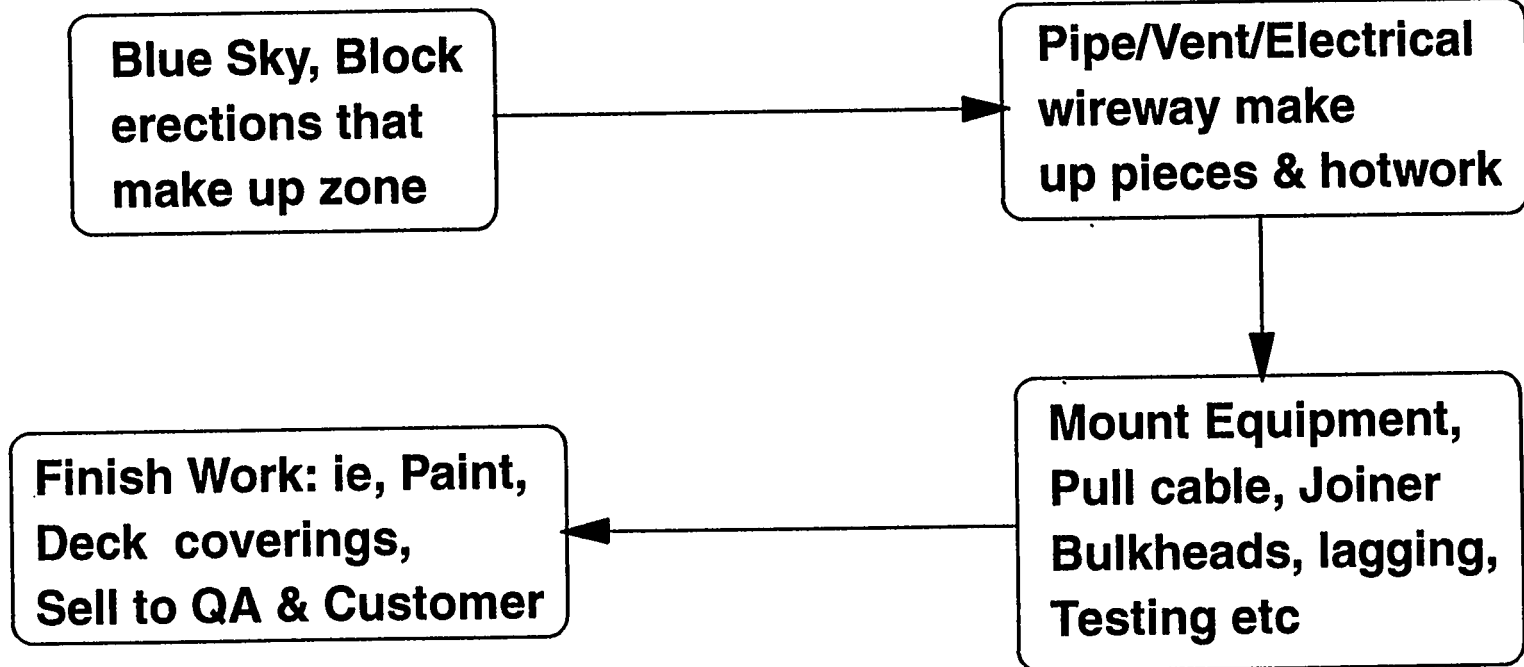
This scheduling practice makes it extremely difficult for outfit planning to establish and then maintain any kind of sequencing between the pallets. The onus for sequencing work with this practice is therefore thrust upon production.

CHART F On-Board Strategy Methodology

This chart represents the overview of the method devised by Outfit Planning to break down the major portions of the work into smaller more manageable work segments. This leads directly into the next two charts.

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

**"On-Board Strategy
Methodology"**



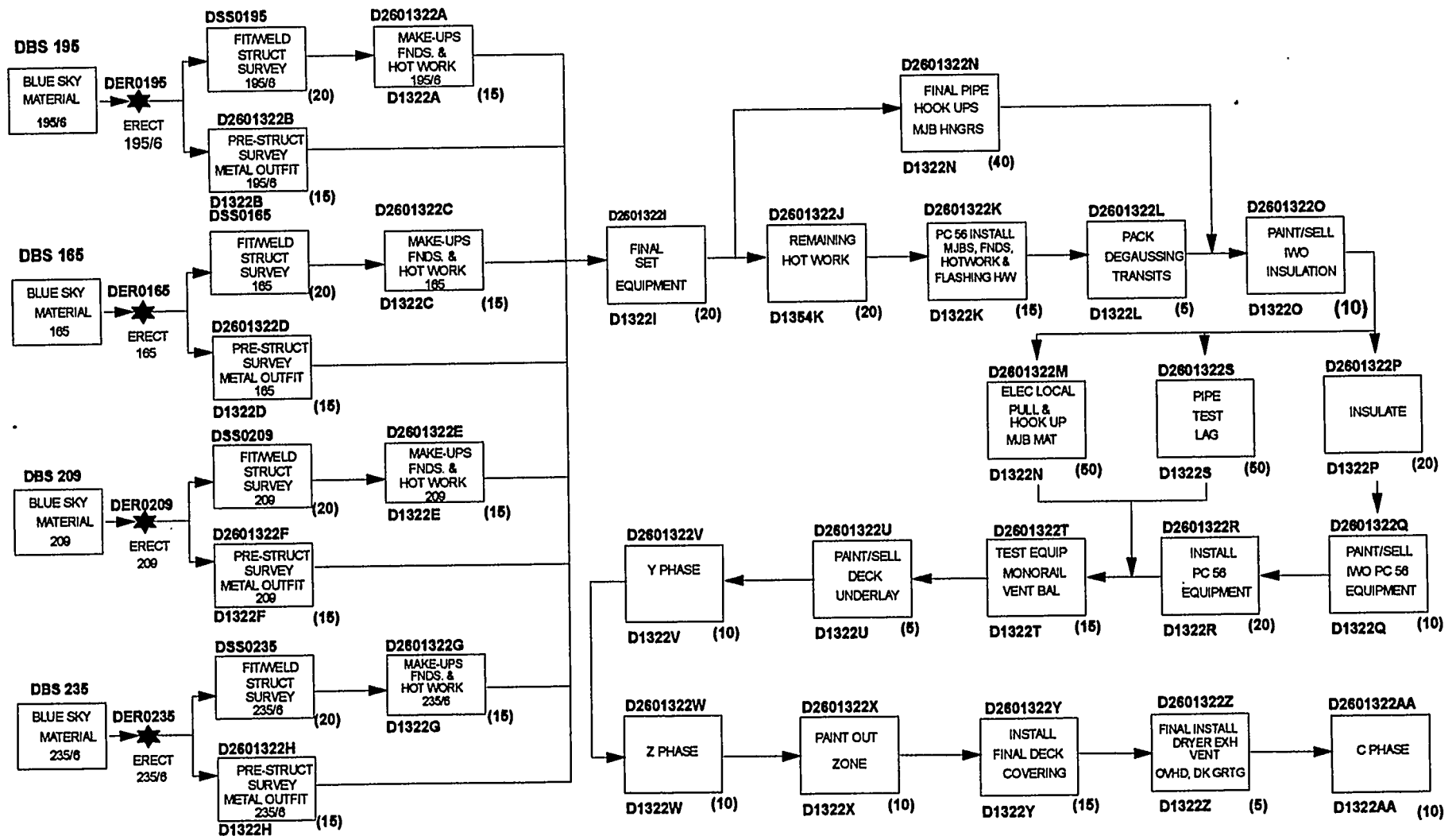
CHARTS G and H Actual Zone Detailed Examples

These are the detail needed to support the final Work Packages. These charts represent the very focus of the IPPS system (the system product).

PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

AOE 10 ON-BOARD
HIGH LEVEL PLANNING STRATEGY
ZONE 1322

FINAL INSTALLATION OF BERP PLATES TO TAKE PLACE
 AFTER ADJACENT COMPARTMENTS ARE C PHASE COMPLETE



REPORT: ACTES

ACTIVITY LISTING by ACTIVITY NUMBER

REPORT DATE:16MAY94

PROJECT: ACE10FLN

ACE10 OPEN PLAN PLANNING MODEL

TIME NOW:01FEB94

ACTIVITY	REM ORIG		DESCRIPTION	CODE 1	CODE 2	EARLY	EARLY	LATE	LATE	TOTAL
	DUR	DUR				START	FINISH	START	FINISH	FLOAT
D2601322A	15	15	M/U'S, FMS, HWK FOR 195 & 196			18JUL95	07AUG95	10AUG95	30AUG95	17
D2601322AA	10	10	C PHASE			07JUN96	20JUN96	07JUN96	20JUN96	0
D2601322B	15	15	PRE-STRUCT SURV MTL O/F 195/196			26JUN95	17JUL95	10AUG95	30AUG95	32
D2601322C	15	15	M/U'S, FMS, HWK FOR 165			03AUG95	23AUG95	10AUG95	30AUG95	5
D2601322D	15	15	PRE-STRUCT SURVEY MTL O/F 165			13JUL95	02AUG95	10AUG95	30AUG95	20
D2601322E	15	15	M/U'S, FMS, HWK FOR 209			03AUG95	23AUG95	10AUG95	30AUG95	5
D2601322F	15	15	PRE-STRUCT SURVEY MTL O/F 209			13JUL95	02AUG95	10AUG95	30AUG95	20
D2601322G	15	15	M/U'S, FMS, HWK FOR 235 & 236			10AUG95	30AUG95	10AUG95	30AUG95	0
D2601322H	15	15	PRE-STRUCT SURV MTL O/F 235/236			20JUL95	09AUG95	10AUG95	30AUG95	15
D2601322I	20	20	FINAL SET EQUIPMENT			31AUG95	28SEP95	31AUG95	28SEP95	0
D2601322J	20	20	REMAINING NETWORK			29SEP95	26OCT95	29SEP95	26OCT95	0
D2601322K	15	15	PC 56 MJB'S, FMS, FLASHING HWK			27OCT95	16NOV95	27OCT95	16NOV95	0
D2601322L	5	5	PACK DEGAUSSING TRANSITS			17NOV95	27NOV95	17NOV95	27NOV95	0
D2601322M	50	50	ELEC LOCAL PULL & HOOK-UP			12DEC95	27FEB96	12DEC95	27FEB96	0
D2601322N	40	40	FINAL PIPE HOOK-UPS, MJB HANGERS			29SEP95	27NOV95	29SEP95	27NOV95	0
D2601322O	10	10	PAINT/SELL TWO INSULATION			28NOV95	11DEC95	28NOV95	11DEC95	0
D2601322P	20	20	INSULATE			12DEC95	16JAN96	12DEC95	16JAN96	0
D2601322Q	10	10	PAINT/SELL TWO PC 56 EQUIPMENT			17JAN96	30JAN96	17JAN96	30JAN96	0
D2601322R	20	20	INSTALL PC 56 EQUIPMENT			31JAN96	27FEB96	31JAN96	27FEB96	0
D2601322S	50	50	PIPE TEST LAG			12DEC95	27FEB96	12DEC95	27FEB96	0
D2601322T	15	15	TEST EQUIP, MONORAIL, VENT BALNC			28FEB96	19MAR96	28FEB96	19MAR96	0
D2601322U	5	5	PAINT/SELL DECK UNDERLAY			20MAR96	26MAR96	20MAR96	26MAR96	0
D2601322V	10	10	Y PHASE			27MAR96	10APR96	27MAR96	10APR96	0
D2601322W	10	10	Z PHASE			11APR96	24APR96	11APR96	24APR96	0
D2601322X	10	10	PAINT OUT ZONE			25APR96	08MAY96	25APR96	08MAY96	0
D2601322Y	15	15	INSTALL FINAL DECK COVERING			09MAY96	30MAY96	09MAY96	30MAY96	0
D2601322Z	5	5	FINAL INSTL DRYER EX VENT, OVHD			31MAY96	06JUN96	31MAY96	06JUN96	0

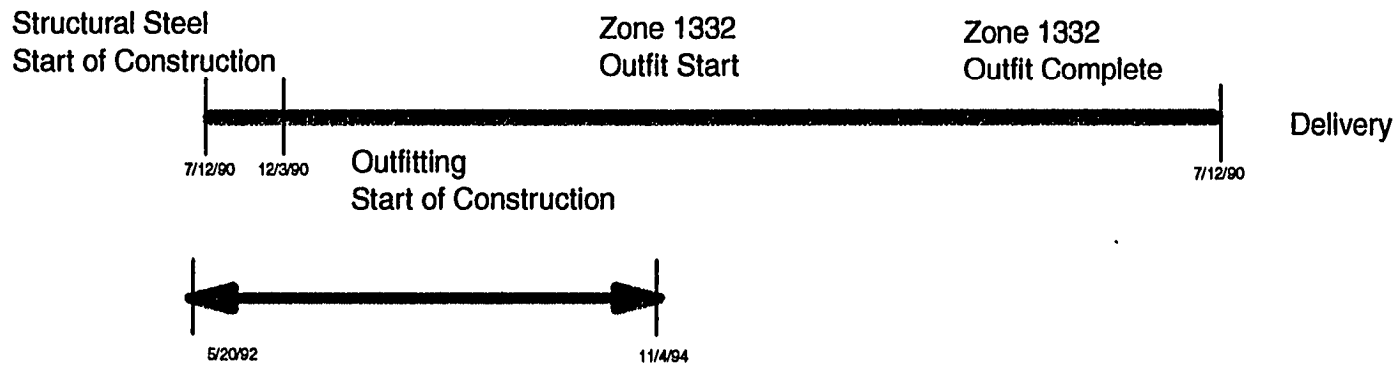
CHART I Zone 1332 - AOE 8 vs AOE 10 Schedule Comparison

The chart clearly shows the throughput effects that are expected. The 59% cycle time reduction is typical for all outfitting and the labor impacts and potential will need close management and direction. Experience will afford additional potential.

