Industrial Management Review Of Puget Sound Naval Shipyard

B-118733

Department of Defense
Department of the Navy

UNITED STATES
GENERAL ACCOUNTING OFFICE

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

LOGISTICS AND COMMUNICATIONS
DIVISION

B-118733

The Honorable
The Secretary of Defense

Dear Mr. Secretary:

We have reviewed industrial management activities at the Puget Sound Naval Shipyard, Bremerton, Washington. Our report identifies opportunities for improving management of maintenance operations and offers a mathematical modeling concept which might be useful in monitoring shipyard activity.

We want to direct your attention to the fact that this report contains recommendations to you which are set forth on page ii. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions he has taken on our recommendations to the House and Senate Committees on Government Operations not later than 60 days after the date of the report, and the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget; the Chairmen, Senate and House Committees on Appropriations, Government Operations, and Armed Services; and the Secretary of the Navy.

Sincerely yours,

F. J. Shafer

F. J. Shafer
Director

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ABBREVIATIONS

DOD Department of Defense

GAO General Accounting Office

NAVSHIPS Naval Ship Systems Command

GENERAL ACCOUNTING OFFICE REPORT TO THE SECRETARY OF DEFENSE

INDUSTRIAL MANAGEMENT REVIEW OF PUGET SOUND NAVAL SHIPYARD
Department of the Navy B-118733

D I G E S T

WHY THE REVIEW WAS MADE

U.S. naval shipyards are major shore activities whose missions include repair, modernization, overhaul, conversion, and construction of ships in the active fleet. During fiscal years 1968-72 the Navy operated 10 shipyards with annual costs of about $1.25 billion. The number of active ships decreased from 917 in 1968 to 523 in 1973 and shipyard employees decreased from over 90,000 to less than 70,000 during the same period.

GAO made a pilot industrial management review at the Puget Sound Naval Shipyard to determine the impact of these changes and the possibility of improving productivity in the shipyards.

FINDINGS AND CONCLUSIONS

Managing a naval shipyard efficiently and economically is difficult because of some limiting factors.

--Shipyard management has no control over most of its workload.

--Overall use of berths and docks at the shipyards decreased sharply during the 1968-72 period.

--Short-range workload is unpredictable and subject to frequent change.

As a result:

--Shipyard facilities have been greatly underused.

--Much equipment has been underused or idle.

--Manpower cannot be readily adjusted for changes in workload.

--The direct labor force has become less productive.

Puget Sound could raise its productivity by:

--Improving machine-use data to aid in decisions on managing, acquiring, retaining, reporting, maintaining, and disposing of industrial plant equipment. (See ch. 2.)

--Improving the shipyard work measurement system and labor standards program to increase productivity and provide better cost control. (See ch. 3.)

--Improving the quality assurance program by accounting for the incidence and cost of defective work and, after analyzing the causes, implementing corrective actions. (See ch. 4.)

GAO concluded, however, that, since the most critical constraint on shipyard operations appears to be the low level and unpredictability of the workload, the best way to improve overall shipyard productivity is to stabilize and increase the workload and develop a viable means of balancing manpower requirements with the workload.

RECOMMENDATIONS

GAO recommends that the Secretary of the Navy:

--Develop a more systematic means to accurately forecast direct and overhead manpower requirements in relation to projected and actual workloads of naval shipyards. (See ch. 2.)

--Reevaluate existing criteria for labor standards to insure that the application of standards at the shipyards contributes to more efficient shipyard management. (See ch. 3.)

--Insure that the shipyards properly record and analyze rework costs for corrective action. (See ch. 4.)

At the Puget Sound Naval Shipyard:

--Develop a program for accumulating actual equipment-use data. (See ch. 2.)

--Examine existing and proposed investments in equipment to insure the equipment is needed. (See ch. 2.)

--Report idle equipment to the Defense Industrial Plant Equipment Center to achieve possible redistribution benefits. (See ch. 2.)

--Use methods and standards personnel in an agressive program to cross-train planners and estimators in developing estimated standards. (See ch. 3.)

--Actively involve shop management in the planning and estimating process. (See ch. 3.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

The Navy generally agreed with most of GAO's recommendations (see app. II) and has taken or is taking corrective action. In the equipment area, for example, the Navy has issued instructions on equipment management; has purchased meters to record equipment use; and is documenting equipment use as part of its shipyard modernization program restructure analysis to validate the need for existing and proposed equipment.

In the labor standards area, the Navy directed all shipyards to transfer responsibility for developing and maintaining standards from the Production Department to the Planning Department. Qualified work measurement technicians are being relocated to the Planning Department, which should insure that planners and estimators receive the recommended cross-training. A new job-planning system is being implemented to define the interaction between shop and planning activities more clearly.

In the quality control area, the Navy has reemphasized to all shipyards the advantages of an effective work and spoilage program.

These are all constructive actions; continued management emphasis and attention should result in improved shipyard operations.

The Navy did not agree that a more systematic means is needed for forecasting workload man-day requirements. It felt that, although the present long-range planning system, which projects 10-year workloads, could be refined to improve responsiveness and accuracy, it was adequate.

Although the Navy said the mathematical model GAO developed to relate manpower consumption to dock and berth use could be used to measure facility use, it did not think the concept could be used to measure overall performance. The Navy expressed appreciation for GAO's efforts but stated that, at the present time, it did not plan to use the model or refine it.

CHAPTER 1

INTRODUCTION

Naval shipyards are shore installations of the Naval Ship Systems Command (NAVSHIPS). Their primary mission is to repair, modernize, and overhaul ships in the active fleet and to construct and convert ships. At the time we began our review, 10 shipyards, most of them at least 100 years old, were in operation. In April 1973 the Navy decided to close two of them. The number of active ships had decreased from 917 in 1968 to 523 in 1973, and the number of employees had decreased from over 90,000 in 1968 to less than 70,000 at the beginning of 1973. Shipyard costs remained relatively constant throughout this period--around $1.25 billion a year.

All naval shipyards are equipped and manned to accommodate a variety of ship classes, each of which has relatively little design standardization and unique complexities. Although each shipyard has some specialized features, such as drydocks large enough to repair or construct the largest aircraft carriers or repair and refueling capability for nuclear-powered ships, each may have to do a wide range of work on any given number of different classes of ships.

Unlike private shipyards, which can vie for as much work as their facilities can handle, Navy shipyards depend on workloads assigned to them by fleet commanders and NAVSHIPS on the basis of fleet operating requirements and shipyard capabilities.

NAVSHIPS has an automated long-range planning system which, it said, can project workloads for naval shipyards as far in the future as force levels, ship configurations, and maintenance policies can be projected. Usually workloads are projected for a 10-year period, with the current fiscal year as the first year. Required production ship manpower and skills, total shipyard employment, a simulation of drydock use, and a determination of maximum waterfront use are included in the projections.

CHANGES IN SHIPYARD ENVIRONMENT

Since 1963 the number of ships and fleet manpower have been reduced without corresponding reductions in shore

facilities. Since 1968 all new ship construction programs and about one-third of the repair, overhaul, and conversion work have been assigned to commercial shipyards.

The Navy began a $1 billion, 10-year shipyard modernization program in 1969 for 9 of the 10 shipyards. The shipyards were to be improved by new or rebuilt facilities, such as piers, shops, and administrative buildings, and by new plant equipment. The 10th yard, Portsmouth, which had been scheduled for closure, recently entered the program.

In April 1973 the Department of Defense (DOD) announced that the Hunters Point and Boston shipyards would be closed to better balance the fleet with its supporting shore facilities.

CHANGES IN WORKLOAD

At Puget Sound the workload changed and decreased significantly in the 5 years ended June 30, 1972. The two major changes were from construction to overhaul and conversion and from surface ships to submarines.

FUNDING

Each shipyard has a working capital fund, referred to as the Naval Industrial Fund, to finance operating costs. Operating commands reimburse the fund for the cost of goods and services provided by the shipyards. The shipyards' operating costs for fiscal years 1968-72 follow.

	Fiscal year				
	1968	1969	1970	1971	1972
	(000 omitted)				
Portsmouth	$ 98,058	$ 100,720	$ 105,856	$ 99,258	$ 100,367
Boston	101,036	98,838	102,680	91,838	[a]91,329
Philadelphia	181,715	194,091	192,051	160,027	133,266
Norfolk	137,865	143,679	143,894	[a]150,414	163,454
Charleston	100,466	[a]101,350	100,750	109,951	106,310
Long Beach	120,467	114,846	119,784	[a]121,380	128,670
Hunters Point	278,390	302,829	[a]120,641	116,080	108,531
Mare Island	(b)	(b)	[a]178,892	174,771	163,246
Puget Sound	146,223	[a]154,809	[a]159,155	148,282	144,045
Pearl Harbor	84,070	92,286	95,269	94,590	100,969
	$1,248,290	$1,303,894	$1,324,969	$1,267,594	$1,240,174

[a]Figures adjusted on the basis of the Navy's comments on this report.

[b]Until fiscal year 1970, Hunters Point and Mare Island were operated as a single shipyard.

REVIEW OBJECTIVE AND APPROACH

We made an industrial management review at the Puget Sound Naval Shipyard, Bremerton, Washington. One of our objectives was to independently evaluate productivity, i.e., the efficiency with which all resources--people, material, equipment, facilities, and management systems--were applied to accomplish the work.

Puget Sound measures overall productivity in terms of ships completed on time and within the costs allowed by the customer. Although this general approach serves management in a broad sense, it assumes that time and cost estimates are valid, and it does not measure productivity by comparing resources consumed with products or services rendered. Because a shipyard has a large industrial plant and work force, we concentrated on these elements in attempting to develop an independent measure of productivity.

CHAPTER 2

IMPACT OF WORKLOAD CHANGES ON MANPOWER AND EQUIPMENT

Puget Sound managers were in a dilemma because the use of shipyard facilities and equipment decreased, the work force could not be quickly adjusted according to workload changes, and the work force became less productive in the face of the decreasing workload.

IMPACT ON MANPOWER

The relationship of the changing and decreasing workload to manpower from 1968 through 1972 is shown in the following table.

