SNAME *Transactions*, Vol. 92, 1984, pp. 151–184

The SNAME Technical and Research Program of 1984

Compiled by the Participating Membership for Presentation by **Ronald K. Kiss,**[1] Life Fellow

This paper traces the progress of the Society's Technical and Research Program since its inception. It provides an up-to-date overview of what is taking place in each of the T&R panels to communicate the diverse activities of panels to SNAME members at large. Sections of the paper cover each of the eight standing Technical and Research Committees (Hull Structures, Hydrodynamics, Ships' Machinery, Ship Technical Operations, Marine Systems, Ship Production, Ship Design, and Small Craft). Special activities such as the Ad Hoc Committee on Maritime Energy Research and Development are also discussed. Finally, the paper provides a look at the future needs and potential to continue to serve the members and their profession.

Introduction

AFTER 45 years of successful growth, the Technical and Research Program of The Society of Naval Architects and Marine Engineers continues to provide a forum for the entire marine industry. Through this program the T&R committees and panels review the state of the art, recommend, fund or "seed" needed research, initiate, coordinate and direct beneficial research projects, and highlight the need for technical investigations.

In 1893 the founders of our Society acknowledged a responsibility for the advancement of knowledge; for recording and disseminating information and ideas; and for sponsoring maritime and ocean-oriented research and engineering. However, it was not until 1939 that an organized effort began with the formation of a vibration research committee. In the ensuing years the program has grown to 68 committees and panels covering nearly all areas of maritime-related research. Despite being "middle-aged," the program remains dynamic. We created two new committees in the past three years. Panels which were created to conduct a specific project, or which have generally outlived their usefulness, have been disbanded.

The development and history of the T&R Program can easily be traced in four papers presented to this Society [1–4].[2] In 1969, ADM Edward H. Thiele stated: "The T&R Program, as part of a major international technical society, is unique in its size and scope of endeavor. It is currently the only industry-wide U. S. maritime nongovernment research organization that enjoys an international stature and functions best as an informal, impartial, coordinating agency not bound by a rigid set of rules or standard procedures [3]. This condition remains true today, though the day-to-day operations are guided by the *T&R Procedures Manual* [5].

Due to the depressed state of shipping and commercial shipbuilding in the United States today, some believe the T&R Program has little purpose. To the contrary, support of an expanding naval shipbuilding program with a primary focus on high-technology weapon systems brings added emphasis to the problem-solving attitudes of the committee. In addition, by our work in safety, energy saving, and efficiency improvement, it may be possible to find breakthroughs in hydrodynamics, structural design, propulsion, auxiliary systems, ship operating practices, and ship production techniques that individually or collectively could return the advantage to the U. S. marine industry. For these reasons those working in the T&R Program must maintain a sense of urgency about their efforts. They must proceed despite minimal funding while constantly seeking to learn more and contribute advancements to the technical base for the benefit of our industry, our government, and our society.

Philosophy

According to *The 1982 Technical & Research Organization and Procedures Manual* the philosophy of the T&R Program is as follows:

> By means of the T&R Program the Society encourages and sponsors maritime research into all areas of the sea sciences, with particular emphasis on the construction and operation of ships, marine vehicles, and offshore structures of all kinds. SNAME was founded and remains an association of individuals. There are no organizational memberships and no mandate for direct support of the industries from which it draws its members. Therefore, SNAME is uniquely qualified as a non-partisan forum for discussion of the problems faced by its members in their technical pursuits. The Society also is widely recognized as being capable of carrying out evaluations on projects and programs of technical interest throughout the marine industry.

The SNAME Technical and Research Program serves the following purposes:

1. To review constantly the status of maritime technology with a view toward stimulating needed research in the following ways:
   a. Through development and sponsorship of specific research projects performed by participating members of the T&R program.
   b. Through planning and/or guiding research programs supported by other industry and government organizations.

[1] Vice President, SNAME Technical and Research Program; Assistant Deputy Commander, Naval Sea Systems Command, Surface Ship Acquisition, Washington, D. C.