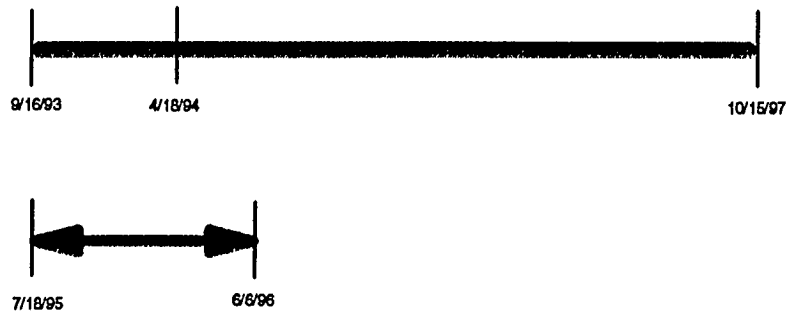
PROJECT: SP - 8 - 92 - 4 PTI
Process Systems Application

Zone 1332 -
AOE 8 vs AOE 10
Schedule Comparison

AOE 8



AOE 10



Conclusion

The foundations of Production Throughput Improvement are based upon process improvements which compress time and lower costs. This is accomplished” by continuous process improvement. This is exactly such an exercise. The constraints of a system were recognized and major improvements were accomplished. And, the process continues on the path of “contiuous improvement”.

Production Throughput Improvement (PTI) and Reengineering has only begun. The throughput improvement via IPPS, Integrated production Planning Systems, yields the following:

The opportunity for real production Throughput Improvement.

These systems are far from being fully defined, computerized, implemented, and committed. However, these are a continuing successful pilot and shall provide valuable experience and lessons learned.

These NASSCO and PTI project efforts can be related directly to any basic startup for reengineering. These are: *Fundamental Radical, Dramatic, and Process based*

GLOBAL CHANGE of the TOTAL PROCESS:
The Measure of Throughput is called
“World Class Ship Manufacture”
This Must be Addressed at the Highest Level
of the Organizational Process

A subsection Report for
NSRP project SP-8-92-4
Production THROUGHPUT IMPROVEMENT

Presented by
NATIONAL STEEL AND SHIPBUILDING COMPANY
San Diego, CA

Global Change of the Total Process

This segment of the project contains possibly the most important work that was done, and yet may be most difficult to understand and initiate as a methodology, or more correctly stated, a group of methodologies. The project was not intended to delve into the questions, “IS this true? Why is it true?” However, in the opinion of the researchers it appears to be so, because questioning the “global nature” of a shipbuilding organization is to question and “put into doubt” *everything*.

Global was defined in the Executive Summary to mean *corporate or company* as a whole, and represents that level of doing business or systems which involve the CEO and senior executive management of a given organization. Unlike the other three methods addressed in this project, this part is fundamentally applicable only from the “top”. This doesn’t imply that a yard must take on everything it does at one time. That is not only impractical, it is also probably impossible. The Global Methodologies can be worked with *organizational and system sub-sets*, however, these can only be accomplished with *total and complete cross functional participation and commitment*, which is derived only from the very highest management level.

Removing local and intermediate constraints is necessary, however, if global constraints are not removed no Throughput Improvement will be accomplished

The industry is very interested in *Concurrent Engineering*. If applied thoroughly and with great discipline these concepts can improve throughput. But, note that this is not only about engineering, but about materials, planning, manning, etc. as well. Therefore, any hope for success with concurrent engineering can not be placed on the shoulders of the Engineering management alone, but requires the equal commitment and energy of the total organization. This is *global*.

For these reasons, the project staff adopted *concurrency as an all* encompassing title for that global activity which compresses cycle times for the whole production process.

Beyond Shipbuilding

It appears that there is no choice but for the industry to change, the competitive gap is great, time is critical. This project shows that each yard can pick what will work best, there is much from which to choose. The inevitable need is a 100% (*up front*) *commitment*.

The project looked into *outside sources*, those industrial activities beyond the shipbuilding horizon. The best information comes from several sources: organizations that have *made the necessary change* or *seek to make the necessary change*, and *methods for accomplishing the necessary change*.

The published information available is overwhelming. As a service to efficiency, the project has produced a bibliography (Appendix), a synoptic review of selected works, and a glossary of terms. The following is the result of extensive reading, interviews with consultants (who

work with the subject methods and techniques), authors, and users, and discussions with industry executives and managers.

Book Reviews and Synopses

This gives the Title, Author, Publisher, and project staff overview.

Title

The Goal

Authors

Eliyahu M. Goldratt and Jeff Cox

Publisher

North-River Press, INC Croton-on-Hudson New York NY 1992 (second edition)

Overview

This is a very successful, well written and read basic business book. The presentation in a novel format provides a successful environment to educate the reader. Goldratt and Cox are able to show that the scientific approach to management takes place in the every day work of business managers, and in their personal lives, as well.

Goldratt is world known for his “Constraints Theory” which has been referred to in the project work. This is a straight forward approach to the kind of thinking that must take place at all levels of the organization in order to address throughput improvement. “Find what is constraining the process and remove that cause”.

This is the kind of book that can be on the “required reading list” of your yard. The global type issues for a shipyard are not addressed here, but this is certainly stimulating for managers throughout the organization.

Title

What is this thing called “Theory of Constraints” and how should it be implemented

Authors

Eliyahu M. Goldratt

Publisher

North River Press, INC., Croton-on-Hudson, New York NY 1990

Overview

A follow up to The Goal. Goldratt develops the Theory of Constraints called TOC. This has some simple bullet charts depicting the approach and methods of TOC application. It is the basic sales pitch to the readers of The Goal.

The staff found this weak for application by a shipyard for serious top level cultural change. Shipyards do not need more classifications of constraints. This one is recommended only for academic purposes.

Title

Competitiveness Through Total Cycle Time: An Overview for CEO's

Authors

Philip R. Thomas with Kenneth R. Martin

Publisher

McGraw-Hill Publishing Company New York NY 1990

Overview

This book as The Goal did, utilizes the scientific approach within a novel format, and quite successfully. The terminology and simplicity of the basic theories and disciplines being presented give ready applicability and understanding to the whole effort.

The alignment with TQM might be the weakest feature, but this is greatly overtaken by its basic simplicity relative to the real issues of throughput. The application potential and success for shipbuilding can be derived from the approaches depicted in this book Thomas also has written books intended to assist managers at other non-global levels.

This book and the methodology of *Total Cycle Time* is recommended for consideration by every shipyard.

Selected Highlights

Preface Page xi - "The culture changes effected included a change in mind set, requiring people to think in terms of radical change instead of incremental changes, to consider how to make the giant leap from weeks of time to hours...."

