SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

June 1978
NSRP 0005

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

REAPS 5th Annual Technical Symposium Proceedings

Paper No. 18: Improving Shipbuilding Productivity Through Use of Standards

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

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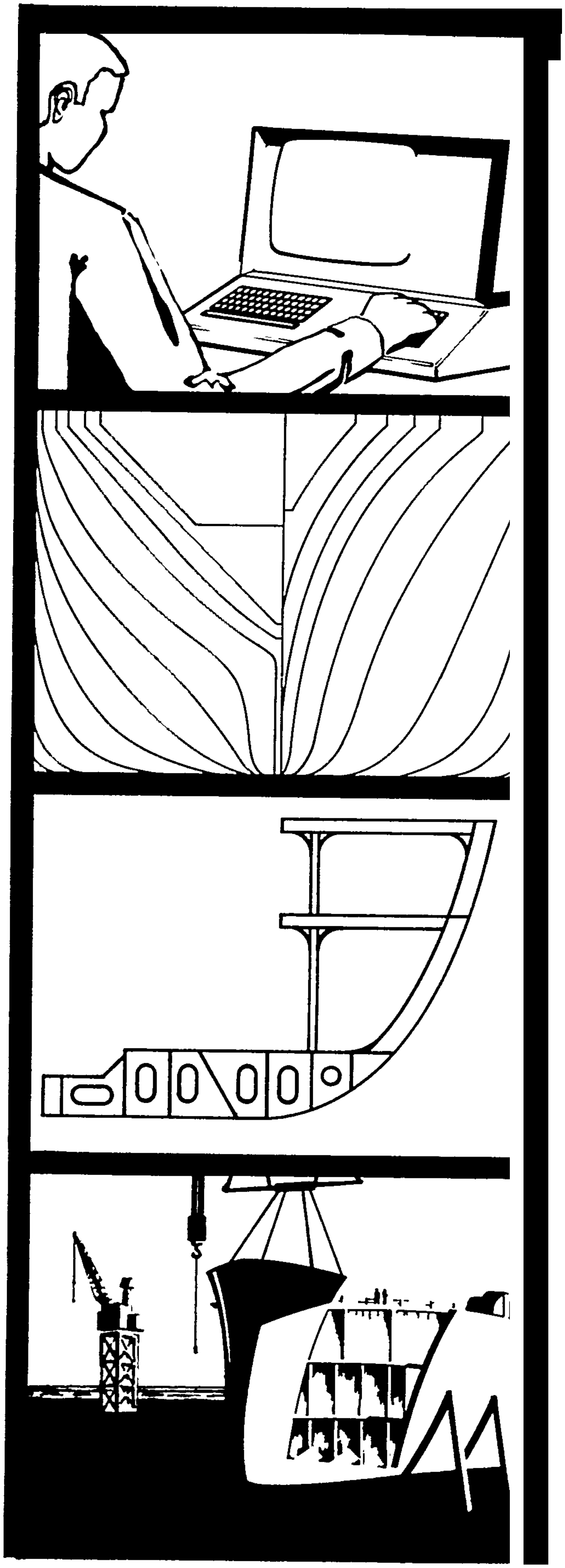

RESEARCH
AND
ENGINEERING
FOR
AUTOMATION
AND
PRODUCTIVITY
IN
SHIPBUILDING

Proceedings of the REAPS Technical Symposium

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IMPROVING SHIPBUILDING PRODUCTIVITY THROUGH USE OF STANDARDS

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Mr. Mason is currently responsible for the administration of the Shipbuilding Standards Research Program under the joint Bath Iron Works/Maritime Administration (MarAd) Ship Producibility Research Program. He also serves as Secretary of the Society of Naval Architects and Marine Engineers (SNAME) Panel SP-6, Standards and Specifications; and was recently elected Secretary of the new ASTM Committee F-25 on Shipbuilding.

Mr. Mason holds a B.S. degree in mechanical engineering from the U.S. Naval Academy and an M.S. degree in administration/management engineering from George Washington University.