[2] Numbers in brackets designate References at end of paper.

Presented at the Annual Meeting, New York, N. Y., November 7–10, 1984, of THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

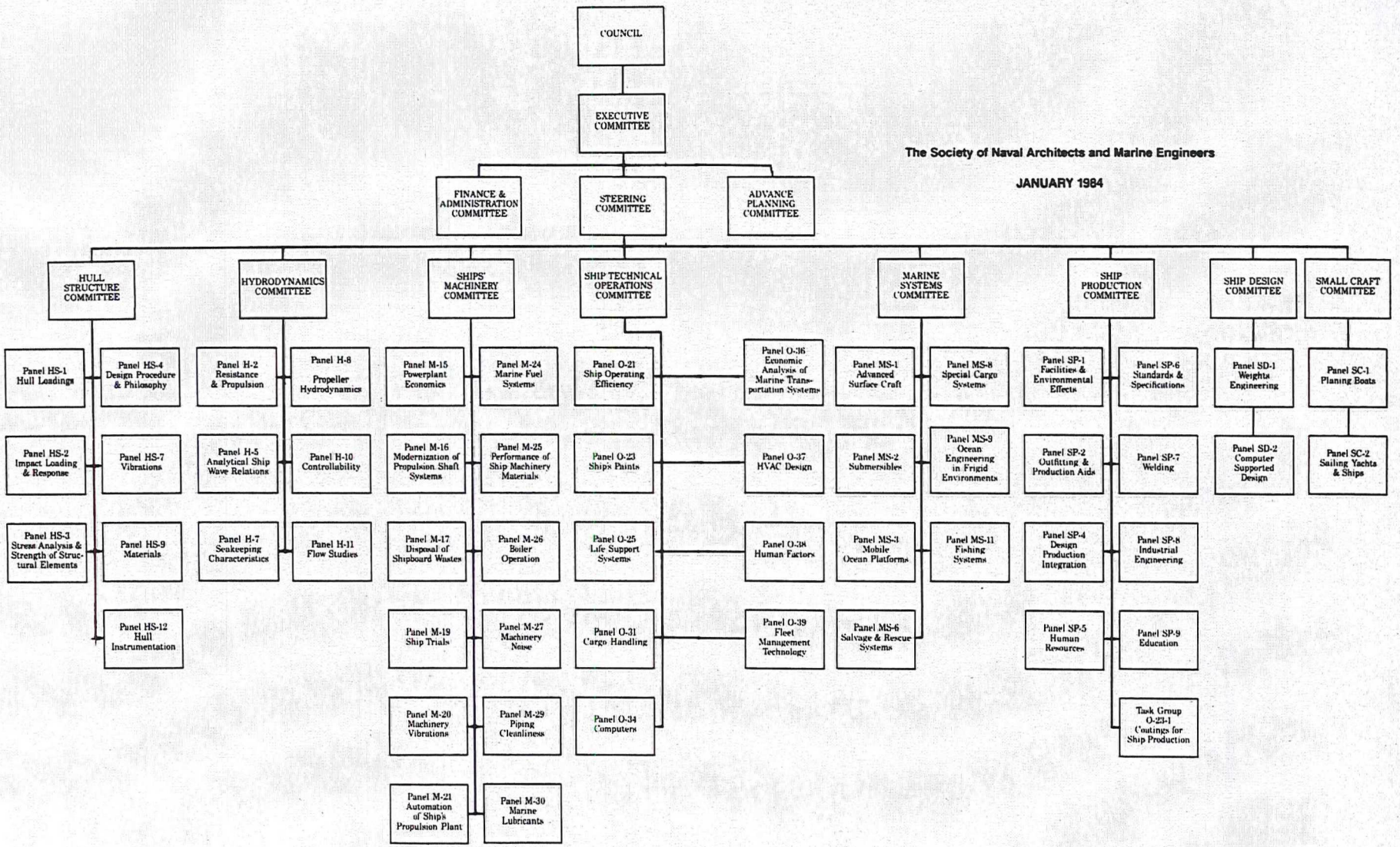

Fig. 1 Organization chart of the Technical and Research Program

c. Through a combination of the above (e.g., seed money or pilot projects, followed by outside support).