Basic Foundations: 1. Total Cycle Time, 2. Entitlement Baseline, 3. Cycles of Learning.

The Three Loops; make/market loop, design development loop, strategic thrust loop, are interlocking; and within each loop are various cycles, each of which approaches to the outline above. [(page 32) We can scan and reprint the charts on pages 33, 34, 35, 37]

"Cultures, not people are the problem!" (page 140)

Title

Reengineering the Corporation: A Manifesto for Business Revolution...
Forget What you know about how a business should work—
Most of it is Wrong!

Authors

Michael Hammer & James Champy

Publisher

Harper Business, Harper Collins Publishers, New York NY 1993

Overview

This book sets forth the logical approach to global implementation of a most challenging concept for change. Instead of utilizing a novel format, the authors have provided strategically well written case histories and examples of consulting engagements.

The book is very strong on the importance of processes, as well as, being very forward and honest in stating that change has *personnel reduction movement and resentment*. The authors provide a realistic overview of the necessary total commitment from top management for change.

Reengineering is and will continue to be one of those catch words in the American business lexicon that evoke great discomfort and consternation. That is, until U. S. businesses feel World Class status has been attained. This is highly recommended reading.

Selected Highlights

(The data given in the definitions is quite sufficient.)

This is the must read publication!!!!

Title

Post-Capitalist Society

Author

Peter F. Drucker

Publisher

Harper Business, Harper Collins Publishers, New York NY 1993

Overview

Peter Drucker has been writing to American and World business management for the second half of the nineteenth century. This book maybe one of his most scholarly works.

This one is probably not for everyone, but it is powerful and should be studied by those with responsibility for the overall business outcome. Drucker provides a thorough philosophical basis and history for the cultural changes now taking place, particularly in American and western society, business and industry.

This is not about a social based economic system replacing capitahn, that was tried for 100 years and failed. It is about the extreme evolution of what has been known and accepted as capitalism. It is about a new knowledged-based capitalism and a society in which both capital and the upper labor class are knowledge based. The balance of labor is serviced-based. *The implications for any world class business are important*

The motto “Knowledge is Power” might be the byline for Drucker’s book He does a great service by adding dynamics to this old quotation. This is recommended as a compliment to the other recommended readings.

Selected Highlights

Page 91— *“By now we have learned that those who actually do a job know more about it than anybody else. They may not “know how to interpret their knowledge, but they do know what works and what does not. And so, in the last forty years, we have learned that work on improving any job or task begins with the people who actually do the work They must be asked ‘What can we learn from you? What do you have to tell us about the job and how it should be done? What tool do you need? What information do you need? Workers must be able to take responsibility for their own productivity and to exercise control over it.” (Drucker is a good Industrial Engineer !)*

Page 93— *“Improving the productivity of knowledge workers and service workers will demand fundamental changes in the structure of organizations. It may even require a totally new organization.”*

“Reengineering the team so that work can flow properly will lead to elimination of most management layers.”

Title

“Relevance Lost”-The Rise and Fall of Management Accounting

Author

H. Thomas Johnson & Robert S. Kaplan

Publisher

Harvard Business Scholl Press, Boston, MA. 1987

Overview

This book has been established as the cornerstone for change in many U.S. corporations. The authors are very thorough in their challenges of well established accounting methods, setting forth the types of change required. Their research and analysis of past and current accounting practices and the negative effects these have had on business decision-making is most profound.

The presentation makes easy reading, and provides a clear understanding of all responsibilities and levels of management. The current prominence of *Activity Based Costing* was the result of the acceptance of this book.

Selected Highlights:

The last three chapters 9 "The New *Global Competition*" ...10 "*New Systems for Process Control and Product Costing*" . . . 11 "*Performance Measurement Systems for the Future*", should be read, and considered for application.

Title

“common Cents”-The ABC Performance Breakthrough–How to Succeed with Activity Based Costing

Author

Peter B. Turney

Publisher

Cost Technology, Hillsboro, OR 1991

Overview

This book is a basic for Activity-Based Costing, which is the widely accepted standard element for change in any current reengineering endeavor. This author has been well received, and the book is the acknowledged textbook on activity analysis.

Please note that all processes are made up of elemental activities. This provides a basic correlation for cost and process analysis.

Selected Highlights:

Page 53-World Class - Definition and applicable discussions.

“Its clear that yesterdays cost systems don’t work in todays competitive environment. This is because global competition% technological change, and information system development have radically changed the rules of the marketplace.”

“There have been equally dramatic changes in the way companies are coping with the competitive challenge. The phrase ‘world class’ defines a new way of doing business, one that embraces continuous improvement in all aspects of a company's business. And the goal of the ‘world-class’ company is to profitably meet the needs of its customers.

But, new ways of doing business demand new ways of measuring performance. The ‘world-class’ company needs information that:

- Shows what matters to its customers (such as quality and service),
- Reveals how profitable its customers and products are,
- Costs a reasonable amount to report,
- Identifies opportunities for improvement, and
- Encourages actions that enhance meeting customer needs profitably.

Criteria of World-Class’ cost in formation

- Customer focused
- Reveals sources of profit
- Economical
- Identifies opportunities
- Encourages improvement

Why conventional cost systems fail

- Indirect, No information about activities, Too late.
- Plant activities only, Inaccurate product costs, No customer costs.
- Intrusive, Many unnecessary transactions.
- Direct labor focus, Little information about activities, Functional silos.
- Promotes excessive output and poor quality, Functional myopia, Misdirected effort, The death spiral.

Page 98–Figure 4-2 “The ABC Model”

Page 104 Forward- "The Process view of ABC”

Page 373 Forward-Steps to Success (28) Figure 15-1 The 28 Steps to Success (we can scan and edit for reprint); Figure 15-2 The 22 Steps to Successfully Designing the ABC Model; Figure 15-3 Achieving the ABC Performance breakthrough.

Title

Infrastructure in Shipbuilding Report on Initial Findings-Parts I & II

Author

Z.J. Karaszewski & M. Wade

Publisher

DTRC, Systems Department 1-91

Overview

This is a comprehensive study of U.S. Shipbuilding which documents the infrastructure by utilizing the IDEF methodology. The study involved various shipyards, organizations and individuals.

It is an invaluable reference document for what is really involved in U.S. Shipbuilding. Please note that most major reengineering endeavors rely on an IDEF type model. One such model was defined in this study and should be referenced and validated for inclusion in any reengineering endeavor for U.S. Shipbuilding. This will save the time and effort of any new IDEF study.

Related Reference/Discussion

There now exists a number of comprehensive, software programs which help companies develop and get into reengineering, via the software business process. One leading product is from Meta Software, of Cambridge, MA. This software can model the current structures of any organization with IDEF level modeling, and develop comparative costing data with application of ABC modeling. These are strategic planning tools for change.

Title

IIE - Publications

Author
various

Publisher
Institute of Industrial Engineering

Overview

The Industrial Engineering function and its parent organization the IIE are common resources utilized by most U.S. companies involved in Business Process Reengineering. The U.S. Shipbuilding industry has not consistently utilized this highly qualified resource.