IMPROVING SHIPBUILDING PRODUCTIVITY THROUGH USE OF STANDARDS

INTRODUCTION

The use of standards to improve productivity in the shipbuilding industry is not a revolutionary concept. In contrast to the European shipyards; however, (who have stated that they could not operate profitably without standards) and to the Japanese shipbuilding industry (which for more than 25 years has employed a sophisticated system of national industrial and individual company standards), the use of standards in this country to improve shipbuilding productivity has been limited.

In recent months significant progress has been made in implementing a National Shipbuilding Standards Program which has the potential for major improvements in productivity and reductions in cost in the U.S. shipbuilding industry. The objective of this brief paper is to provide an overview of the National Shipbuilding Standards Program effort and to illustrate the potential benefits of the use of standards.

BACKGROUND

In the summer of 1970, the Maritime Administration Office of Advanced Ship Development joined forces with the Ship Production Committee of SNAME (the Society of Naval Architects and Marine Engineers) in a joint venture to plan and finance research projects which would reduce the time and cost of ship construction. One-of the principal efforts within the National Shipbuilding Research Program is the Ship Producibility Research Program sponsored by Bath Iron Works Corporation.

As a result of research conducted in the original “standardization” portion of the Ship Producibility Research Program between 1973 and 1976, and the findings of related research, it became clearly apparent that many aspects of the U.S. shipbuilding industry would benefit significantly from the coordinated development and use of industry standards. In October, 1976, a National Shipbuilding Research Program report was published entitled “Feasibility of Shipbuilding Standards”. This report concluded that shipbuilding standards are technically and economically feasible, and recommended development and implementation of a National Shipbuilding Standards Program.

During 1977, planning was accomplished for a major redirection of the Ship Producibility Research Program to focus on the areas of Shipbuilding Industrial Engineering and Shipbuilding Standards. It should be noted that improved productivity, and therefore reduced cost, is also the prime objective of the Shipbuilding Industrial Engineering Program - specifically through the development and application of shipyard labor standards and other traditional I.E. techniques. Additional information on this program is available from either Frank Munger or Jim Helming, Bath Iron Works Corp., (207) 443-3311.

Implementation of a National Shipbuilding Standards Program began in November, 1977 with the reactivation of SNAME Panel SP-6, Standards and Specifications. Through this group an initial program of shipbuilding standards research projects was developed, and the American Society for Testing and Materials (ASTM) was selected as the best "system" for the development and ongoing maintenance of national shipbuilding standards.

MECHANICS OF THE NATIONAL SHIPBUILDING STANDARDS PROGRAM

ASTM COMMITTEE F-25 ON SHIPBUILDING

The American Society for Testing and Materials (ASTM), founded in 1898, is a non-profit management system for the development of standards on characteristics and performance of materials, products, systems, and services; and the promotion of related knowledge. It is the world's largest source of voluntary consensus standards; and is currently the administrative, legal, and publications arm for some 130 standards-writing committees. ASTM standards are submitted to ANSI (the American National Standards Institute) for parallel approval as American National Standards. (ANSI is not in the business of writing standards, but performs the function of national coordinator; ASTM is the major standards writing organization.) Recognizing the problem of semantics surrounding the word "standard", ASTM uses it as an adjective in conjunction with five (5) types of standards - standard specifications, test methods, definitions, recommended practices, and classifications.

On May 31 - June 1, 1978 over 175 senior representatives of all segments of the shipbuilding industry (shipbuilders, owner/operators, design agents, major vendors, regulatory and government agencies, and academia) met at ASTM Headquarters in Philadelphia and officially organized the new ASTM Committee F-25 on Shipbuilding. During this meeting the scope of the committee was defined, a technical and administrative subcommittee structure was approved, committee officers were elected, and the technical subcommittees met to establish initial membership, leadership, and the scope of each subcommittee's work[2] Anyone who has an interest in the work of this committee may join at any time, and, in fact, individuals interested in working on the various technical subcommittees are encouraged to join these now active groups as soon as possible by contacting the author.