2. To provide a neutral forum where members can evaluate and discuss mutual technical problems.
3. To provide guidance to outside groups on nonproprietary technical matters of general interest to the profession [5].

Organization

The present organization of the T&R program is shown in Fig. 1. Over 1300 active participants, representing the best talent available, volunteer their time, knowledge, and experience to serve their profession through this program. Though the participants need not be members of SNAME, policy requires that committee chairmen be members since they help direct the expenditure of Society funds. At the technical level, we make every effort to obtain the best talent available. Of course, we also hope that the stimulation of the T&R program will induce nonmembers to join the Society.

The three T&R Standing Committees include the T&R Steering Committee, which is the overall guiding committee of the entire T&R Program. This committee is chaired by the Vice President–Technical and Research, who is responsible to the Council for the activities of the Steering Committee. Under the leadership of the chairman, the Steering Committee has authority to fund research projects, assign priorities and reject proposed projects. It meets at least four times per year. The Council of the Society annually approves an overall budget for the year's operations. Each of the eight technical committees reports to the Steering Committee for policy guidance.

The eight technical committees which fall under the guidance of the Steering Committee cover the following disciplines: Hydrodynamics, Hull Structure, Ships' Machinery, Ship Technical Operations, Marine Systems, Ship Production, Ship Design, and Small Craft. Each committee is composed of panels specializing in specific areas. The committees are responsible for the technical quality and timeliness of the various research projects undertaken by these panels as well as the administration of allocated funds. Each committee acts individually within its own technical area. They are the central guiding body for their panels. They assist the panels in suggesting research activities and recommending priorities. The committees are primarily made up of panel chairmen, resulting in a good representation of a variety of topics.

The other two Standing Committees are the T&R Advance Planning Committee and the Finance and Administration Committee. The Advance Planning Committee has been established to recommend relevant long-range goals for the Society. This committee completed its landmark work, "High Priority Research in the U. S. Maritime Industry—A Pilot Program" (T&R Report R-26), in 1979. It is evident that the broad areas of priority research treated by R-26 are the areas of current attention in the industry, although on a much smaller scale than recommended. The Finance and Administration Committee is responsible for the direction of fund raising in support of all research activities of the Society and directs the fiscal and contractual administration of such funds.

The coordinating functions of the Society's Technical and Research Program and the liaisons existing between the Society and other technical agencies and organizations, both governmental and private, national and international, are shown in Fig. 2. Through this existing liaison the Society is able to assist numerous organizations by providing technical backup to aid in their determination of policies and regulations. At the same time, the Society's research committees stay informed of the activities and the achievements of related organizations:

- leading interested scientific, technical, and classification organizations and societies,
- governmental departments and agencies,
- academic institutions,
- shipyards,
- operators of ships and offshore structures,
- design agents and naval architects,
- marine-oriented equipment and product manufacturers, and
- marine underwriters.

It truly occupies a central position among those building, supplying, operating and managing ships and related marine structures of all sizes and types.

The SNAME T&R organization, existing as an impartial representative nongovernmental body embracing the entire marine industry, is in a unique position to speak and act with respect to technical matters. By limiting itself to the technical aspects of a problem, it does not lobby, thereby maintaining the Society's tax-exempt status. The Society's ability to deal impartially on engineering matters with commercial interests, government departments, and research laboratories eliminates any accusation of its representing or fostering any single segment of industry. Engineering problems peculiar to one company or organization are normally not undertaken as a research task and, similarly, an effort is made to assure that the competitive position of any company is not jeopardized through the Society's work. Thus, industry can freely participate in the mutual effort with an exchange of knowledge and ideas flowing among the technical membership.