From the SNAME and NSRP perspective, it is important to note that this project is from the Industrial Engineering Panel SP-8. The utilization of resources of this panel is highly recommended.

(Please refer to the Bibliography in the Appendix for specific articles.)

Title

Periodical Readings

Author
various

Publisher
various

Overview

In recent years a large number of major corporations, of every size, in every industry has gone through cultural change and reengineering to become competitive in their global market. Many periodical publications have articles relating to these vast numbers of experiences. It is incumbent upon this project to selectively review some of these for this study.

Further Comment

The resources beyond the shipbuilding industry are exhaustive. Some information is far more directly applicable than other information, and there is no substitute for involved and committed research on the part of a specific yard. This project has been a serious part of the undertaking to evaluate and set forth high quality *global* impacting potentials for improving throughput. The staff holds great faith that these sources will be of value even though it is recognized that other quality information exists.

In the judgment of this collective work the best methods emphasize: Process Analysis, *Leadership, Long Term Commitment, Empowerment* and, stress the elimination of *micro management* and *tampering*.

Europe and the Pacific Basin

It is important to note that benchmarks from the Pacific Basin and Europe were used to describe *world class commercial shipbuilding* as a base of reference for our industry. There appears to be great danger in too often looking for benchmarking of the *outside yard* or the yards beyond the U.S. Industry for the best changes to make. World Class is a moving, ever advancing dynamic, and therefore will ultimately require a *quantum step* on the part of each yard, in its own evolving program. This means *original thought and action, a new benchmark*. And, why not? If a global reengineering can offer the best in new opportunities, why shouldn't the resulting process be an *originator*?

The key principles in all successful *world class methods* applied *globally* are

SYSTEM-Each yard has a Shipbuilding System used to manage the engineering, planning and scheduling, procurement, and production functions required to produce a given ship or group of ships.

PROFOUND KNOWLEDGE-Each yard's System functions at all levels upon The Profound Knowledge, individually and collectively, of the members of the yard organization, the yard data base, and outside information.

QUALITY-Quality suggests the degree of success of that system and knowledge in producing a ship.

If not measured by the system, it is certainly measured by the customer, the effectiveness of the system, and the throughput. This is another way to describe *the process*. *If the yard throughput is not satisfactory, is not on a World Class level.*

The Manufacture of Ships

It is the stated intention of the U.S. Shipbuilding Industry to attain World Class Throughput. In order to fully accomplish this, our yards must manufacture ships. By designing, engineering, planning, procuring, and providing facilities for manufacture, highly effective

and efficient total yard systems can be developed. World class shipbuilding manufactures ships and measures itself in those terms.

Only at the most *global* decision-making level of the yard, company, or corporation can the commitment to *manufacture be* appropriately made. It means committing long term capital to facilities and product design, stabilization of certain skilled manpower, new creativity in labor structure (and contracts), forceful engagement in the regulations sector, and development of a manufacturing/marketing mind set. The latter requiring design and engineering responses that are fractions of historic time cycles. Standard data at every function of the business will be required. And, *concurrent systems using* yard-wide electronic CAD/CAM/SIM or Totally Integrated Manufacturing Systems will be needed.

Global shipbuilding strategies developed by companies in both Europe and the Pacific Basin have been accomplished primarily through three actions:

- 1) Determine what classes of ships to produce based upon Facility, Market, and Experience. A yard must produce ships within the limitations of its facilities, but how best within economic constraints can these limits be extended. This must be constantly reviewed. What market(s) match to the best ship to produce within the facility? And, what are the experience strengths of the skilled engineers and tradesmen? How must these be changed to complete the match?
- 2) Pre-Design and Engineer these basic product(s). Accomplish all basic design, engineering, planning, and procurement sourcing for the ‘standard portions of these products’. These are literally “on the shelf plans and specs”.
- 3) Completely develop a manufacturing plan which combines all of these ingredients into a production process. This includes a “best fit critical path”, specific to the yard products, facilities, and strategies, which can provide the shortest time cycle and lowest *cost . . .best throughput. This is a ship manufacturing process* where
 - Any ship in the yard class is manufactured,
 - To *appropriate standhrds*;
 - Using the same, similar, or equal production methods from class to class, ship to ship,
 - And, the same *manufacturing systems* for: Engineering, Planning, Procuring, and Controlling.

The throughput factors upon which the successful system must be developed are:

Manufacturing Strategy

Schedule Attainment

Individual Work Package Schedule Maintenance

Shop/Supplier Schedule Maintenance

Individual Production Methods

A Vehicle for Continuous Change and Improvement

Summary

This Global aspect of the project has addressed the problems of Improving Production Throughput through *Cultural Change issues, Reengineering*, and the concept of manufacturing ships. These admittedly are the most difficult methodologies to not only apply, but to totally understand.

It was simply not possible to perform an actual application of this methodology within the scope and time of this project work. However, the exposure to this most important *process improvement* as a fundamental to “World Class” shipbuilding transformation was a necessary part of this project and publication. The importance of *globally* addressing throughput issues cannot be over-emptilzed.

Application of these methods will require complete “top down” commitment, virtual organizational trust and honesty, inexhaustible pursuit, and “best practice” application of technology. The good news is that this must be taken in steps, well-planned steps, but manageable steps. The bad news is that the “big picture” must be maintained while this very time consuming effort is advanced. It will take 5 to 7 years to make the *global transformation*.

Each yard from a *management facilities, marketing, and systems perspective* will address this challenge in its own way and will arrive at its own conclusions. The project work performed has the potential to assist in this endeavor.

APPENDIX

IIE Journal—Selected Related Articles

<i>Date</i>	<i>Title</i>
10-94	"TQM PRACTICES: A Survey of Companies in the Pacific Northwest"
9-94	"IS REENGINEERING COMPATIBLE WITH TOTAL QUALITY MANAGEMENT" "BUILDING A FOUNDATION FOR SUCCESSFUL BUSINESS PROCESS REENGINEERING" "PAVING THE WAY FOR CONCURRENT ENGINEERING"
5-94	"THREE PRACTICAL STAGES IN ORGANIZATIONAL PERFORMANCE IMPROVEMENT" "IMPLEMENTING RADICAL CHANGE : THE RIGHT STUFF"
7-94	"USING SIMULATION IN THE BUSINESS PROCESS REENGINEERING EFFORT"
6-94	<i>Federal Program Announcement for Advanced Manufacturing Technology 1-800-421-0586</i>
4-94	"PATENT AND TRADEMARK OFFICE SETS STANDARD FOR REENGINEERING GOVERNMENT"
3-94	"VIRTUAL REENGINEERING" "BENCHMARKING IS MORE THAN ORGANIZED TOURISM" "PERFORMANCE MEASUREMENT TAKES CENTER STAGE AT JOHNSON SPACE CENTER" <i>Under the new approach, management is continuously striving to base decisions on evaluation of data, instead of subjective opinions and gut feelings.</i>
	<u><i>The above article utilizes techniques similar to those utilized in our PTI—Measurement Studies.</i></u>

- 11-94 “WHAT IS AGILITY’ (Reprint of Figure 1, Figure 2)
- 1-95 “..REENGINEERING READINESS TEST..”
- 12-94 “PRODUCTIVITY: REENGINEERING FOR COMPETITIVEVENESS”
- “TQM AND THE PENTAGON”
- 3-95 “THE SECOND INDUSTRIAL REVOLUTION: THE IMPACT OF THE
INFORMATION EXPLOSION”
- “CYCLE TIME AND THE BOTTOM LINE”
- “TAKE A FLEXIBLE APPROACH-COMBINE PROJECT MANAGEMENT
AND BUSINESS PRINCIPLES INTO PROGRAM MANAGEMENT”

Please try to read this publication and assure that your teams have ready access to such publications.