	1968	1969	1970	1971	1972	Percent of decrease 1968-72
Berths and docks--days used (of 6,188 available)	3,752	2,681	2,912	2,198	2,254	40
Direct man-years	5,554	5,414	5,339	4,619	4,348	22
Overhead man-years	3,348	3,214	3,295	3,185	3,110	7
Total man-years	8,902	8,628	8,634	7,804	7,458	16

The decreased use of shipyard berths and docks indicates a decrease in total workload. At the same time, the average number of man-days spent for each day of dock and berth use increased, as shown in the following table.

	1968	1969	1970	1971	1972
Direct labor	540	737	669	767	704
Overhead labor	326	439	413	529	504

Increased labor per day of berth and dock use indicates an imbalance between workload and manpower. This indication is further supported by the fact that, even with the 22-percent reduction in the direct labor force, shipyard work-sampling studies showed a trend of decreasing productive effort by the direct labor work force, as shown in the following summary of work-sampling results.

Work-sampling period	Percent of observations				
	Productive	Travel loaded	Personal and idle	Travel empty	Total
May 71	78.0	4.1	13.9	4.0	100
Nov. 72	76.4	5.4	10.6	7.6	100
Apr. 72	80.9	4.0	11.4	3.7	100
Oct. 72	70.0	6.4	16.6	7.0	100
Feb. 73	69.9	4.6	17.3	8.2	100

Puget Sound managers took some reduction-in-force actions during the period but avoided them as much as possible because the managers considered such actions cumbersome and frequently counterproductive. Instead, they attempted to balance manpower with workload by reducing overtime and loaning employees from one shop to another within the Production Department and from the Production Department to other departments.

Reductions in overhead are difficult to make; i.e., within the shipyard's organizational structure, some jobs require manning regardless of the workload. Although it is possible to decrease the number of personnel in those functions, the primary consideration becomes whether an entire overhead function can be eliminated. The shipyard eliminated one, the Methods and Standards Branch, which is an integral part of the work measurement program discussed in chapter 3.

IMPACT ON USE OF EQUIPMENT

As of June 30, 1972, Puget Sound had over 3,200 pieces of industrial plant equipment worth over $26 million, excluding small items and handtools costing less than $1,000 each.

We considered (1) how well equipment was managed within the workload constraints and (2) the impact of reduced and changing workload on equipment management.

Equipment management

Use data was collected only for about 26 percent of Puget Sound's equipment, and its accuracy was questionable.

Hours of reported use were often merely repetitions of arbitrary time periods, such as 1,440 hours or one 8-hour shift times 180 days and therefore hours of actual use were not recorded.

Justifications for new equipment were based on similarly questionable estimates. In addition some equipment requests covered several items without individual justifications as to their need.

We did not make machine-use studies since the Naval Audit Office had already done so. The Naval Audit Office, reporting on a limited number of machines during a 6-month period, found that about 24 percent were not used at all and only about 33 percent were used 75 percent or more on a one-shift basis. The report also stated that, contrary to DOD requirements, idle and underused equipment had not been reported to the Defense Industrial Plant Equipment Center for possible redistribution to other activities.

Accurate information on machine use is necessary in making the best management decisions concerning retention, replacement, upgrading, and preventive maintenance.

Reduced and changing workload

In our opinion, the low use of equipment reported by the Naval Audit Office was partly a direct result of the reduced workload. In addition, changing the workload from construction to overhaul and conversion prevented some equipment from being used effectively. For example, a new $318,000 numerical control machining center was justified in 1968 for use in ongoing and planned ship construction. Puget Sound projected annual use of 3,000 hours, a 2.6-year amortization period, and estimated annual savings of $93,153. By the time the machine was installed in April 1972, Puget Sound had no ship construction projects, and the machine has received very little use.

CONCLUSIONS

Managing a shipyard efficiently and economically is difficult in an environment of external constraints and particularly at Puget Sound, where the workload has decreased

40 percent during the past 5 years. Unless the workload can be stabilized and increased, managers will continue to have difficulty in balancing manpower and workload and in obtaining highly productive use of facilities and equipment.

The equipment management program, however, can be improved by accumulating proper use data. This would permit better visibility for

--removing unneeded machines,

--increasing use of remaining machines,

--reducing investment in machines,

--making excess equipment available to other DOD installations, and

--acquiring equipment.

RECOMMENDATIONS

We recommend that the Secretary of the Navy develop a more systematic means to accurately forecast direct and overhead manpower requirements in relation to naval shipyards' projected and actual workload.

We recommend that the Puget Sound Naval Shipyard:

--Develop a program for accumulating actual equipment-use data.

--Examine existing and proposed investments in equipment to insure the equipment is needed.

--Report idle equipment to the Defense Industrial Plant Equipment Center so that possible benefits from redistribution can be realized.

NAVY COMMENTS AND OUR EVALUATION

The Navy does not agree that a more systematic means of forecasting manpower requirements is needed. Their comments on this matter are discussed in chapter 5.

The Navy agreed with the intent of our recommendations concerning equipment management and has taken or is taking the following actions.

1. NAVSHIPS is conducting a shipyard modernization program restructure analysis which, in the equipment areas, is documenting equipment use and projecting future needs. This analysis, according to the Navy, will validate the need for existing and proposed equipment.

2. NAVSHIPS has procured use meters to be installed on existing equipment.

3. In August 1973, NAVSHIPS issued instructions covering policies and procedures for managing, acquiring, retaining, reporting, maintaining and disposing of industrial plant equipment.

4. In July 1973, NAVSHIPS established procedures for recording savings from and use of equipment procured. When fully implemented, the Navy believes these procedures will further improve the management of its equipment.

All of these are positive actions, and full implementation should result in meaningful improvements in the management of industrial plant equipment.

CHAPTER 3

IMPACT OF WORKLOAD CHANGES ON LABOR STANDARDS PROGRAM

Development and use of labor standards is difficult and can be costly when the workload frequently changes. When Puget Sound was heavily involved in ship construction, labor standards covered up to 53 percent of the direct labor. As of June 1972, when the workload was low and had changed to submarine conversion and overhaul, standards covered only about 29 percent of the direct labor and, as of April 30, 1973, only 7 percent.

Concurrently, employment at the organization responsible for establishing and maintaining the standards, which had never been fully manned, was further reduced in March 1973.

LABOR STANDARDS

Potential production efficiencies can be identified by comparing actual accomplishments with planned (standard) accomplishments. Labor standards normally form the basis for this comparison. They indicate the time an experienced operator needs to do a standardized operation at a normal pace, allowing adequate time for fatigue and personal needs. Labor standards are also valuable in (1) determining production costs, (2) scheduling and controlling men, material, and machines, (3) improving equipment use, and (4) pricing services provided to customers.

Over 20 years ago, NAVSHIPS developed the methods and standards program, which encompassed work measurement techniques, to help shipyards better manage their resources. In the mid-1960s, DOD implemented the defense integrated management engineering system as the principal work measurement system to be used by all DOD components. NAVSHIPS altered its methods and standards program to conform to the engineering system.

The Methods and Standards Branch of Puget Sound's Production Department operated the methods and standards program, using three classes of labor standards:

1. Uniform engineered standards, generally based on methods time measurement, standard data, and work sampling and designed for use in every naval shipyard.

2. Local engineered standards, similar to uniform standards, but developed specifically for local use on work not covered by uniform standards.

3. Estimated standards, based on good work practices and recorded and used consistently.

Engineered standards are generally more accurate than estimated standards but are more expensive to develop and maintain. Therefore, they apply to high-volume, highly repetitive tasks in which accrued savings from improved methods and better scheduling generally offset the cost of establishing and maintaining the standards. Estimated standards are less accurate but are also less expensive. They are used primarily for low-volume tasks.

Changes in Puget Sound's workload created the need for more standards in order to attain the NAVSHIPS goal of 40-percent engineered standards coverage. In additon, existing uniform standards needed updating due to the age and condition of the equipment undergoing repair. However, as of June 30, 1972, the standards program had only 20 technicians, and they apparently were unable to establish the quantity of new standards needed or update existing ones.

As a result the standards themselves, as well as coverage, greatly deteriorated. Nevertheless, planners and estimators in Puget Sound's Planning Department continued to plan work and estimate time using out-of-date standards and other estimating criteria from the Methods and Standards Branch. Shop personnel became very dissatisfied with both uniform and local engineered standards because they saw very little relationship between the time allowed and the time actually required to do a job.

Puget Sound management decided the methods and standards program was an expensive operation which did not work satisfactorily for them. Therefore, in January 1973, Puget Sound stopped assigning work controlled by engineered standards and in March 1973 reduced the number of people assigned to the Methods and Standards Branch to nine. It also decided to use

estimated standards to be developed by shipyard planners and estimators, who normally are not trained in the techniques of standards development. As of April 30, 1973, only 7 percent of the work assigned was covered by any type of standard.

Planning Department officials said the estimated standards are to be documented so they can be used consistently by all estimators. They stated that parts of engineered standards are used where applicable but that most will be estimates based on historical data and estimators' knowledge of the job and condition of the equipment to be repaired. Estimators are encouraged to discuss estimates with shop personnel to obtain information which may affect the amount of time the job will take. Planning officials hope this will improve communication and reduce conflicts between estimators and shop personnel.

Puget Sound has asked NAVSHIPS for authorization to continue to develop estimated standards for at least a 2-year trial period and has proposed a goal of 60-percent estimated standards coverage instead of the NAVSHIPS goal of 40-percent engineered and 20-percent estimated standards coverage.

CONCLUSIONS

Because of the changing, unpredictable and low workload at Puget Sound, we cannot give an opinion on the optimum level of engineered standards coverage or the need for changing NAVSHIPS criteria for the number of industrial engineering technicians which the shipyard should employ.

We agree with shipyard officials that, for low-volume work, less emphasis should be placed on establishing and maintaining costly engineered standards and greater emphasis should be placed on estimated standards. However, estimated standards should be well founded and properly developed by qualified work measurement technicians. It is doubtful whether planners and estimators can develop valid estimated standards, since they are not trained in standards development and these standards are likely to incorporate existing inefficiencies.