Both U. S. and Canadian Government marine departments and research agencies cooperate fully with the Society. In return, we assist in the formulation and evaluation of various government programs and projects. This work is fostered by the Society's Advisory Public Service Committee which had designated liaison members for Congress and key executive department activities.

The output of the Technical and Research Program emphasizes improved economic return through engineering research. The only facilities maintained by the Society are a small technical and secretarial staff at headquarters and an office with conference rooms for necessary meetings. The limited funds available are used to implement small research projects; to seed larger projects requiring long-term financial support from those segments of industry and government which would most directly benefit; and to "harvest" existing research from various sources by summarizing them in a form useful to designers and builders.

Financial support

The cost of operating the T&R Program over the past five years averages about $50 000 per year, exclusive of administrative costs. Support for this program over the past few years has come from annual contributions of every segment of the maritime and ocean-oriented industries. We solicit contributions from shipowners, ship operators, shipbuilders, suppliers, ship designers, ocean engineering organizations, and interested individuals. An effort is made to solicit all organizations known to be interested in the maritime field, ocean engineering, and the small boat and yacht industry on an annual basis, hoping to obtain monetary support for the SNAME T&R Program in each organization's annual corporate budget. Donations range from $25 each to as high as $10 000 annually. To this we must add the contributions of the various individuals who voluntarily participate. This additional value includes contributions of time, material, services, and travel, in order to attend meetings and participate in the many Society research projects. The time and effort of the members of the committees, panels and