As the technical subcommittees identify standards to be developed, task groups of 2 to 5 people are formed to do the required background work and actually prepare an initial draft, which is reviewed by its parent subcommittee through a balloting procedure. If the document is approved by two-thirds of those returning ballots (a minimum of 60% of voting interests must return ballots), the document proceeds to the main committee ballot. Here, 90% of those returning ballots (again a 60% return i-s required), must approve the document. It then goes to a Society ballot where a minimum of 50 ballots is required, and 90% must vote affirmatively to make it an approved ASTM standard.

SHIPBUILDING STANDARDS RESEARCH PROGRAM SUPPORT

In pursuit of the overall objective of reducing the cost and time of ship construction, the Ship Producibility Research Program with SNAME Panel SP-6 has implemented an initial group of research projects which will directly support the efforts of the new ASTM committee[3].

First, to establish a baseline for the research program and for the ASTM committee, Task S-20 - “A Compendium of National Shipbuilding Standards” constitutes a survey of three (3) major areas:

(1) identification of ’standards currently in use in the shipbuilding industry. In addition to the more familiar standards (e.g. ASME Boiler and Pressure Vessel Code, IEEE-45, etc.) this will include an index of existing shipyard standards, accepted practices, etc.;

(2) identification of existing national standards not currently used in the shipbuilding industry, which have potential application; and

(3) a survey of selected foreign shipbuilding standards (IS0[4], IEC[5], Japanese, Swedish, and West German) to determine potential application in the U.S.

The index of shipbuilding standards which results from this project will be made available to all interested parties as an invaluable aid in planning, priority setting, and avoiding potential duplication of effort. On the latter point, it is not the intent of either the research program or the ASTM committee to duplicate existing standards. Rather, it is envisioned that the new ASTM standards will simply reference valid standards as appropriate (e.g. ASME Boiler and Pressure Vessel Code), and will hopefully work hand in hand with the various regulatory requirements (e.g. ABS Guidelines for Building and Classing Steel Vessels).[6]

The second, and principal, effort within the shipbuilding standards research program is currently comprised of a total of eight (8) cooperative shipyard standards writing efforts. These are, for the most part, design/Construction standards for routine items (e.g. ladders, manholes, etc.), and have been structured to "prime the pump" by providing several draft standards to each of the ASTM technical subcommittees within the next twelve months.

Future development of standards through the shipbuilding standards research program, beginning with follow-on efforts to the projects in the initial package, will emphasize well defined Priorities for cost reduction and productivity improvements through the continued cooperative efforts of participating shipyards.

POTENTIAL BENEFITS OF STANDARDS

In general, attempts to describe or moreover, to quantify the benefits of using standards in the shipbuilding industry can be as frustrating as trying to eat an elephant between two slices of bread. For one thing, our industry is a very special and complicated system. Compounding this, the impact of even one simple standard might be described as a complex, three-dimensional ripple/multiplier effect. The following sections of this paper represent the author's attempt to first describe some of the secondary or "ripple" benefits of using standards, and secondly, to focus on some direct improvements in productivity.

SECONDARY BENEFITS OF STANDARDS

Assessing the full impact of the application of standards in the shipyard requires an appreciation of the entire management cycle as shown in Figure 1.[7] Some examples of the impact of standards in

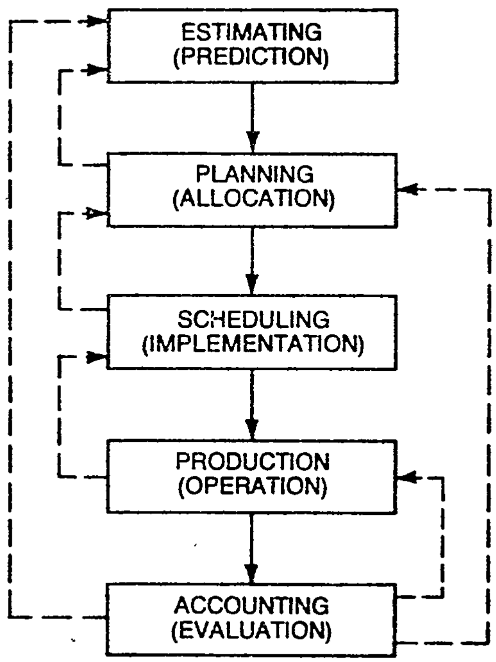

Figure 1 - Management Cycle

the general management cycle are:

- Reduced bidding costs - more accurate estimates
- More accurate planning and scheduling - less uncertainty
- Reduced design, engineering, approval and inspection cost
- Facilitation of automation - computer aided design and manufacturing

- Elimination of unnecessary variations in design factors and construction details
- Improved customer acceptance - clear communication
- Increased equipment reliability - reduced spares

DIRECT PRODUCTIVITY BENEFITS OF STANDARDS

Focussing now on the production or operations function of the shipbuilding management cycle, the objectives of this section are two-fold: (1) to describe in general terms some of the direct improvements in productivity which can be realized through the use of standards, and (2) to provide some specific, quantitative examples of potential productivity improvements and the related cost savings.

What are some of the direct productivity improvements which can be realized through use of standards? The following examples, certainly not all inclusive, are offered for consideration.

Reduced Shipyard Purchasing and Material Cost - the use of standard parts, components, and materials will result in fewer material line items, a reduction in inventory levels, improved material availability, potential quantity discounts, and general streamlining of the purchasing/material functions.

Reduced Shipyard Hours Due to Increased Production Efficiency - producibility will be an integral consideration in design/construction standards; definitive standards and the learning curve effect will result in improved quality (fewer errors and less rejection/rework), shops will be more level-loaded due to improved planning and scheduling, special requirements (mock-ups, models, etc.) will be eliminated.

<u>Facilitation of Batch Manufacturing</u> - standards will encourage batch manufacture of parts for future use, or even sale to other yards; shops would be more level-loaded; scrap reduced through cross-nesting, etc.

<u>Reduced Time, Contract Award to Production</u> - the utilization of standards will simplify the post contract design, allowing shipyards to start work sooner on the contract, and let the design of modified areas proceed along with the construction.

How realistic are these potential benefits of using standards in shipbuilding? The following are selected specific examples which are the results of standards research projects and/or actual shipyard application.

(1) <u>Rectangular Vent Duct Standards</u>

Quoting the findings of this research project:[8]

1.3 Findings

Overall costs for rectangular vent duct installations in ships could be reduced significantly through the use of standards. For example a 20 c savings is estimated for such installations in a 75.000 DWT Panamax tanker. The savings are manifest in all of the required shipbuilding disciplines and mostly result from eliminating virtually all custom components and thus allowing a reduced number of line items both for purchased and in-process materials.

These standards are currently being used by Tacoma Boatbuilding Co. and J. J. Henry Co. in the design and construction of new class of USCG cutter.

(2) Propulsion Plant Standards

One of the original standardization research projects of Ship Producibility Research Program was the "Propulsion Plant Standards Feasibility Study" done by M. Rosenblatt & Son, Inc., under subcontract to Bath Iron Works Corp. The conclusions of that study were:[9]

> Development and implementation of propulsion plant standards is both feasible and desirable. Early emphasis should be on Total Plant Standards and Procurement Standards.
>
> The savings that can be realized from the application of these standards to a 26,000 SHP steam plant include:
>
> Labor savings of about $250,000 on the first ship in a series.
>
> Schedule savings of 5 months in the lead ship which would contribute additional savings on the first ship of $750,000.
>
> Schedule savings of 2 months on the second ship in a class, saving about $300,000, raising savings on a class to $1,300,000.
>
> Total savings on the class of 4 ships would be about 20% of the shipyard design and installation costs for the class.

For any one individual shipyard, these savings could be modified depending upon to what degree they have already standardized their designs and technical and procurement procedures.

Application of Total Plant Standards and Procurement Standards to the propulsion plants projected for the decade would save nearly $100 million on plants which will have an installed value approaching $2 billion. (Almost 5%.)

(3) Improved Design Process

One of the principal recommendations of this study under the Ship Producibility Research Program was "that the use of standards be substantially increased . . . to reduce design time and cost, minimize errors, reduce risk, and improve the product."[10] General Dynamics Corp., Quincy Shipbuilding Division (where the study was done) has successfully applied standardization of such items as tripping brackets and steel plate in their current series of LNG tankers.