RECOMMENDATIONS

So that Puget Sound can establish an effective work measurement program, we recommend to the Secretary of the Navy that:

--The shipyard use Methods and Standards Branch personnel in an aggressive program to cross-train planners and estimators in developing standards.

--NAVSHIPS reevaluate its criteria for standards mix and coverage to insure that the application of engineered standards contributes to more efficient shipyard management.

--Puget Sound actively involve shop management personnel in the planning and estimating process to (1) increase their understanding of work measurement techniques and (2) improve their communication with the Planning Department.

--The report "Improving Work Measurement Systems in the Federal Government" be used as a guide in developing a more meaningful work measurement system. This report, dated June 1973, was prepared by the U.S. Army Management Engineering Training Agency.

NAVY COMMENTS AND OUR EVALUATION

The Navy agreed with the intent of our recommendations and has initiated the following actions.

1. By instruction dated July 17, 1973, NAVSHIPS transferred the responsibility for developing and maintaining estimated standards from the Production Department to the Planning Department in all shipyards. Qualified work measurement technicians are being relocated to the Planning and Estimating Division to insure that standards are properly developed and applied. This action should insure that planners and estimators receive the recommended cross-training because responsibility will be placed within a single functional area.

2. In early 1973, the Navy directed the shipyards to realign the standards function to concentrate on improving local methods.

3. The Navy is currently implementing a work-oriented job order (WOJO) system designed, among other things, to provide planning methodology so that the

interaction between shop personnel and the planing process can be more clearly defined. The Navy anticipates that this system will be applied during 1975.

4. The Navy agreed that the report entitled "Improving Work Measurement Systems in the Federal Government" could be used as a guide in developing work measurement systems, recognizing that this guide is general in nature and requires careful analysis and interpretation before it is applied.

The actions outlined by the Navy are constructive and should result in improved operations.

CHAPTER 4

QUALITY CONTROL PROGRAM

Quality control is a procedure used to systematically insure high-quality work. Defective work is likely in any production process, particularly if the work is complex and is processed through several different areas. Whether due to poor workmanship, lack of training, poor supervision, inadequate inspection, or inaccurate specifications, the causes of defective work should be identified so remedial action can be taken. Also, the costs of correcting defective work should be recorded, so the cost effectiveness of alternative solutions can be measured.

At Puget Sound the Quality Assurance Office was responsible for supervising the quality control program. Shop supervisors were to make inspections while work was in progress and to make certain that all prescribed quality standards were met. Although these procedures provided reasonable assurance that defective work would be identified and corrected before ships were returned to the fleet, they did not provide for accumulating data on the incidence or cost of correcting defects.

NAVSHIPS has directed that the costs of correcting defective work (rework costs) be recorded for use by shipyard management. Although Puget Sound issued an instruction requiring that rework costs be charged to an overhead account, very few costs were recorded. A number of reasons were given.

1. Shop supervisors were authorized to correct defects that were within the scope of a job and to charge the cost directly to the job order.

2. Defects beyond the job scope were given additional man-hours, or new job orders were issued to correct the discrepancies. In either case, costs were not accumulated to show the rework costs specifically.

3. Shop personnel were reluctant to record defective work because they felt that such information might be self-incriminating.

4. Shop personnel were reluctant to charge rework costs to overhead because of shipyard emphasis on maintaining a low overhead rate.

5. Shop personnel were confused about the costs to be charged to the overhead account. The confusion stemmed from the instruction's statement that "a small but significant amount of rework is a normal industrial hazard," which was interpreted to mean that normal rework costs did not have to be charged to the overhead account.

Puget Sound records showed incidents of defective work which had to be corrected. However, because few rework costs were charged to the overhead account, the total amount and cost of rework could not be determined. Consequently, rework became an integral part of doing a job and was not identified as contributing to variances between planned and actual time to do the job.

For example, specifications estimated that 340 man-hours would be needed to repair a main steam system on a submarine. Because the specifications were inaccurate, the repair work was defective and required 400 more man-hours. Instead of charging this rework separately, a new job order was issued. Had the rework been recorded separately, shipyard management would have been alerted to the need for determining its cause and taking corrective action.

Shop officials informed us that occurrences similar to the example above were not unusual.

CONCLUSIONS

The program at Puget Sound lacks systematic feedback to management on the nature, cost, number, and causes of defects. Therefore, management cannot take corrective action.

We suggested that the shipyard advise all levels of management and shop personnel of the benefits of recording and analyzing the costs to correct defective work.

We also suggested that the shipyard clarify instructions by (1) defining the rework to be recorded, (2) establishing a cost account, keyed to the original job order,

to record the cost of rework resulting from both internal and external causes, (3) requiring supervisors to record rework costs on the defective work account, and (4) requiring the Quality Assurance Office to analyze the rework account to determine the causes of the rework and to correct the problems.

Puget Sound officials agreed that present records do not accurately show the costs of correcting defects and that improved information would be beneficial if it could be obtained economically. They said they would investigate the feasibility of implementing our suggestions.

RECOMMENDATION

We recommend that the Secretary of the Navy insure that rework costs are properly recorded and analyzed for appropriate corrective action.

NAVY COMMENTS AND OUR EVALUATION

The Navy agreed with our recommendation and said it had reemphasized to all shipyards the management advantages of an effective work and spoilage program.

Continued management emphasis and proper accounting for defective work should not only result in better control in this area but should also provide the necessary feedback for management to improve operations.

CHAPTER 5

EVALUATING SHIPYARD PERFORMANCE

BY RELATING RESOURCES CONSUMED TO CAPACITY USED

The decreasing use of shipyard facilities, the reduced employment, and the shipyard's lack of control over its major workload have had an impact on shipyard performance which needs to be evaluated. A prerequisite for such an evaluation is developing a method for comparing resources consumed with products or services rendered.

This chapter discusses two prior attempts to measure shipyard performance and then describes a model which GAO developed at Puget Sound and tested at the other shipyards. The Puget Sound model appears to have considerable potential as a means to help management appraise personnel and facility needs. However, the model should be used as an analytical tool only. It needs to be further refined, requires considerable interpretation, and should be used collectively with other management indicators to appraise performance.

OTHER STUDIES OF SHIPYARD PERFORMANCE

Booz-Allen Applied Research, Inc., developed cost-volume relationships as performance indicators in naval shipyards and developed related techniques for assessing cost implications of the shipwork allocation pattern for fiscal years 1966-71.[1] The study concluded that naval shipyards incur costs ranging from 20 to 100 percent higher than comparable work in private yards. It attributed the higher costs largely to differences in payroll, fringe benefits, and overhead; the shipyards' mission to respond to urgent fleet needs; and the shipyards' apparent lower productivity.

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[1] "Study of the Relative Costs of Ship Construction, Conversion, Alteration, and Repair in Naval and Private Shipyards," Booz-Allen Applied Research, Inc., Bethesda, Maryland, June 30, 1972, NAVSHIPS Contract No. N00024-72-C-5244.

In August 1971, DOD asked the Logistics Management Institute to develop methodology for evaluating naval shipyard performance.[1] The Institute investigated four models and rejected all of them. The first two, a scheduling-cost model and a linear programing model, were rejected because they did not provide a way to measure shipyard productivity. Moreover, the Institute believed, a model to measure productivity could not be constructed because (1) the nature of overhaul and repair work is complex, (2) few jobs recur regularly and when they do, work content varies widely, (3) there are constraints on shipyard operations, and (4) there are differences among shipyards themselves.

The third and fourth models, a total cost comparison model and a fixed-cost analysis model, assumed that productivity remained constant at all shipyards. The difficulty in finding comparable overhaul and repair work at the shipyards suggested that the total cost comparison model would not be useful. According to fixed-cost analysis model, operating shipyards had fixed costs which would be avoided by closing a yard. However, finding little evidence to support that assumption, the Institute rejected the model.

NEED FOR PRODUCTIVITY MEASUREMENT

From the studies performed to date it is evident that developing a means for measuring shipyard performance has been a matter of concern, both in and outside the Navy. Such a means should enable top-level decisionmakers to assess the usefulness of each shipyard in relation to the others, and it should provide a basis for evaluating the shipyards' performance and capacities.

CONCEPT FOR DEVELOPING SHIPYARD ACTIVITY INDICATOR

In viewing Puget Sound as a production-oriented facility, we had the same difficulties as those cited by the Institute in that we could not readily identify a unit of output. We, too, rejected the hypothesis that productivity could be measured in the classical manner of relating output to input. We viewed Puget Sound, therefore, as a service facility.

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[1] "Methodology for Evaluating Naval Shipyards," Phase I, Model Feasibility, Task 72-8, Logistics Management Institute, Washington, D.C., February 1972.

Lacking an identifiable unit of output, we reasoned that, if shipyard capacity could be measured, we potentially could develop a model which would relate resources consumed, at whatever the level of capacity used, to the shipyard's total capacity and derive from this relationship a gross measure of shipyard activity. If a strong relationship were found between resources and capacity used, the model might then be useful in evaluating shipyard performance.

Conceptually, a shipyard, if viewed as a service facility, is analogous to the stalls and lifts in a local automobile service station. The number of stalls and lifts and the amount of time they are productively occupied logically should relate directly to the quantity of men, materials, and equipment necessary to service automobiles. If so, all of these elements, in turn, would affect the service station's total productivity and, hence, its profit.

This concept, of course, is useful only when motivating elements are present, such as commitments to complete on schedule, satisfy customers, and make a profit. Otherwise, a service facility could show high use while producing little in finished products or profit. Although naval shipyards do not have a profit motive, they are motivated to avoid costly schedule overruns and satisfy customers. We considered these two elements sufficient basis for further developing and testing the basic concept.