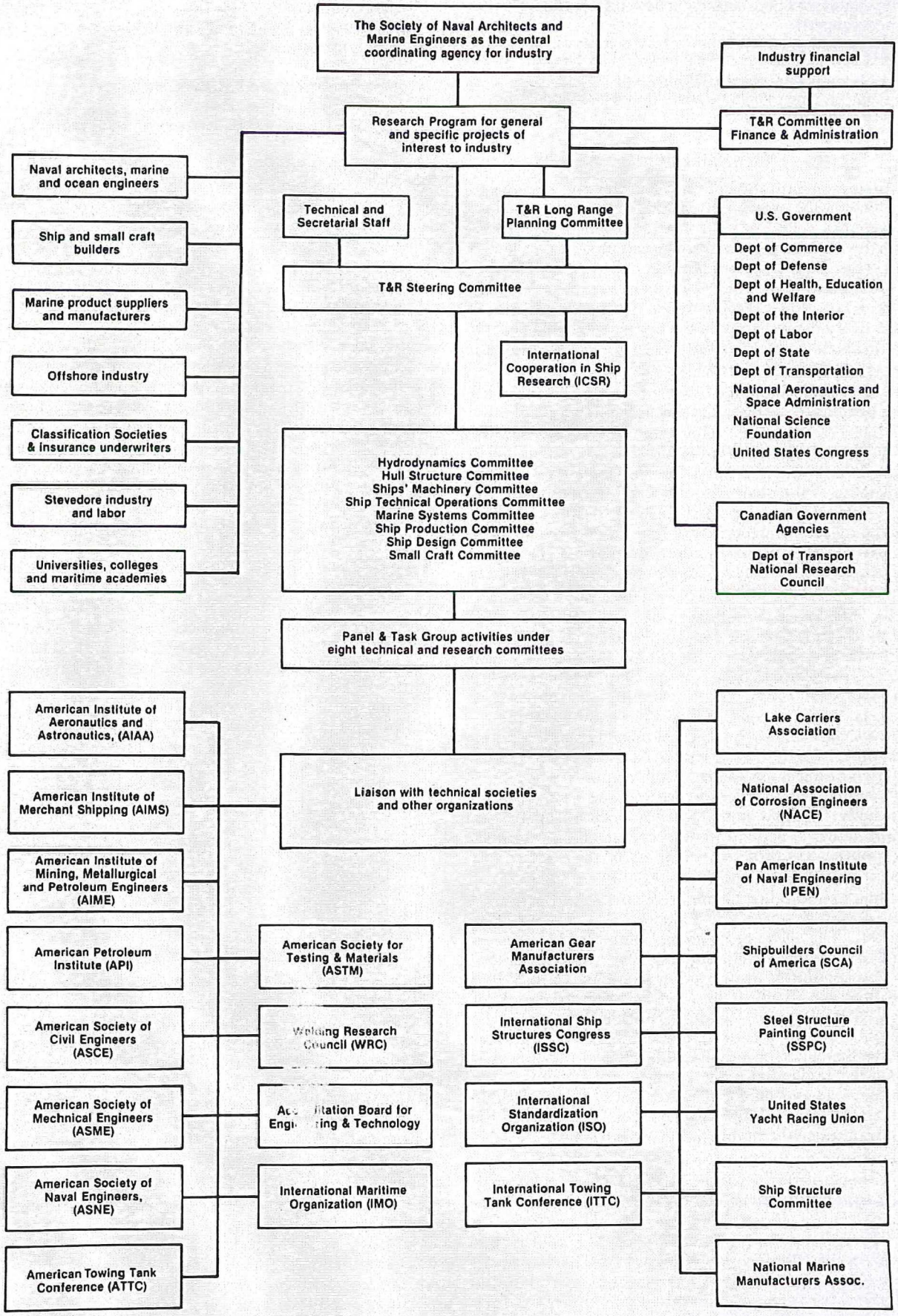

Fig. 2 SNAME T&R Program interrelationships with other individuals and organizations

task groups are given in a cooperative effort to further the profession. No Society funds are expended for the services of these individuals. In 1946 the membership of the T&R group consisted of 14 volunteers; at the present time there are 68 committees, panels and task groups with over 1300 members. It is almost impossible to put a financial value upon the volunteer man-dollars thus represented. There are few organizations which can call on and utilize such an array of talent and knowledge for engineering research and development.

The Ship Production Committee's projects are funded separately from the other seven committees. This is explained more fully in the section on the Ship Production Committee. However, the level of outside funding provided to support the work guided by the Ship Production Committee has increased substantially notwithstanding the difficult economic condition facing the country and the industry. In 1984 about $4 million was committed by the U. S. Navy and Maritime Administration to projects monitored by the Ship Production Committee.

Dissemination of information

As mentioned in the preceding, a major contribution of the Society's T&R Program is the dissemination of the results of its work. All material developed, from summaries and evaluations of existing information, through descriptions of analytic investigations and test data to final results and recommendations, is usually presented in the form of a report or paper. These reports normally take the form of bulletins, reports, data sheets, or papers, and are disseminated to the maritime world in the following ways:

Technical & Research Bulletins—These bulletins contain the final reports of projects sponsored by the T&R Program. Some include guides to accepted design practice in specific areas.

Technical & Research Reports—These reports, issued periodically, contain useful information resulting from projects sponsored by the T&R Program. They do not necessarily represent conclusive research.

Journal of Ship Research—This is a SNAME quarterly periodical which frequently includes papers or reports on work, usually of a scientific and analytical nature, sponsored, guided, or influenced by the Technical and Research Program.

Marine Technology—This is a SNAME quarterly periodical which frequently includes papers or reports of significant technical value on work undertaken, coordinated, or influenced by the SNAME T&R Program.

Transactions—This annual SNAME publication includes all papers presented before the Society's annual meeting. Many of these papers are the result of investigations implemented, guided or sponsored by the T&R Program.

STAR Proceedings—Papers presented to the Ship Technical And Research (STAR) Symposium, held in conjunction with each Spring Meeting of the Society, are published in annual proceedings. They also often report on T&R Program research.

Papers—The 17 sections of SNAME and the T&R Panels or Committees themselves periodically hold meetings or symposia where technical papers are presented to local members and guests. Over 100 such papers are presented annually. A significant number of these papers are either directly influenced and guided by the T&R Program or are the direct result of its work.

Currently there are about 110 bulletins, reports, and other T&R publications available to both members and nonmembers of the Society at nominal cost. A list is published annually by the Society. Additional reports are being prepared.