(4) Standard 10 FT^3 Raq Locker

This final example of a 10 $ft.^3$ rag locker which was standardized by Avondale Shipyards, Inc. is intended to illustrate that even the most mundane items may offer the potential for productivity improvement and cost reduction through standardization. By standardizing the design and construction of this rag locker (normally one or two of these items are called for in the ship's machinery spaces), Avondale has been able to save the time and cost of some 70 direct manhours of repetitive design effort - not to mention the input to the secondary impact areas mentioned in an earlier section. If an owner wants a 12 $ft.^3$ rag locker, certainly the standard can be modified - and the owner will pay the incremental cost involved. Not using standards for such items is almost analogous to an automobile manufacturer sizing the car's glove box to the individual buyer's specification.

CONCLUSIONS

In conclusion, the use of standards not only represents one of the most significant opportunities for productivity improvement and cost reduction in shipbuilding, but is also a necessary requirement in the development of automation in the industry.

Through the new ASTM Committee F-25 on Shipbuilding Standards the industry now has an effective vehicle for the development, coordination, implementation, and maintenance of National Shipbuilding Standards. Solid, broadbased support currently exists for the work of this committee, and with our real commitment to the program the benefits of standardization described herein can become a reality.

John C. Mason
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Bath, Maine 04530
(207) 443-3311, Ext. 2115

FOOTNOTES

[1]The minutes of that meeting, which include a list of attendees, are available from: Mr. Robert D. Bauer, ASTM, 1916 Race Street, Philadelphia, PA 19103.

[2]The ASTM Committee scope, subcommittee structure, and slate of officers are included in Attachment (1) to this paper.

[3]A summary of the initial Ship Producibility Research Program ship building standards projects is included as Attachment (2) to this paper.

[4]International Organization for Standardization.

[5]International Electrotechnical Commission.

[6]Both ABS and the U.S. Coast Guard are actively involved as members of the new ASTM committee. Also, the U.S. Navy, through the Naval Ship Engineering Center, is actively participating on almost every technical subcommittee of ASTM F-25 in line with OMB directive for government agencies to participate in the development and use of industry standards as applicable.

[7]"Rectangular Vent Duct Standards" May 1977, National Shipbuilding Research Program, U.S. Maritime Administration in Cooperation with Todd Shipyards Corp., Seattle Division, p. 5.

81bid., P. 1

[9]"Propulsion Plant Standards Feasibility Study", August 1975, National Shipbuilding Research Program, U.S. Maritime Administration in Cooperation with Bath Iron Works Corp., p. IV-I.

[10]"Improved Design Process", April 1977, National Shipbuilding Research Program, U.S. Maritime Administration in Cooperation with Bath Iron Works Corp., p. IV-9.

ASTM COMIITTEE F-25 ON SHIPBUILDING

SCOPE

"THE DEVELOPMENT OF STANDARD SPECIFICATIONS, TEST METHODS, AND PRACTICES FOR THE DESIGN, CONSTRUCTION, AND REPAIR OF MARINE VESSELS, THIS COMMITTEE WILL COORDINATE ITS EFFORTS OTHER OTHER ASTM COMMITTEES AND OUTSIDE ORGANIZAT10NS HAVING MUTUAL INTEREST,"

ATTACHMENT (1)

TECHNICAL SUBCOMMITTEES

HULL STRUCTURE	SHIP CONTROLS & AUTOMATION
HVAC	MATERIALS
MACHINERY	COATINGS
DECK MACHINERY	OUTFITTING
PIPING	SUPPORT OPERATIONS
WELDING	GENERAL REQUIREMENTS
ELECTRICAL/ELECTRONICS	

SLATE OF OFFICERS

CHAIRMAN	R. J. TAYLOR MANAGER TECHNICAL-TANKER DEPT, EXXON INTERNATIONAL CO,
FIRST VICE CHAIRMAH	H. S. SMITH MACHINERY & OUTFIT SUPERINTENDENT BETHLEHEM STEEL/SPARROWS POINT
.SECOND VICE CHAIRMAN	CAPT. C. B, GLASS, USCG CHIEF, MERCHANT MARINE TECHNICAL DIVISION
SECRETARY	J. C. MASON PROJECT ENGINEER BATH IRON WORKS CORP.