Developing the model

Perceived as a service facility, a shipyard comprises drydocks, berths, production shops, equipment, manpower, and funds. This model assumes that the most critical of these elements in determining shipyard capacity is the number of drydocks and berth spaces available to service the fleet. Therefore, we converted shipyard capacity to days that berths and drydocks were available. For example, Puget Sound's total capacity was expressed as 6,188 available dock and berth days a year (6 docks and 11 shipyard-designated berth spaces, available 7 days a week, 52 weeks a year).

Next we determined the number of days a year that docks and berths were occupied with ships undergoing repair, as shown in the following table.

	Fiscal year				
	1968	1969	1970	1971	1972
Berth and dock days available	6,188	6,188	6,188	6,188	6,188
Actual use	3,752	2,681	2,912	2,198	2,254
Percent used	61	43	47	36	36

Although one can argue that the physical capacity of production shops and equipment contributes to a shipyard's capacity, we did not include it because (1) shop capacity is less fixed than docks and berths, (2) the degree of variability in capacity could not be ascertained from available information, and (3) shop capacity supports the waterfront facilities, for the most part.

We also excluded funds as an input variable because the Navy Industrial Fund operates on a break-even concept, and revenues derived from shipwork are a direct function of costs incurred in doing the work. Including funds in the model, we concluded, could produce biased results.

We therefore used the manpower of all production shops as the input variable in the model, believing it to be the most sensitive to shipyard dock and berth use.

The following table shows manpower and dock and berth use at Puget Sound during fiscal years 1968-72.

	Fiscal year				
	1968	1969	1970	1971	1972
Dock and berth days used	3,752	2,681	2,912	2,198	2,254
Direct man-years	5,554	5,414	5,339	4,619	4,348
Overhead man-years	3,348	3,214	3,295	3,185	3,110
Total man-years	8,902	8,628	8,634	7,804	7,458

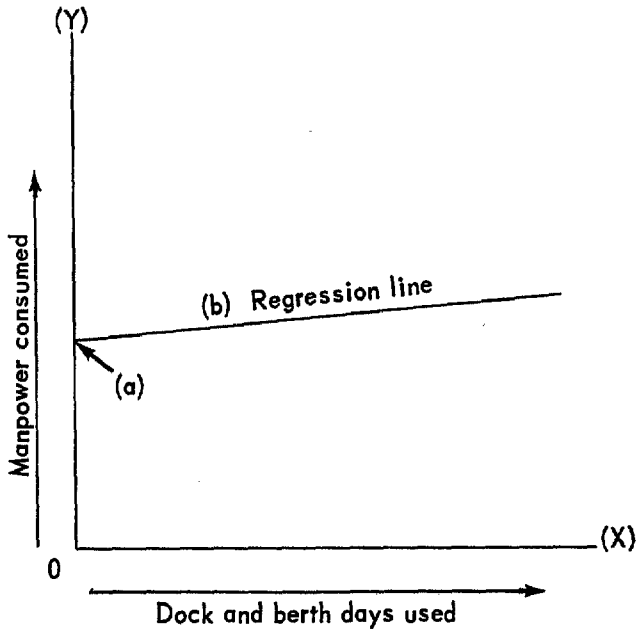
The model developed uses the simple linear regression analysis equation $Y=a+b_X$, shown below, in which:

1. Y=the dependent variable (manpower consumed).

2. a=the point on the verticle (Y) axis at which the regression line intersects.

3. b=the slope of the regression line.

4. x=the independent variable (dock and berth days used).



A perfect correlation occurs when any changes in the slope of the regression line are fully explained by changes in the independent (X) variable. This would produce a "coefficient of determination" of 1.0, or 100-percent correlation. For the shipyard model, a perfect correlation would mean that all increases or decreases in manpower consumption would be exactly explained by increases and decreases in the use of docks and berths.

A perfect correlation is rarely attained with only a single independent (X) variable. Therefore, we established an arbitrary acceptance level of a coefficient of determination of at least 0.64, with 95-percent confidence that the results were not achieved by mere chance.

Testing the model

We made a series of tests using a computerized linear regression analysis program. Initial tests related manpower (direct, overhead, and total) to dock and berth use on a quarterly basis. When we used quarterly data, results did not meet our criteria, i.e., produced a coefficient of determination of less than 0.64, so we rejected them. However, the relatively weak relationship could have indicated the shipyard's inability to adjust manpower as rapidly as its workload changed. This seems reasonable, considering that it takes 3 to 9 months to complete a reduction-in-force action and that workload and manpower planning is usually done annually.

This suggested that a yearly analysis might be more meaningful, and indeed it produced a coefficient of determination of 0.7225 and a confidence level greater than 99 percent that the relationship did not occur accidentally.

Thus, the model indicates that over 72 percent of the variability in total labor consumption can be explained by the level of dock and berth use. Therefore, if workload can be forecast with reasonable accuracy and can be stated in terms of dock and berth days required, the model becomes a potentially powerful analytical tool.

Additional analysis

Although these results appear to be exceedingly favorable as a potential way of gauging gross manpower and waterfront facility needs, the model needs to be analyzed further to (1) relate individual shop activity to shipyard activity, (2) provide an assessment of employee productivity, and (3) assess the usefulness of individual shipyards in relation to other shipyards. Some observations from the limited additional analysis which we made are discussed below.

Shop activity and employee productivity

Relating labor consumed by individual shops to dock and berth use produced acceptable correlation for some shops but not for others. Those shops which showed a weak relationship consistently showed increased labor consumption per dock and

berth day. A logical reason for this, according to Puget Sound officials, was that work had changed and become more complex.

Our attempts to devise a suitable means for including a complexity factor in the model were unsuccessful. However, we obtained shipyard work-sampling studies which had been conducted over a 22-month period, May 1971 through February 1973 (see p. 5), and compared the resulting trends with trends of shop activity. Charts depicting trends in the shipyard as a whole and in four sample production shops are shown on pages 24 to 29.

As can be seen from the charts, the workload dropped continuously; three shops showed increased labor consumption (as did the shipyard as a whole); and one shop showed a downward trend in labor consumption approximating the drop in workload. What is perhaps more noticeable is that the productive curve of all shops consistently showed a downward trend, including the shop whose work force was balanced with the shipyard's workload.

Thus, if complexity accounted for all increased labor, the productivity curve should have reflected either a stable or upward trend. However, the consistent downward productive trend in all four shops and in the shipyard as a whole indicated that decreasing employee productivity might be attributable to the low workload level. We observed that the shipyard's workload had dropped to 36 percent of dock and berth capacity in 1971 and by February 1973 had dropped further to 32 percent. Shop personnel stated that their work was severely affected by the decreased workload and that employees were concerned about losing their jobs.

It seems reasonable, therefore, that increased labor consumption per dock and berth day was, in part, due to lower employee productivity and was not solely a result of increased complexity.

The usefulness of combining the regression model with shipyard work-sampling studies can only be proven over time. However, it appears that using the two sets of data together adds a significant dimension to the model, particularly as a tool for developing trends and investigating causes at shipyard or even shop level.