Outside Sourcing:
 GLOBAL CHANGE OF THE TOTAL PROCESS
 LIST AND DEFINITION OF KEY TERMINOLOGIES AND CONCEPTS

Item # Subject and Definition:

1 *Global:* *loose issues such as goals, industry standards, organization structures, industries etc, which form the overall framework for the business; corporate or company; that level of doing business or system which involve the CEO and senior executive management.*

2 *beak nose* *issues directly derived or relating with the specific area or process; that level of organization system, and work which directly produces the ship or directly supports the same; hands on activities.*

3 *Intermediate:* *All the levels between Global and Local; middle management organization and responsibilities.*

4 *Reengineering:* *Starting Over!! “Reengineering,” properly, is “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed” This definition contains four key words: Fundamental, Radical, Dramatic and Process. Reengineering the Corporation, Page 32.*

Reengineering seeks breakthroughs, not by enhancing existing processes, but by discarding them and replacing them with entirely new ones... Reengineering is about beginning again with a clean sheet of paper. It is about rejecting the conventional wisdom and received assumption of the past. Reengineering is about inventing new approaches to process structure that bear little or no resemblance to those of previous eras. Fundamentally, Reengineering is about reversing the industrial revolution. Reengineering rejects the assumption inherent in Adam Smith’s industrial paradigm-the division of labor, economies of scale, hierarchical control, and all the other appurtenances of an early-stage developing economy. Reengineering is the search for new models of organizing work Tradition counts for nothing, Reengineering is a new beginning. Reengineering the Corporation, Page 49.

- 5 **Functional:** The nature of something that depends on or varies with something else; to act in a required manner; influence of process, rather than organization.
- 6 **Process:** “We define a business process as a collection of activities that takes one or more kind of input and creates an output that is of value to the customer...” Reengineering the Corporation, Page 35.
- “However the customer of the process is not necessarily the customer of the company. The customer may be inside the company as it is, for instance for the materials acquisition or purchasing process, which supplies materials to a company’s manufacturing operations. Reengineering can apply to all these processes too...” Reengineering the Corporation, Page 39.
- 7 **Quality Improvement or TOM:** Recognizing the importance of processes, and the needs of the process customers, and working backward from there; Quality programs work within the framework of a company’s existing processes and seek to enhance these by what the Japanese call kaizen or continuous incremental improvement. The aim is to do what we already do better. Quality improvement seeks steady incremental improvement to process performance. Reengineering the Coloration, Page 39.
- 8 **Management** Manage-VI 1) To control the movement or behavior of: 2) To have charge of: direct (to manage a household); 3) To succeed in accomplishing-VL 1) To carry on business; 2) To contrive to get along. **Management:** Noun 1) The act, art, or manner of managing, controlling, etc.; 2) The persons managing a business, institution, etc. Webster-New world Dictionary.
- 9 **Discipline:** A system of rules; training that develops process control, efficiency. To follow the process, to maintain the commitments to change, to remove those or that which does not fit the reengineered processes. BMS
- 10 **Leadership:** "A leader is anyone who has followers. Conversely, regardless of the title, you can not be a leader without followers."
- “A person who has subordinates but not followers is not a leader. Subordinates who are not followers may be viewed as resources to be managed-and that’s just the view taken by a supervisor who is not a leader.”
- “Are you managing subordinates?”

“Or Are you leading followers?”

“Leadership is not a function of titles; it is a function of relationships.”
Lundy, J. , Lead Follow Or Get Out of the Way, Pages 37-39.

11 Commitment: An obligation; ultimate performance; completion.
“... Commitment must be 100%... throughout the organization at the start of the effort...” Reengineering the Corporation, Page 113.

12 Fiscal/Financial Practices: “Finance and/financial practices are the metrics upon which business decisions are both made and measured . If these are not valid than how can a business even consider meeting Global Competition.”
This is a summary of the theme of the book Relevance Lost: The Rise and Fall Management Accounting-- H. Thomas Johnson and Robert S. Kaplan.

“...flawed cost information can sabotage your competitive position by encouraging you to set the wrong priorities and focus on the wrong problems, you’ll see how it can lead to:

- Sell the wrong products or services,
- Serve the wrong customers,
- Design costly products,
- Increase the cost of production,
- Institute cost cutting programs that fail,
- Incorrectly change the structure of your company,
- Obtain the wrong parts from outside suppliers

...how changes in the world in which you compete have increased the value of good cost information.... This is a new world in which conventional cost systems-cannot compete because they:

- Don’t communicate what matter to the customer,
- Don’t report which products and customers are profitable or unprofitable,
- Are often costly to operate,
- Provide few insights about how to improve, and
- Encourage actions that damage competitiveness

Common Cents-The ABC Performance Breakthrough-How to succeed with activity-based costing Peter B. B. Turney

It must be noted that most Reengineering projects utilize ABC or ABM (Activity-Based Costing or Activity-Based Management), these concepts when applied provided for accurate process (activity) analysis and cost analysis.

“...executives and managers know how to think ‘deductively’. That is, they are good at defining a problem or problems, then seeking and evaluating different solutions to it. But applying information technology to business Reengineering demands ‘inductive’ thinking-the ability to first recognize a powerful solution and then seek the problems it might solve, problems the company doesn’t even know it has.” Reengineering the Corporation, Page 84, 85

The finance and cost data must be concurrently analyzed as part of Reengineering.

- 13 Concurrence: "Timing is everything, all aspects of the overall process must be examined to one fully integrated and committed to plan" ..., "...tasks and analysis must not be serially planned and analyzed...", "...The Reengineering plan must be like synchronizing a clock or leading the musician in an orchestra", "...Change must also be concurrent and through out the organization." BMS
- 14 Shipyard: "U.S. shipyards have for the last few decades plus been the seller of hours and space...", "A facility based operation containing most of the processes for ship production and repair...", "Historically a business entity wishing to have all business functions and operations self-contained." BMS
- 15 Manufacture of Ships: "If a country has a knowledge base, it will also manufacture". Peter Drucker, Post-Capitalist Society, Page 73. "...A primary goal towards being Globally Competitive is to successfully apply Reengineering, so that one is in the business of the manufacture of ships...."
- 16 Industrial Engineering Techniques: "The objective application of Industrial Engineering principles to organizational concepts such as processes, organizations, cost, systems, people, and markets." BMS

A DISCUSSION OF CRITICAL PATH

Many things have been written about Critical Path Technology. And, the debate over this subject will go on long after this report has taken a place in the NSRP Library. However, the project staff felt a special need to make some statement as part of the final results of this effort.