PANEL SP-6 STANDARDS & SPECIFICATIONS

AVONDALE SHIPYARDS

BATH IRON WORKS

BETHLEHEM STEEL/SPARROW POINT

GENERAL DYNAMICS/QUINCY

INGALLS SHIPBUILDING

LEVINGSTON SHIPBULDING

MARAD

N A S S C O

N A V S E C

SUN SHIPPBUILDING

INITIAL RESEARCH PROJECTS

- TASK S-20, "A COMPENDIUM OF SHIPBUILDING STANDARDS"

  CORPORATE-TECH PLANNING, INC.

- SHIPYARD PROJECTS

  BATH IRON WORKS

  TASK S-23, MECHNICAL CONSTRUCTION STANDARDS
  TASK S-25, HVAC CONSTRUCTION STANDARDS

  GENERAL DYNAMICS /QUINCY

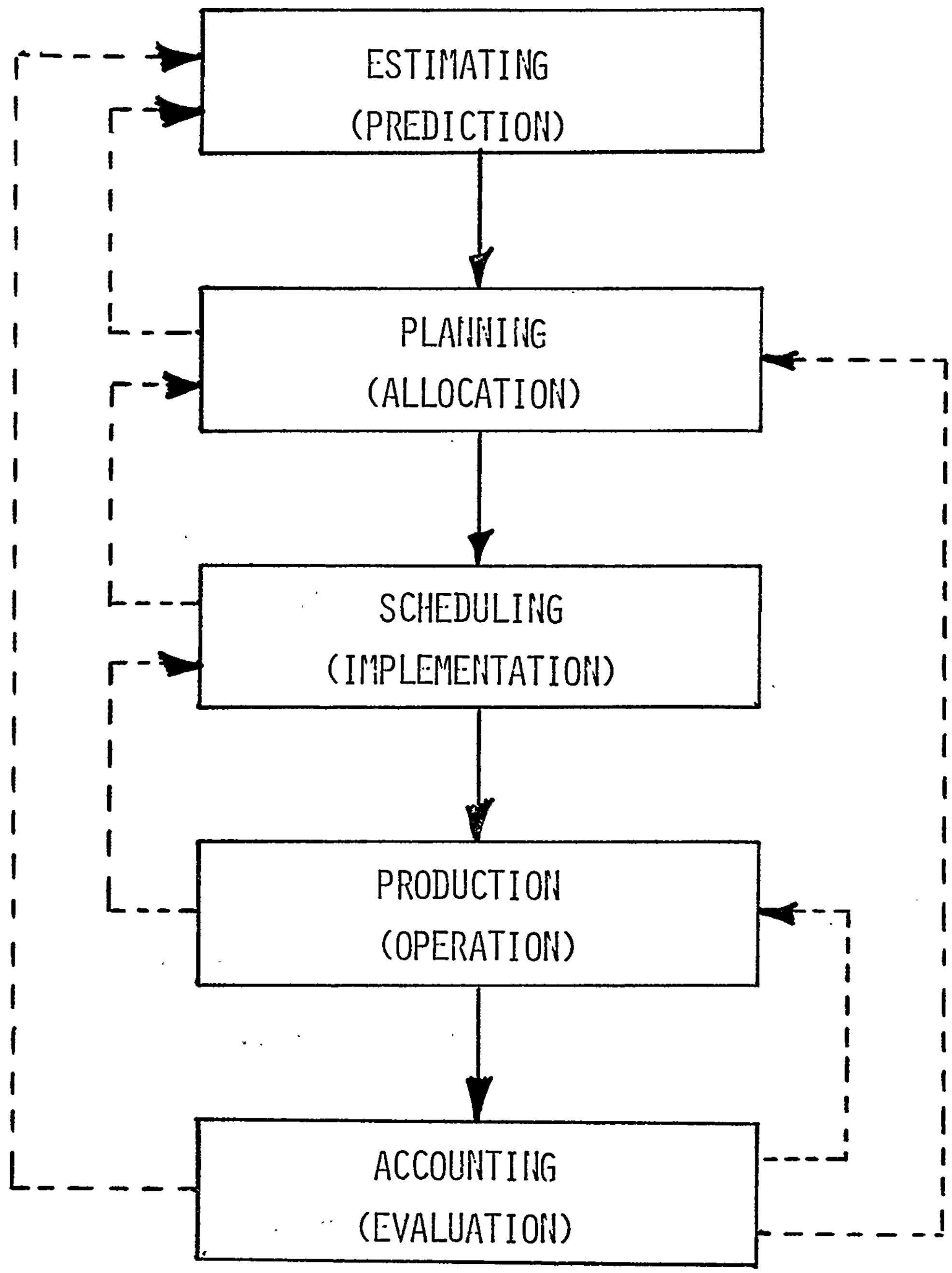
  TASK S-II, STANDARD STRUCTURAL ARRANGEMENTS

  NASSCO

  TASK S-24, MECHANICAL COKSTRUCTIOIN STANDARDS
  TASK S-26, ELECTRICAL CONSTRUCTION STANDARDS

  SUN SHIPBUILDING

  TASK S-21, SHAFT ALIGNMENT STANDARD
  TASK S-22, DEFECT TOLERANCE STANDARD
  TASK S-27, OUTFIT CONSTRUCTION STANDARDS



ESTIMATING
(PREDICTION)
PLANNING
(ALLOCATION)
SCHEDULING
(IMPLEMENTATION)
PRODUCTION
(OPERATION)
ACCOUNTING
(EVALUATION)

SUMMARY

SHIP PRODUCIBILITY RESEARCH PROGRAM

SHIPBUILDING STANDARDS PROJECTS

U.S. Department of Commerce

Maritime Administration

In cooperation with

Bath Iron Works Corp.

June 15, 1978

Attachment (2)

FOREWORD

Work in the shipbuilding standards portion of the Ship Producibility Research Program will be closely coordinated with the ASTM Committee on Shipbuilding Standards. The following initial research projects have been structured to provide some early contributions to the various subcommittees.

Task S-20, "A Compendium of Shipbuilding Standards"

Corporate-Tech Planning, Inc. of Portsmouth, NH will coordinate work on this project with the Executive Subcommittee. When complete, Task S-20 will provide input for general planning and decision making in the overall Shipbuilding Standards Program. The scope of the project includes:

- Identification of standards being used in the shipbuilding industry today.
- Identification of existing national standards not currently used in the shipbuilding industry, but which have potential application.
- Recommendations from a survey of selected foreign shipbuilding standards (ISO[1], IEC[2], Japanese, Swedish, and West German).

The following projects will be undertaken in order to provide early and diversified contributions to the development of standards by the various technical subcommittees:

[1]ISO - International Organization for Standardization
[2]IEC - International Electrotechnical Commission

Task S-11, "Standard Structural Arrangements"

(Hull Structure Subcommittee)

General Dynamics/Quincy Shipbuilding Division is nearing completion of a group of recommended standards which include:

- Tripping brackets
- Alignment criteria
- Clearance cuts
- Snipes
- Tight collars
- Reeving slots
- Structural intersections
- Miscellaneous cut-outs
- Patches
- End connections
- Face plates
- Chocks
- Panel stiffeners
- Clip connections
- Beam brackets

Task S-21, "Line Shaft Alignment Standard"

(Machinery/Piping or General Requirements Subcommittee)

Sun Shipbuilding & Drydock of Chester, PA will coordinate the development of draft standards which specify realistic recommended techniques and tolerances for shafting alignment. Propulsion systems to be addressed are:

- Geared steam turbine, inboard shafting
- Slow speed diesel, outboard shafting
- Geared steam turbine, outboard shafting

Task S-22, "Defect Tolerance Study"

(Hull Structure or General Requirements Subcommittee)

Sun Shipbuilding will coordinate the development of draft standards for industry-wide, engineered defect acceptance standards which will ultimately result in significant cost reduction.