CHART 1
SHIPYARD LABOR USED AS A RATIO TO BERTH AND DOCK USAGE BY PUGET SOUND NAVAL SHIPYARD

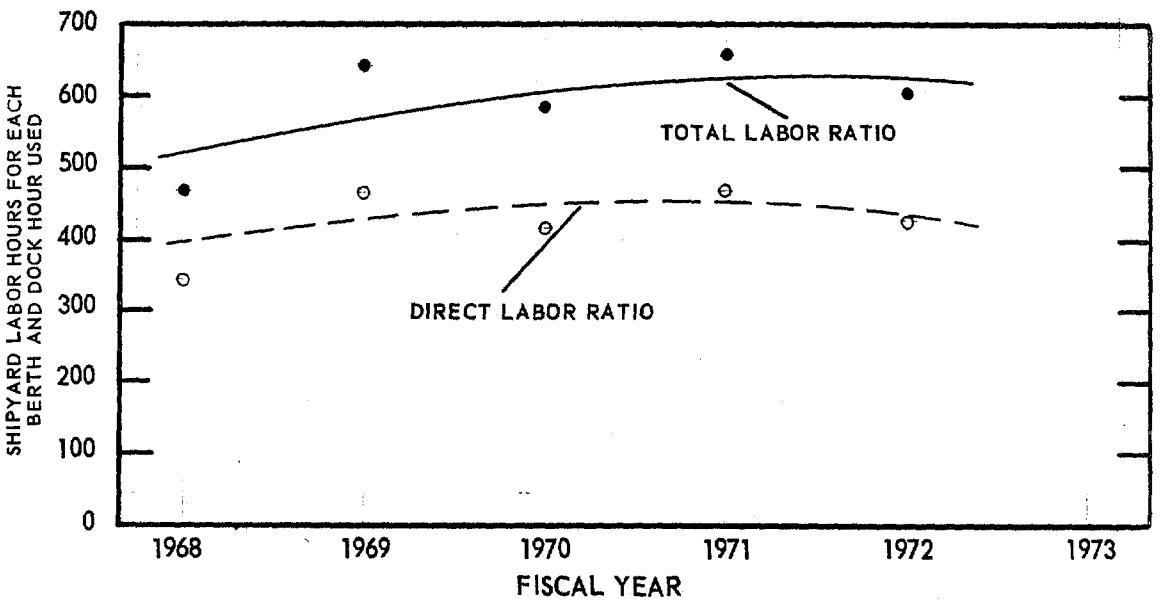


CHART 2
BERTH AND DOCK USAGE AND PRODUCTIVE TREND PUGET SOUND NAVAL SHIPYARD

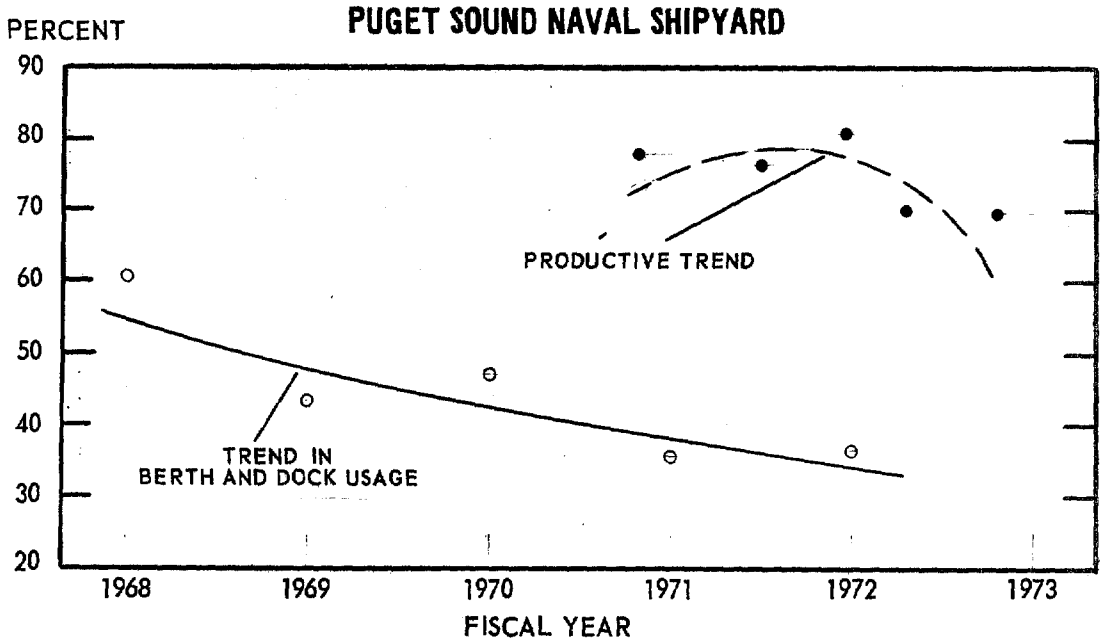


CHART 3
OUTSIDE MACHINE SHOP LABOR AS A RATIO TO BERTH AND DOCK USAGE

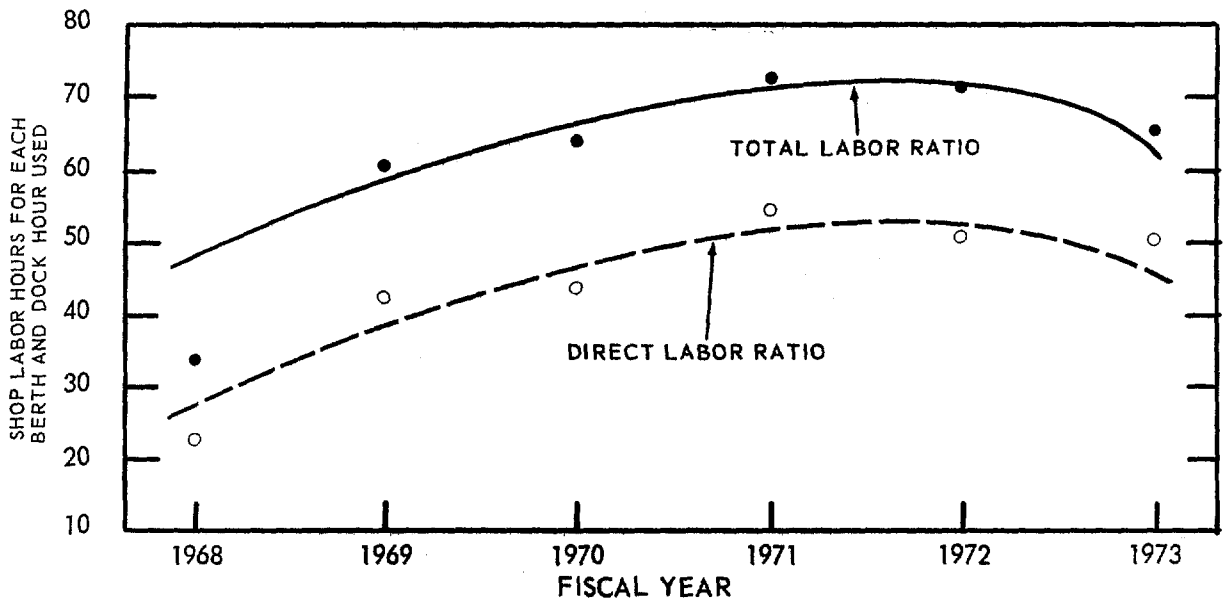


CHART 4
BERTH AND DOCK USAGE AND PRODUCTIVE TREND OF THE OUTSIDE MACHINE SHOP

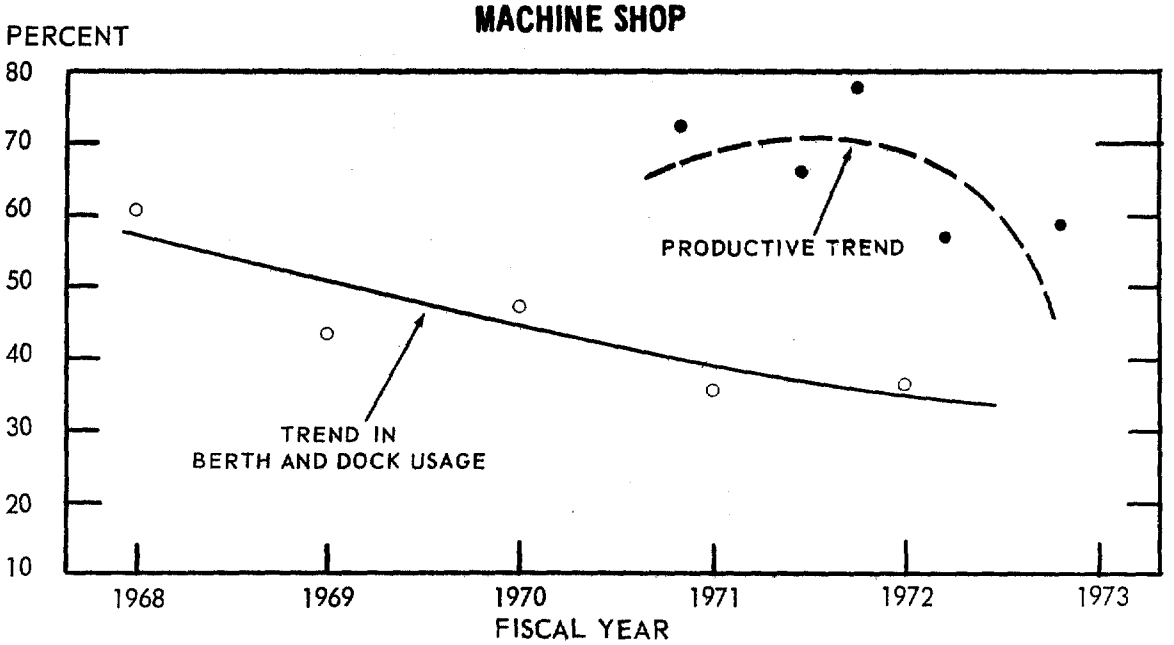


CHART 5
INSIDE MACHINE SHOP LABOR AS A RATIO TO BERTH AND DOCK USAGE