This seems to be an ideal point in the report text to make such a statement, since the Integrated Planning and Scheduling System has as one of its main objectives the *ability to produce a critical path*. Quoting from Chart 4 of the IPSS Project Section, PLANNING SYSTEM “OUTFITTING MODEL”, “The *main objective of Integrated Production Planning and Scheduling is to ensure that all systems being used by Materials, Planning, Engineering, and Production have the capacity to exchange information and therefore provide a medium in which a critical path can be produced*”

From this it appears that a Critical Path is derived from the application of a specific system or a combination of interacting systems, rather than something that exists as an original absolute, definable form. In short, this application is based upon the idea that CP (critical path) is a *derived resultant* and not a formulated, fixed course of events. This is the perspective in which this discussion is presented.

First, CP as a methodology has long and good standing as a management technique for planning, scheduling, and controlling activities. PERT may be the benchmark for the earliest accomplishment of CP on a grand scale. Certainly, producing a ship is a “grand scale” activity.

Second, like finding the “holy grail”, a system for establishing and maintaining a specific CP (in this case for a ship) is an on-going and serious endeavor. There are and will be models and computer systems dedicated to this end.

A system which establishes and maintains a CP for a given ship can be attained in a rather straight forward manner, granted, this requires a lot of hard work This is so because of the capabilities of computers and the industry’s ability to apply these. However, to create a system which can be universally applied to any ship, in

any yard, at any level of detail is a far greater issue. This is so because each ship type is uniquely different, each yard is different, and therefore the methodology and sequences for production will be uniquely different. All of these have such a large impact upon the CP System parameters that it makes the *universal CP method* impractical or impossible.

Not all is lost, maybe nothing is lost, This project has indicated that Critical Pathing for a specific ship, in a specific yard will be a readily available buy-product of a good planning and scheduling system. This assumes that the system is based upon *integration* and *concurrent action*. *This is so because a CP is really the product (resultant) of a plan and not the basis of the plan.*

Recognizing the possibility of rebuttal, there is a need to discuss what is meant on all sides of this subject.

Critical Path is defined as the *Shortest time to produce a ship*, or the *Path of Critical Elements or Work Activities*.

Critical Element (Work Activity. Work Element) is defined as *A work event which lies on the CP and must be completed before the next critical element can be initiated*

There are Real Critical Path Events and Resultant Critical Path Events. A real event is one that is immutable. Some real CP events are: The keel for any ship is on the CP, as is each construction block of the ship. The launch is on the CP of both the ship being produced and the next ship to be constructed on the same ways or dock. Resultant events might be. The system test of the final dockside work may be on the CP but is the result of the system completion which is the result of several outfitting work elements each with a critical path of work elements. This supplies a logical basis for deciding between *Real* and *Resultant*.

There is a SHIP Critical Path and sub-CP's which are defined as the *Shortest time to produce a given ship sub-set of work elements*. Any sub-set can be a critical element to the ship CP as a *real event* or as a *resultant event* or may not be on the CP at all because it is shorter in duration and doesn't effect the *shortest time* issue. The same sub-set may initially be *non-critical* and due to delays or rework become a CP element and *real* because of the event it is impacting. If the material for the keel is not available and causes a delay in laying the keel it becomes as *real* as the *Keel* on the ship CP.

From this it appears that two things need to be recognized in dealing with CP technology and application

- Every shipyard can (and probably already does have) develop an Overview *Real Event Critical Path Model specific* to the yard facility and the production system and methodology desired. This will be based upon the *Real Elements specific* to ship and yard. This can be relatively easily accomplished.
- It is the *resultant elements* which need to be determined, addressed, and controlled in a dynamic and “real time” way. It is the changing nature of these due to interdependence and inter-actions which determine the *shortest time to produce a ship*. Therefore, it is the system(s) which yields the *critical path analyses* (as regular buy-products) and becomes vital to resolving the need. PERT was just this kind of a system.

Yes, some general computer model for CP exists or can be developed. Most anything of this nature can be done, but what value will it be? Will it contain every variable for every possible ship, for every possible yard? If not, what is to be left out of the model and why? Will it create the schedule(s) or will another system be required? Will it only be redundant to other necessary planning work? And exhaust resources? Probably.

This project was never intended to give specific answers that might resolve a given problem for a given yard, but rather, to research methods that can serve as basics for improving production throughput. This discussion of Critical Path is intended for this same purpose.

NSRP PTI SP-8-92-4
National Steel and Shipbuilding Company
San Diego, California

For the Project Staff
W.O.Appleton Proj. Mgr.

Acknowledgments

It is not possible to acknowledge everyone who has supported and worked with this project by name, and for that we give our sincere apology. The roles of the project staff and management are mentioned later in this report. However, practically the whole of the NASSCO organization should be listed here.

We thank the Outfitting Production Managers and Trade Superintendents, Ship Managers and Area Managers, Trade General Foremen, Foremen, and Leadmen, and all others who participated in the studies.

We particularly thank the men and women of NASSCO who are always interested in improving how ships are produced and how they might play their parts.

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Let us not forget that most important contributor to these projects, the NSRP SP-8, Industrial Engineering Panel members, associates, and meeting guests, who participated in meeting reports with their full and energetic critiques, suggestions, and support.

Thank you all.

Project Comment

NSRP

In 1991, the Executive Control Board of the National Shipbuilding Research Program issued an annual report which not only outlined the function and activities of NSRP but set forth a Plan For The Future. This plan outlined five significant goals made up of sixteen objectives. The plan was targeted for achieving the Goals by 1997, and the Objectives by 1994. (A copy of the plan and goals may be found in the Appendix, page 108.)

The first and second goals are specific to this project and worth highlighting.

GOAL 1

Reduce the overall design, acquisition, construction and repair process time.

Objectives:

- A. Reduce the amount of time of ship construction on the building ways by 30%.
- B. Develop a library of reusable standard design modules for a range of ship machinery plants, structure and accommodations.
- C. Continue efforts to get U. S. Regulatory Body approval of foreign standards.

GOAL 2

Reduce the cost to design, build and repair ships.

Objectives:

- A. Reduce shipyard man hours 20%.
- B. Reduce material cost by 10%.
- C. Reduce indirect and time dependent costs proportionally.

These goals and objectives are clearly drivers to this project and are addressed in the context of the work in one fashion or another.