Task s-23, "Mechanical Design/Construction Standards-Group I"

(Machinery/Piping Subcommittee)

Bath Iron Works Corp. of Bath, Maine will coordinate the development of an initial set of draft mechanical construction standards and engineering guidelines. Items included are:

- Pipe welding
- Instrumentation piping details
- Insulation usage and application data
- Branch connection usage tables
- Gage boards
- Pipe hangers
- Slip-on welding sleeves for steel pipe
- Cleaning and flushing of ship's piping systems
- Electrical, machinery, and piping test memo development and utilization
- Interface control procedures for shipboard automation
- Guidelines for preparing, Sea Trials Agenda, acquisition of special trials instrumentation, and organizing a ship's trial crew.

Task s-24, "Mechanical Design/Construction "Standards-Group II"

(Machinery/Piping Subcommittee)

National Steel and Shipbuilding Co. of San Diego, CA will coordinate the development of an additional set of draft mechanical construction standards. Items included are:

- Bolting usage table
- Piping system diagram preparation
- Bolted and insulated watertight bulkhead and deck connections
- Steel flange, faced with monel inlay
- Funnels
- Welded bulkhead and deck sleeve watertight and oiltight penetrations for steel structure for ferrous and non-ferrous pipe
- Commercial steel air receivers
- Commercial steel potable water tank
- Commercial steel hot water tank
- Steel reinforcing sleeves for non-tight bulkhead and deck
- Expanded pipe socket silver brazing joint for tubing and IPS pipe
- Insulated watertight bulkhead and deck connections for steel structure (250° max.)

Task s-25, "HVAC Design/Constructiion Standards"

(HVAC Subcommittee)

Bath Iron Works Corp. will coordinate the development of an initial set of draft HVAC design and construction standards. Items included are:

- Drafting standards - hull, outfit, and HVAC
- Procedure for volumetric testing
- Gooseneck
- Watertight covers
- Structural penetrations

- Type "JA" terminal
- Ventilation flanges
- Elbows with splitters including veins
- Duct hangers
- Balance damper
- Wire mesh details
- Flexible connections
- Bolted access plates
- Lashing hook for canvas cover
- Hinged access door
- Methods of flanging acoustical ductwork
- Typical duct ratproofing details
- Hinged fire closure
- Fire dampers
- Type “E” terminal
- Typical grilled and diffuser connections
- Sliding damper
- Quick-action flange

Task s-26, “Electrical Construction Standards".

(Electrical/Electronic Subcommittee)

National Steel and Shipbuilding Co. will coordinate the development of an initial set of draft electrical construction standards. Items included are:

- Installation methods - electrical cable and equipment
- Cable penetrations of Class A, B, and frame tight bulkheads and decks
- Mounting of electrical boxes and cable supports using welded studs

- Mounting light fixtures
- Cable entrances to watertight and non-watertight equipment
- Cable penetrations and electrical equipment mounting in refrigerated spaces
- Cable hangers
- Multi-cable transit details
- Cable penetrations of Class B draft stops
- Methods of grounding equipment and cables
- Water sealing and end sealing of cable

<u>Task s-27, "Outfit Construction Standards"</u>

(Outfitting Subcommittee]

Sun Shipbuilding will coordinate the development of an initial set of outfit related construction standards. Items included are:

Bilge keel details - typical welded construction

Standard air and drain holes design in tanks

Manholes

Selected welding details

Vertical ladders and grabs

Rails (open storm and guard)

Machinery space floor plates and handrails - typical construction and installation details

Inclined ladders

Surface preparation and application of inorganic zinc

<u>Contacts for Additional Information:</u>

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John C. Mason (207) 443-3311, ext. 2115

Task S-20
Corporate-Tech Planning, Inc.
James A. Burbank (603) 431-5740

Tasks s-21 and S-22
Sun Shipbuilding & Drydock Co.
Dr. Richard Bicicchi (215) 876-9121, ext. 8310

Tasks s-23 and s-25
Bath Iron Works Corp.
Walter Orlovsky (207) 443-3311, ext. 2760

Tasks s-24 and s-26
National Steel and Shipbuilding Co.
George A. Uberti (714) 232-4011, ext. 604

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