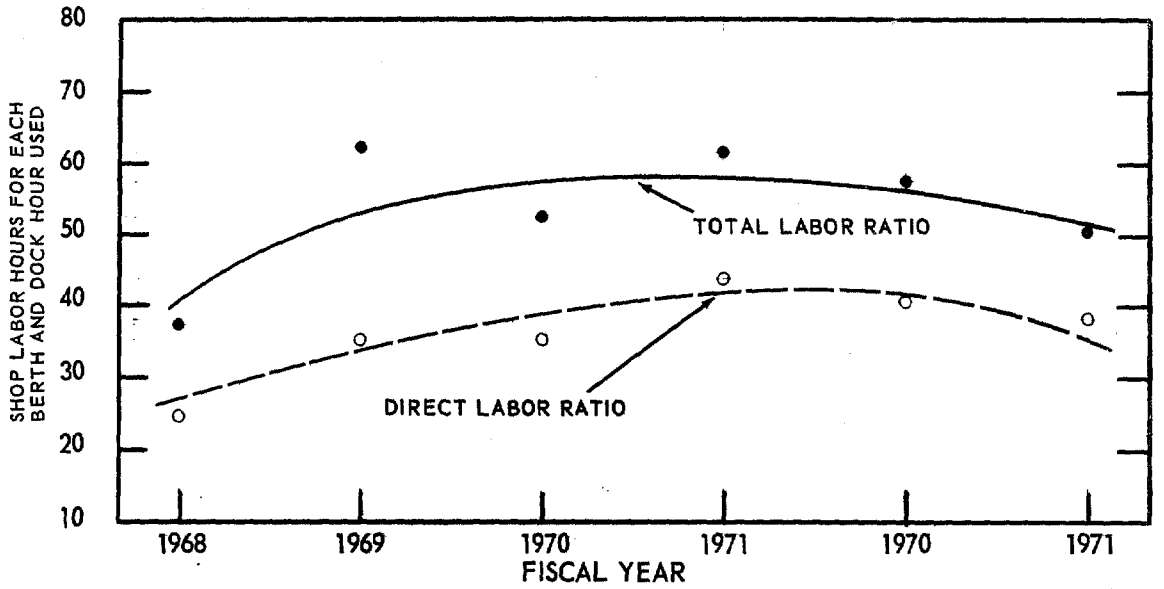


CHART 6
BERTH AND DOCK USAGE AND PRODUCTIVE TREND OF THE INSIDE MACHINE SHOP

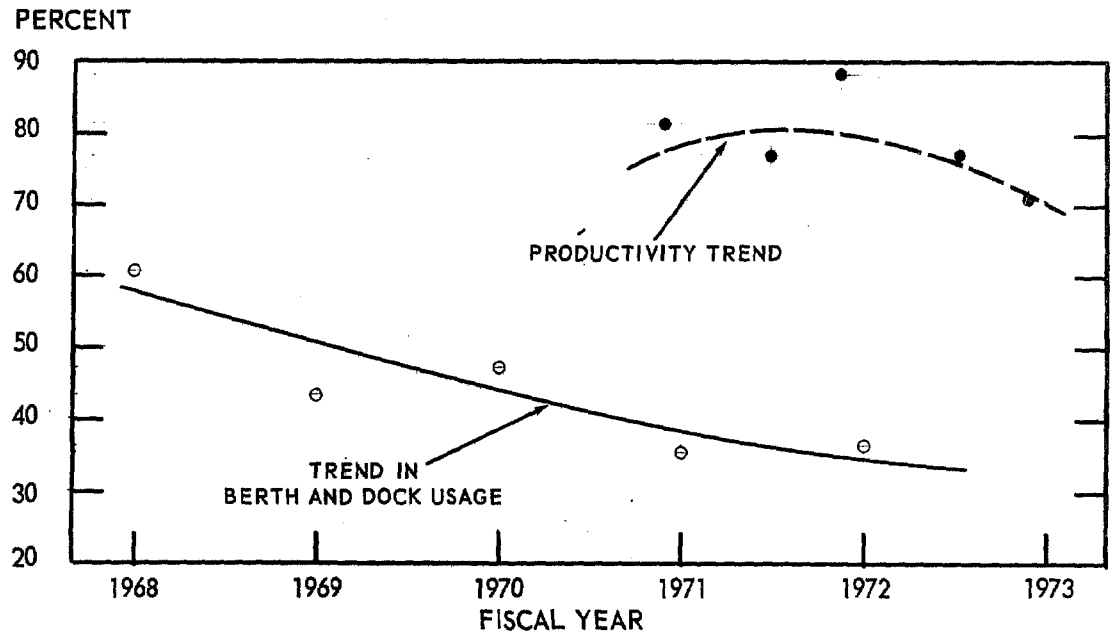


CHART 7
ELECTRONIC SHOP LABOR AS A RATIO TO BERTH AND DOCK USAGE

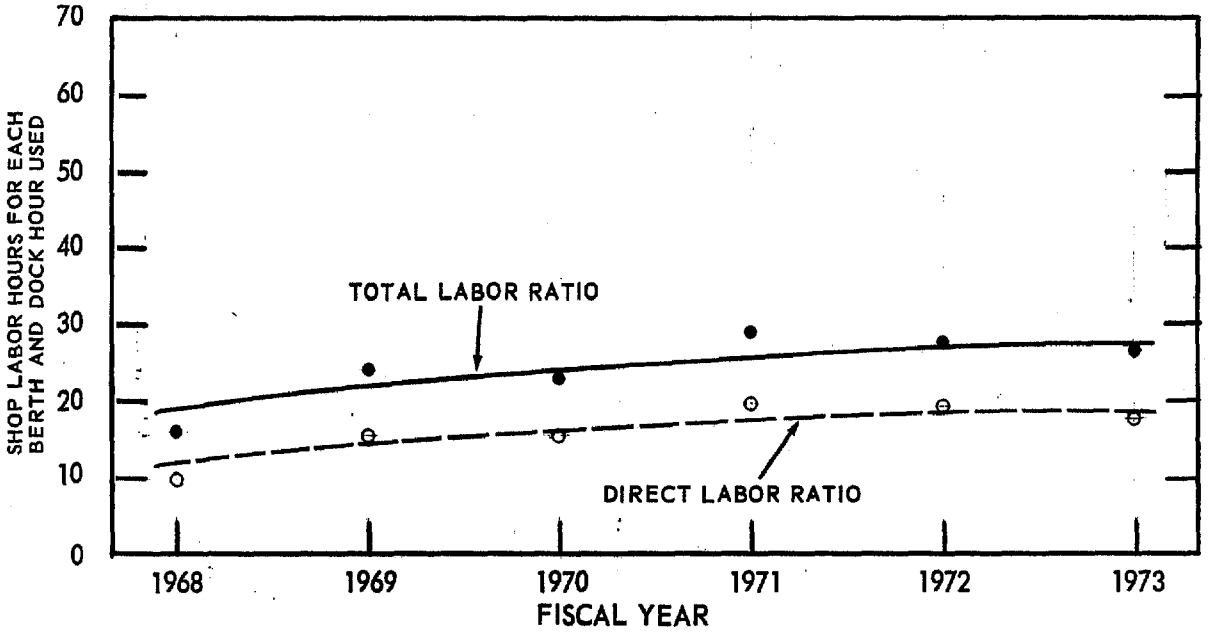


CHART 8
BERTH AND DOCK USAGE AND PRODUCTIVE TREND OF THE ELECTRONIC SHOP

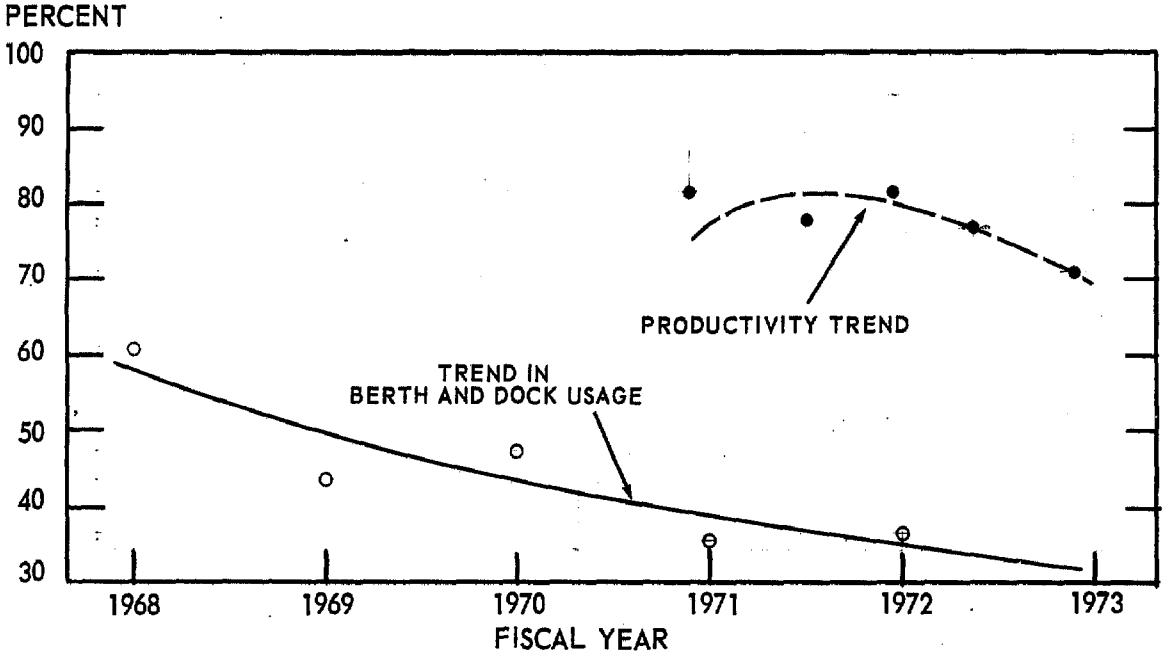


CHART 9
WELDING SHOP LABOR AS A RATIO TO BERTH AND DOCK USAGE

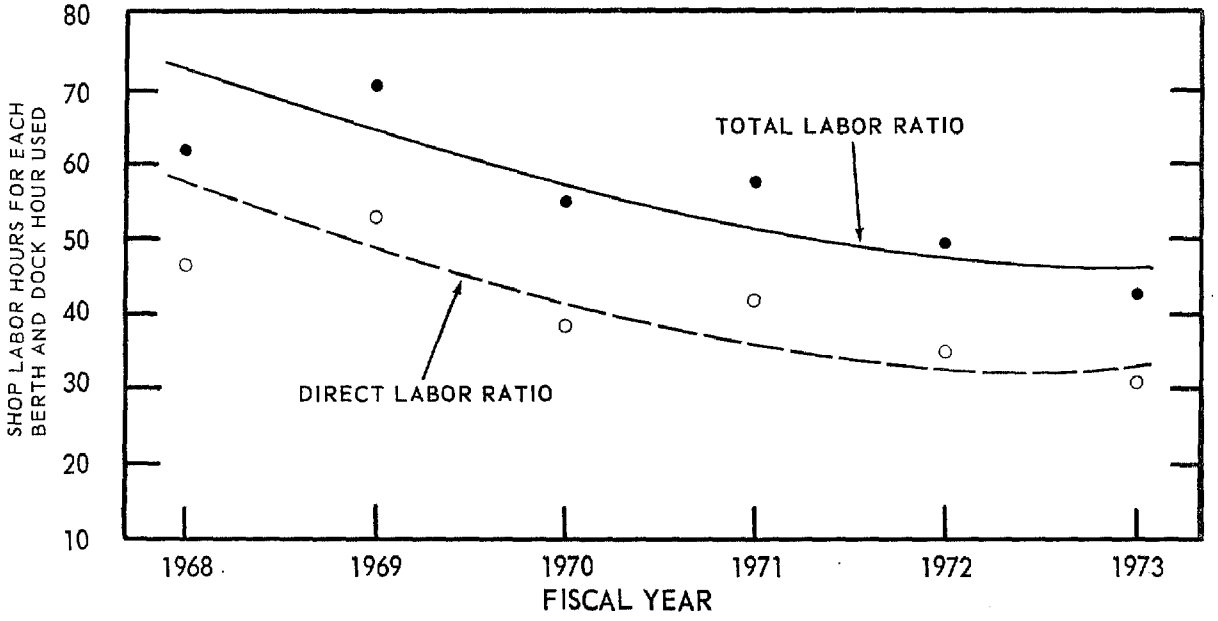
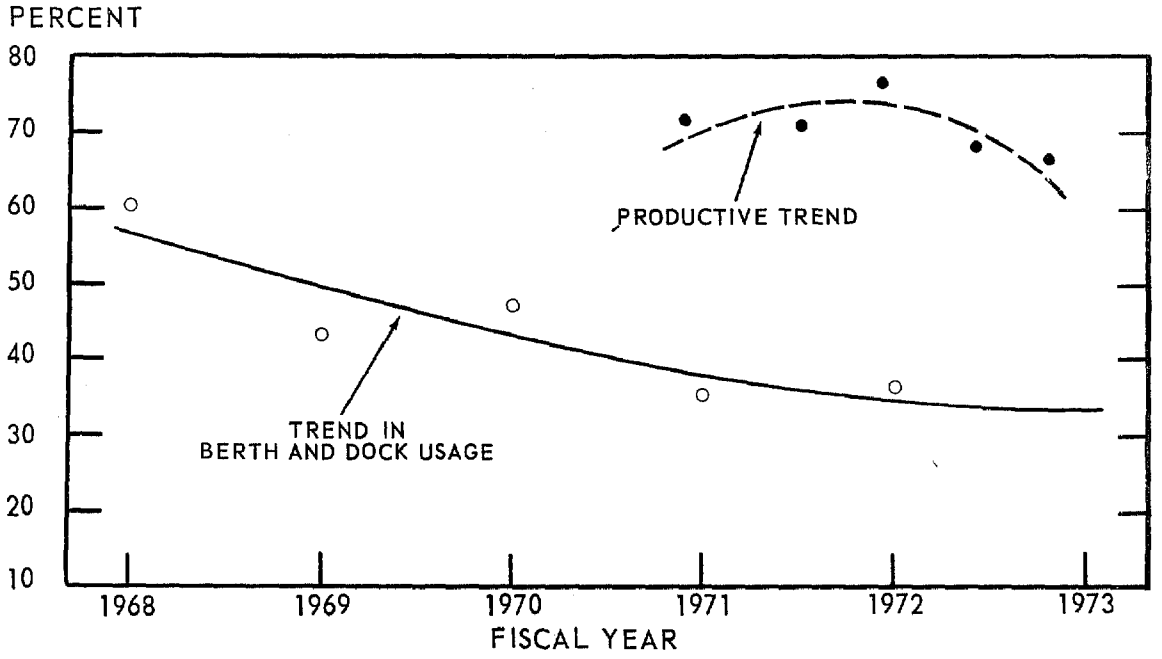