An assessment of the SNAME Technical and Research Program indicates that there are 25 distinct projects underway, ranging from propeller roughness studies to shipboard instrumentation to determine structural loadings. Many of the projects are newly initiated, of short-term duration, and others are of a continuing nature, extending over a period of years. To describe or discuss all of these projects would be a considerable task. However, we will make an effort here to high-light some of the ongoing work of the eight committees and their panels.

The Hydrodynamics Committee

The Hydrodynamics Committee, one of the Society's first technical committees, was organized in 1947, when the design of a ship's hull form was based primarily on stillwater resistance and propulsion. It has persevered to the present day. In its tenure it has supported the development of modern seakeeping and maneuvering theories; the development of computer calculation and simulation techniques; the application of lifting-line and lifting-surface modeling techniques to the analysis of propeller steady-state and vibratory phenomena; potential singularity modeling of wave resistance, both linear and nonlinear; bow bulbs; roughness and drag reduction additives; plastics; optimum sailing rigs and racing hulls; and impact and slamming analysis. Its survival has been aided by adding to the original committee and by establishing panels with memberships made up of both generalists and specialists, mostly from inside SNAME, to cover the expanding spectrum of ship and boat hydrodynamic research. Members' interests and abilities range from the theoretical (for example, wave theorists) to the practical (for example, ship masters). Often such a range will be contained within a single panel.

The Hydrodynamics Committee includes six panels. Each panel meets from a minimum of one to a maximum of five or six times a year, and there are occasional joint meetings between panels of this committee or with panels of other committees. The panel chairmen are also members of the Hydro Committee, to provide a line of communication to and from the Steering Committee.

The Hydro Panels themselves fall into certain categories: Resistance and Propulsion, Seakeeping, Propeller Hydrodynamics, and Ship Controllability mix theory and experiment with practice and are industry-oriented in outlook and membership. Analytical Ship Wave Relations and Flow Studies are much more theoretically based and staffed.

Industry support for the hydrodynamics area faces a different problem than some of the other committees and panels. If a ship breaks in two, or its power plant does not work, or if the shipyard has trouble welding it, someone takes immediate notice and tries to remedy the situation. Usually someone can be encouraged to expend money and effort to insure the same thing will not happen again. But if a ship has excessive resistance due to her hull design, no one may notice it, or at least not immediately, although the operator might eventually go broke if he had a fleet of such vessels. Hydrodynamic failures are relatively subtle—they don't make a noise or turn red! And yet, especially in the 1980's, with increasing energy costs, hull design improvements could be the most important breakthrough in our industry. In the past, much of the basic technology was transposed from research for U. S. naval ship design. This source is still readily available, but how do we get to it and find someone who would fund its commercial exploitation? That is one of the crucial questions today, one that occupies considerable discussion time. It must be answered before needed research programs in the hydro area can emerge.

The specific aims, objectives and activities of the hydrodynamics panels are discussed in the following subsections.

Panel H-2: Resistance and Propulsion

The purpose of the H-2 panel is to identify and promote research in hull form and propulsion, including surface conditions, with primary emphasis on powering benefits for the ship operator. Displacement vessels of all sizes, both self-propelled and not, are considered, but high-speed and/or dynamically lifted vehicles and non-water-based propulsion are excluded from this panel's interest.

Most funded H-2 projects have now been completed or are in the final stages. They include publication of barge resistance data, a ship hull roughness resistance study, and a propeller/roughness performance study. These will be published as T&R Bulletins for the benefit of the membership. The panel is presently assessing alternatives for useful new research. Projects under consideration include chine fishing trawler design and stern bulbs. Improving awareness of the importance of a good hull design before construction could be a real contribution of this panel in the future.