Project Staffing

Staffing for the project was accomplished by NASSCO personnel and subcontracted engineering support where required. Thomas Caffo and John Robertson, both graduate mechanical engineers, were assigned full time to the project and performed the *Process Effect Measurement studies* and analytical development technique; as well as the presentations and written report. Mike Cheney provided the important data processing and electronic archival support.

John Ball, Manager of On-Block Production and his staff supplied much needed insight into the needs of production management and how team participation might be accomplished.

David Webb and Richard Neuman, both graduate marine engineers, worked over a lengthy period developing and applying the *Integrated Production Planning System*.

And, Barry Schram, BMS Associates, supplied the much needed outside research and tedious review. His consultation throughout the project was very professional, as were his contributions to this final report.

W. O. Appleton served as Project Manager and industrial engineer.

NASSCO Management Involvement

This could not have been possible without the direction, leadership, and support of NASSCO Executive Management. Don Spanninga, Senior Vice President of Operations, gave direct support in setting the guidelines and necessary limitations for the project.

Pete Jaquith, Director of Facilities, Environmental, and Manufacturing Engineering, supplied constant leadership and consultation. John Lyle, Director of Outfitting, both personally and organizationally provided support and participation.

Bob Ruble, Manager of Quality Assurance, was the project *guru* and objective reviewer. His endless supply of knowledgeable books and research work was most helpful. And, Lyn Haumschilt, Manager of Facilities and Environmental and a long time NSRP participant, was most helpful in the early period, and in reviewing the final report.

Plan For the Future

1992–1997

The NSRP Executive Control Board, the Chairmen of the Technical Panels, and the NSRP Program Managers meet annually to prepare a Strategic Plan. In the fall of 1991 the Strategic Plan agreed upon for the NSRP to be executed in 1992 consisted of the following Mission, Goals and Objectives.

The NSRP Mission

Assist the U.S. Shipbuilding and Repair Industry to achieve and maintain global competitiveness with respect to quality, time, cost, and customer satisfaction

To accomplish its mission the NSRP has established the following goal and objectives. Goals are expected to be achieved in five years, objectives in two.

GOAL 1

Reduce the overall design, acquisition, construction and repair process time

Objectives:

- A. Reduce the amount of time of ship construction on the building ways by 30%.
- B. Develop a library of reusable standard design modules for a range of ship machinery plants, structure and accommodations
- c. Continue efforts to get U.S. Regulatory Body approval of foreign standards

GOAL 2

Reduce the cost to design, build and repair ships

Objectives:

- A. Reduce shipyard man hours 20%.
- B. Reduce material cost by 10%
- c. Reduce indirect and time dependent costs proportionally

GOAL 3

Promote a commitment to quality and customer satisfaction through people and processes

Objectives:

- A. Develop measures of performance in quality and customer satisfaction
- B. Provide feedback to industry on quality and customer satisfaction
- c. Sponsor industry seminars to improve quality through people and processes
- D. Disseminate information on successful programs to improve quality and customer satisfaction.
- E. Improve the quality of working life in shipyards

GOAL 4

Obtain a 3% share of the international shipbuilding market

Objectives:

- A. Develop and maintain information on international customer needs.
- B. Actively support the capability to build to international standards and qualifications.

GOAL 5

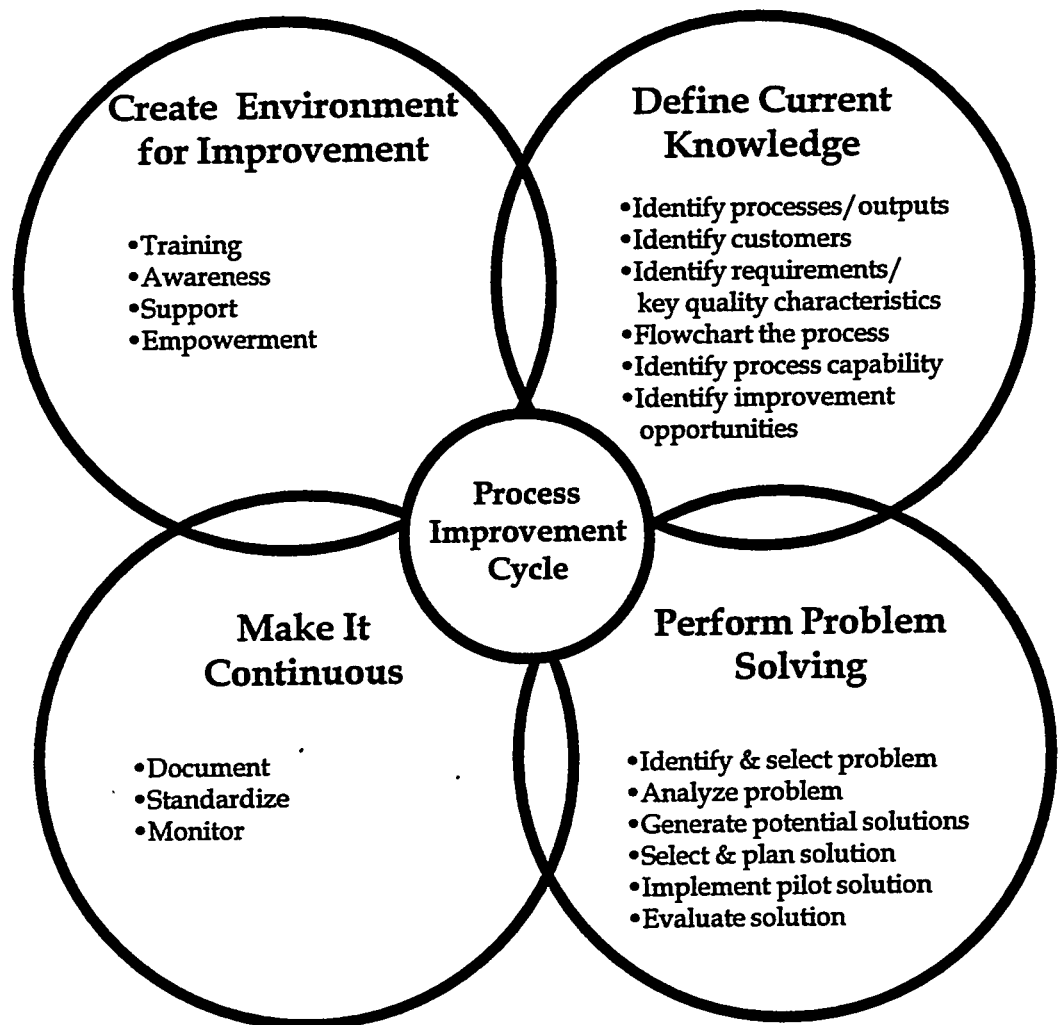
Become the nationally recognized forum to advance shipbuilding and ship repair technology.

Objectives

- A. Increase membership to include all principal shipbuilding and ship repair yards and regulatory bodies.
- B. Continue to improve the mechanism for marketing, disseminating and implementing NSRP project results.
- c. Increase the number of NSRP sponsored workshops and other activities within shipyards.



Process Improvement Cycle



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