CHART 10
BERTH AND DOCK USAGE AND PRODUCTIVE TREND OF THE WELDING SHOP



Comparing the performance of different shipyards through the activity indicator model

To assess the usefulness of the activity indicator model as a device for comparing the performance of all yards, we tested the model, using manpower and facility use data obtained from the other shipyards. The results of those tests generally supported the results obtained at Puget Sound, indicating a viable and broader application of the model.

CONCLUSIONS

Studies made to date indicate that developing a means for measuring shipyard performance is of vital concern, both in and outside of the Navy. Efforts so far have not been satisfactory.

The amount of time shipyard docks and berths are used provides a means for appraising the level of shipyard capacity used. Use, in turn, is influenced by the workload assigned to a shipyard. The relationship between manpower consumed and use of docks and berths, through regression analysis, depicts management's effectiveness in adjusting manpower to changing workload. Although not precise, the model concept is valid and could be a useful analytical tool in evaluating shipyard activity.

Our tests of the model indicate that the relationship can be improved by stabilizing the shipyard's workload. Thus, if the workload can be predicted with reasonable accuracy and can be scheduled more regularly the activity indicator model may then be useful in appraising gross manpower and facility needs and overall shipyard resource use and performance.

NAVY COMMENTS AND OUR EVALUATION

The Navy does not agree that a better means of forecasting manpower requirements is needed. The Navy said that its present long-range planning system projects the required production shop manpower, skills, and total shipyard employment. We did not specifically examine the long-range planning system, but we are familiar with its objectives.

The Navy stated that the service facility technique possibly can be used as a measure of facility use but not as a measure of overall shipyard performance. It cited a number of factors which, if not properly accounted for in the model, could bias its results.

Although we do not agree that some of the factors cited would impute the usefulness of the model concept, we do acknowledge that the model needs further refinement and would have to be used together with other management indicators.

The Navy expressed appreciation for our efforts in providing the service facility concept but stated that, at the present time, it did not plan to use or refine it. Rather, it said, it was concentrating on developing carefully defined boundaries for authorized work so that it could compare levels of effort from ship to ship and within or among shipyards. The Navy anticipates that this effort will provide a basis for measuring performance. If this effort is successful, the Navy said, it would then be appropriate to further evaluate the activity indicator concept, as well as similar concepts, to improve the Navy's ability to evaluate equipment and facility use as well as performance.

We cannot express an opinion on the Navy's proposed action. However, its approach of comparing levels of effort from ship to ship and within or among shipyards appears to be essentially the same as that used in prior unsuccessful efforts to relate resources consumed to specific units of output (ships completed).

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

MAR 26 1974

Mr. Werner Grosshans
Associate Director
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Grosshans:

The Secretary of Defense has asked me to reply to your letter of January 18, 1974, concerning the Industrial Management Review of Puget Sound Naval Shipyard (Code 947007) (OSD Case #3763). I am enclosing the Department of the Navy reply.

The attached detailed comments respond specifically to the GAO recommendations. A number of other comments and conclusions, offered by GAO in the report digest and introduction, have not been addressed because they are not particularly supportive of the report's recommendations. Additionally, subjects such as identified below have been addressed extensively by the Navy in various communications to Congress and GAO.

- Homeporting policy as related to public and private shipyard workload.

- Policy of new ship construction in the private sector since the FY 68 program.

- Dramatic reduction in fleet size during the last several years.

The dynamics of the shipyard workload/workforce relationship have been influenced by the above factors and others such as emergent work, heavy SEASIA operational commitments, increased ship complexity, changes in ship type mix at specific yards, civil service regulations, and restrictive fiscal guidance imposed by higher authority.

In recognition of the situation confronting us, the Navy commenced the closure of two naval shipyards while selectively increasing employment at the remaining shipyards to obtain a more efficient workforce. We are continuing to increase employment in order to execute the larger FY 74 and FY 75 overhaul programs brought about, in part, by SEASIA related deferred maintenance.

The findings and conclusions listed in the digest seem to create an impression that major problems exist. However, this is not specifically borne out by the GAO recommendations. While GAO does recognize and highlight the challenges associated with efficient shipyard management, the report does not fully recognize the Navy's awareness of those challenges as evidenced by some very visible and concerted improvement efforts.

Sincerely,

Jack L. Bowers
Assistant Secretary of the Navy
(Installations & Logistics)

Encl:
(1) Department of the Navy Reply

Department of the Navy Reply

to

GAO Draft Report of 18 January 1974

on

Industrial Management Review of Puget Sound

Naval Shipyard

(OSD Case #3763)

I. GAO Findings and Recommendations

The General Accounting Office (GAO) performed a pilot industrial management review at the Puget Sound Naval Shipyard to identify ways to improve or enhance productivity in the shipyards. One of GAO's objectives was to independently evaluate productivity, i.e., the efficiency with which all resources--people, material, equipment, facilities, and management systems--were applied to accomplish the work.

GAO found that managing a shipyard efficiently and economically is difficult because shipyard management has no control over its workload, workload at Puget Sound decreased 42 percent during the 1968-72 timeframe, and workload is unpredictable and is subject to frequent changes. GAO states that as a result: (1) shipyard facilities have been greatly underutilized; (2) much equipment is underused or is idle; (3) shipyard management has not adjusted manpower to workload and (4) the direct labor force has become less productive.

GAO concluded that since the most critical constraint on shipyard operations appears to be the level and predictability of workload, the greatest opportunities for improving overall shipyard productivity require stabilizing and increasing the workload, and developing a viable means of balancing manpower requirements with the workload. GAO developed a mathematical model for relating manpower consumption to shipyard dock and berth utilization. The concept, model development and test results are discussed in Chapter 5 and are presented in this report. With additional refinements, GAO believes the model could be useful to top level management in gauging overall facility and manpower needs as well as shipyard performance.

GAO makes four recommendations to the Secretary of the Navy; in the last one GAO includes three recommendations for the Puget Sound Naval Shipyard. Specific comments concerning all of these recommendations are in Paragraph II below.

II. Navy Comments

The Navy does not concur with Recommendation 1, concurs with Recommendation 3, and with the intent of Recommendations 2 and 4. With regard to the activity indicator model developed by GAO, the Navy does not consider it to be a valid measurement of overall shipyard performance.

Recommendation 1 - The Secretary of the Navy develop a more systematic means to accurately forecast direct and overhead manpower requirements in relation to projected and actual workload.

COMMENT - Do not concur that a more systematic means than currently available is required to forecast manday requirements. This does not however preclude refinements in the present system to improve its responsiveness and accuracy. The Naval Ship Systems Command (NAVSHIPS) has an effective automated Long Range Planning System (LRPS) which is capable of projecting workloads for naval shipyards as far in the future as force levels, ship configurations and maintenance policies can be projected. Usually a ten year period is projected with the current fiscal year as the first year. Outputs include not only the projections for required productive shop manpower and skills and total shipyard employments, but also a simulation of the utilization of drydocks and determination of maximum waterfront facility requirements. Workloads developed in the LRPS are used as input into a computerized Shipyard Modernization System (SMS) which in turn develops industrial equipment and facility requirements. Considering all the variables in the workload forecasting process, the current headquarters system is considered to be effective. A more sophisticated system is not required and would not provide any foreseeable benefits.

In the introduction to the draft report and data leading to the recommendation, GAO stated that:

" - shipyard management has no control over its workload
- workload at Puget Sound decreased 42 percent during the 1968-72 timeframe
- workload is unpredictable and is subject to frequent changes."

Shipyard management has direct control over acceptance of unscheduled ship availabilities (RAV), manufacturing and restoration. Although shipyard management does not initially assign scheduled ship availabilities (overhaul and conversion) to their yard, they are consulted by NAVSHIPS in the process of developing the schedule and do recommend changes where difficulties are foreseen. Since Puget Sound workload consists largely of nuclear ship overhaul and conversion, its workload has been actually more stable and predictable than most other naval shipyards. The references to shipyard workload as having decreased by 42% during the FY 68-72 timeframe are incorrect. GAO used the number of ship starts as indicative of shipyard workload year to year. The 42% decrease was computed from GAO figures of 26 ship starts in FY 68 and 15 in FY 72. Such an analysis is completely invalid as it treats availabilities of 400 and 451 mandays in FY 68 as equal to two availabilities of over 270,000 mandays each in FY 72. In addition to the NAVSHIPS headquarters workload forecasting (LRPS) described above, the shipyards have a very effective one year

workload forecasting system that is a part of the Shipyard Management Information System which is uniform for all shipyards. This standard system is currently operational at six of the eight naval shipyards and will be operational at Puget Sound, the last shipyard, by July 1974. Puget Sound has an existing workload forecasting system that is basically equivalent to the standard application less some refinements and gaming capability. Accordingly, NAVSHIPS plans no action as a result of this recommendation that is beyond that already in progress as noted above.

Recommendation 2 - The Secretary of the Navy re-evaluate existing criteria for labor standards; develop and closely monitor procedures to ensure that the application of standards demonstrate useful contribution to more efficient shipyard management; use Methods and Standards Branch personnel in an agressive program to cross-train planners and estimators in developing standards; and actively involve shop management in the planning and estimating process to (1) increase their understanding of work measurement techniques and (2) improve their communication with the Planning Department.

COMMENT - While not agreeing with all the specifics set forth in the conclusion leading to these recommended requirements the Navy agrees with the basic intent described in them. They are consistent with existing NAVSHIPS policy and practices. Specifics regarding the current status of these programs are as follows:

(1) By Change 6 to NAVSHIPSINST 4854.5 dated 17 July 1973, the responsibility for the development and maintenance of estimated standards was transferred from the Production Department to the Planning Department in all naval shipyards. Qualified work measurement technicians are being relocated to the Planning and Estimating Division of the Planning Department to assure that standards are properly developed and applied. Specifically, the Puget Sound Naval Shipyard is in the process of relocating five industrial engineering technicians. This action should ensure the recommended cross training of planners and estimators as the total responsibility for the estimated standards program will reside within a single functional area.

(2) In early calendar 1973 NAVSHIPS directed the naval shipyards to realign the standards function so that future methods and standards efforts would be concentrated primarily on local methods improvements. It was emphasized to all naval shipyards that NAVSHIPS requires each shipyard to have a viable methods and standards effort that places the principal effort on the achieving of real savings through the continual application of the methods and standards personnel to the improvement and simplification of methods with subsequent translation of the results into reduced standards to be used in estimating and monitoring work.

(3) The need to actively involve shop management in the planning and estimating process has long been recognized by NAVSHIPS. The recent development and the current implementation of the Work Oriented Job Order (WOJO) System represents a major change in the philosophy and in the ability to construct work packages or job orders. WOJO reflects a

production vice financial oriented approach and provides a planning methodology that permits clearer definition of the interface/interaction of related ship work. One of the essential requirements of this system is the active participation of shop personnel in the planning process to ensure production oriented work packages. An increase in the shops' understanding of work measurement and improved communication between the shops and planning will be an inevitable result of the cooperative effort required. Four of the eight naval shipyards are presently utilizing WOJO to various extents. It is anticipated that general application of the system in all naval shipyards will occur, after a suitable learning period, no later than calendar year 1975.

[12] [See GAO note.]

(4) On page 21 of GAO's report, GAO suggests the use of a report titled "Improving Work Measurement Systems in the Federal Government". The Navy agrees that this referenced report can be used as a guide in developing work measurement systems and fully concurs with the statement on page 3 of that report which states: "It is suggested that the results of this study be reviewed and carefully considered from the perspective of your organization". Accordingly, it must be recognized that the guides furnished in this document are general in nature and require careful analysis and interpretation prior to application.

Recommendation 3 - The Secretary of the Navy insure that rework costs are properly recorded and analyzed for appropriate corrective action.

COMMENT - The Navy concurs completely with this recommendation and has recently re-emphasized to all naval shipyards the management advantages of an effective work and spoilage program.

Recommendation 4 - The Secretary of the Navy require the Puget Sound Naval Shipyard to:

a. Develop a program for accumulating actual equipment use data.

b. Examine existing and proposed investments in equipment to ensure the equipment is needed.

c. Report idle equipment to the Defense Industrial Plant Equipment Center so that possible benefits from redistribution can be realized.

COMMENT - Concur with the intent of this recommendation as is evidenced by NAVSHIPS and Shipyard efforts as follows:

(1) NAVSHIPS is presently conducting a Shipyard Modernization Program Restructure Analysis, which in the equipment area, is documenting equipment utilization and projecting future utilization requirements. The restructure effort will validate the need for existing and proposed equipment. It must, however, be pointed out that some equipments are special purpose machines peculiar to naval shipyard mission performance.

GAO note: The number in brackets refers to the page in this report.

(For example, large boring mills for machining propellers, large structural sections and heavy armor.) No private industry in the Pacific Northwest has such capabilities. If the Puget Sound Naval Shipyard is to properly and adequately carry out its mission of service to the Fleet, such capabilities must be retained regardless of the utilization time.

(2) NAVSHIPS has procured 1000 hour meters for each shipyard to retrofit existing equipment for determining utilization. There is a breakoff point where the types and cost of equipment make it impractical to install hour meters. In addition, since the start of the Shipyard Modernization Program, all equipments have been procured with hour meters, when practicable.

(3) NAVSHIPSINST 4870.18 of 9 August 1973 covers "Policy and Procedures Governing Plant Equipment" i.e.:

- -Industrial Plant Equipment (IPE) project development, submission and acquisition.
- -Action concerning installation of new IPE and release of replaced equipment.
- -Reporting procedures for defective IPE.
- -Preventive Maintenance of IPE.
- -Procedures concerning retention of IPE idled by shrinking or fluctuating workloads and reporting of excess IPE.

In addition, NAVSHIPSINST 4870.9C of 13 July 1973 established procedures for recording savings from and utilization of IPE procurements. When fully implemented these procedures will provide a tool for effective management of Industrial Plant Equipment.

Chapter 5. "Evaluating Shipyard Performance Through Capacity Utilization." GAO states that the activity indicator model was considered to be an excellent analytical tool in evaluating shipyard activity. It was, however, noted that the model needs further refinement and should be used in concert with other indicators of performance, particularly where program results, complexity of work, effectiveness and quality are involved.

COMMENT - The service facility technique has possible use as a measurement indicator on facility usage, however, it cannot be considered as a truly valid - or even remote - measurement of overall shipyard performance. Following are two examples of how the facility measurement technique can give false impressions of performance:

(1) Puget Sound started two Fleet Ballistic Missile Submarine (SSBN) conversions in FY 72. These availabilities required more Production Shop mandays of work than all seventeen ships started in FY 68 combined. Since work in the shops is not included in the service facility concept, a great portion of work is excluded for measurement.

(2) Despite a decrease in ship starts from FY 68 to FY 72, production shop mandays actually increased 453,154 in FY 68 to 651,132 in FY 72. Here again inside shop work is not covered using the service facility technique.

With respect to the macro indicator concept, the following is noted:

The 17 available service facilities in Puget Sound include 4 very large drydocks while most of the 11 berths are among the longest and best equipped in the naval shipyard complex. These facilities were not built with any reference to what might become the peacetime workload in the future but for what appeared to be the need at the time and what may be an emergency need in the future. The requirements of a peacetime (reduced) workload as is now experienced were not a part of the deliberations. These facilities are given the same weight as marine railways, short berths and even inoperable berths in other naval shipyards. If the facilities were all operable and were all fully utilized, the industrial plant to support them would not be sufficient and there would be an imbalance between the drydocks and the berths. A workload that had all berths occupied would produce a docking requirement far beyond the available capacity.

The Navy appreciates GAO's efforts in providing the service facility concept but, at the present time, does not plan to utilize the activity indicator model or to perform further refinement to it. Rather, efforts are being concentrated on the development of carefully defined boundaries for authorized work such that comparison of levels of effort can be made from ship to ship of a class, both at a shipyard and between shipyards. It is anticipated that this, when completed and implemented, will provide an effective base for the measurement of performance. At that time, after development and implementation of the system described, it will be appropriate for the Navy to further evaluate the activity indicator model as well as other similar concepts in order to continue improving the capability of evaluation of equipment and facility utilization as well as performance.

[See GAO note.]

GAO note: Material no longer related to this report has been deleted.

PRINCIPAL OFFICIALS OF THE DEPARTMENTS OF DEFENSE AND THE NAVY RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
James R. Schlesinger	Apr. 1973	Present
Elliot L. Richardson	Jan. 1973	Apr. 1973
Melvin R. Laird	Jan. 1969	Jan. 1973
Clark M. Clifford	Mar. 1968	Jan. 1969
Robert S. McNamara	Jan. 1961	Feb. 1968
DEPUTY SECRETARY OF DEFENSE:		
William P. Clements, Jr.	Jan. 1973	Present
Kenneth Rush	Feb. 1972	Jan. 1973
David Packard	Jan. 1969	Dec. 1971
Paul H. Nitze	July 1967	Jan. 1969
ASSISTANT SECRETARY OF DEFENSE (INSTALLATIONS AND LOGISTICS):		
Arthur I. Mendolia	Apr. 1973	Present
Hugh McCullough (acting)	Jan. 1973	Apr. 1973
Barry J. Shillito	Feb. 1969	Jan. 1973
Thomas D. Morris	Sept. 1967	Feb. 1969
DEPARTMENT OF THE NAVY		
SECRETARY OF THE NAVY:		
J. William Middendorf	May 1974	Present
John W. Warner	May 1972	Apr. 1974
John H. Chafee	Jan. 1969	May 1972

DEPARTMENT OF THE NAVY (continued)

ASSISTANT SECRETARY OF THE NAVY (INSTALLATIONS AND LOGISTICS):			
Jack L. Bowers	June 1973	Present	
Charles L. Ill	July 1971	June	1973
Frank Sanders	Feb. 1969	July	1971
CHIEF, NAVAL MATERIAL COMMAND:			
Admiral I. C. Kidd, Jr.	Dec. 1971	Present	
Vice Admiral J. D. Arnold	Aug. 1970	Nov.	1971
Admiral Ignatius J. Galantin	Mar. 1965	July	1970

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