Panel H-5: Analytical Ship Wave Relations

The primary purpose of the H-5 panel is to provide a forum to address theoretical treatment of marine hydrodynamics, especially those concerned with free-surface effects. Panel members are interested in a wide range of problems, including ship wave resistance, ship motions, ship maneuvering, and offshore engineering. Although the primary interests of the panel are in the theoretical aspects of hydrodynamics, experimental results are often discussed in the context of their relation to theoretical predictions. When results with potential practical application to the marine field are identified by this group, it will usually transfer such development to one of the more practically oriented T&R panels. Many of the calculation methods routinely used by designers in industry and the Navy were first presented at H-5 panel meetings.

Panel H-5 also helps to organize the Weinblum Memorial Lecture. This lecture, presented each year by an internationally recognized authority in ship hydrodynamics, is sponsored in Germany by the Institut für Schiffbau of the University of Hamburg and in the United States by the David W. Taylor Naval Ship Research and Development Center (NSRDC), the Office of Naval Research, and the Naval Studies Board of the National Research Council. The lectures are chosen by a four-person selection committee representing the Institut für Schiffbau, the Fachausschuss Hydrodynamik, and the *Journal of Ship Research* Committee and Panel H-5 of the Society. The lectures are printed by the Institut für Schiffbau and offered for publication in the *Journal of Ship Research* or *Schiffstechnik*. One of the most recent lectures was given in Washington by Dr. George Gadd from England on "Scale Effects in Hydrodynamic Phenomena."

The panel plans to carry out much the same program in the foreseeable future, but will improve the communication of its ideas by distributing its minutes to a wider group. The new audience will include corresponding members, some from abroad who will not be expected to attend more than a few meetings, members of other T&R panels, and faculty or students at universities. The minutes themselves will be expanded to include references to ongoing research other than that actually presented at the meetings.

Panel H-7: Seakeeping Characteristics

Safety of a ship in extreme seas is a concern both from a stability and structural point of view. The aim of this panel is to suggest and pursue research in order to better equip ship designers and operators with analytical or experimental tools to assess the seakeeping aspects of design of all types of ships, though primary emphasis is on self-propelled displacement types. This includes knowledge of sea state for particular routes.

To assist in its research planning, the panel supported a study of the status of commercial seakeeping research, with results published in 1982 as T&R Bulletin 1-39. A list of recommendations for research was given, with general indications of priorities. The top-priority subjects recommended for further research were design case studies that would compare the economic merits of alternative designs having different seakeeping qualities. These case studies should determine whether or not real economic benefits can be expected from considering seakeeping in the early steps of design. Hence, a new project covering seakeeping design was begun. This research will develop methods of incorporating seakeeping into merchant ship preliminary design, as it is being introduced in naval design. The impact of improved seakeeping characteristics on the representative ship designs will be assessed during this work, to find out if the tradeoffs are of a positive or negative net effect compared with weather-routing and other current practices.

Research into the motions of a vessel drifting broadside to the waves was completed recently. The purpose of this work was to determine effects of drift velocity on roll and other motions to assist in safety and survival analyses of vessels. A project on seakeeping and human engineering also has been active during the past year. The purpose of this research is to develop information on how different vessel motions affect people working at sea. Actual at-sea experiences of professionals are being evaluated.

Panel H-8: Propeller Hydrodynamics

This panel identifies research needs and plans and implements projects to improve the performance of marine propellers both from a powering and vibratory point of view, the latter considering effects on the hull and rudder as well. The emphasis of this panel (as compared with the Panel H-2) is on the detail design of the propeller for a particular hull and inflow, using both the analytical and experimental approaches and including the effects of cavitation.

Panel H-8 has several meetings a year at which a wide range of topics are discussed. These include the theoretical calculation of propeller performance by lifting-surface theory versus lifting-line theory, experimental problems such as the calibration procedure for force-disk vibration force measurement in water tunnels, laser-doppler measurement techniques in the same facility, and design considerations such as the U. S. Navy unsteady thrust design criterion involving multiple factors of safety. The panel has several T&R research projects nearing completion. It has proposed a standard coordinate system for propeller and hull vibration studies.

One of the most important projects was the recently completed questionnaire polling industry for problems in the field. Respondents included eight naval architects, eight operators, seven shipyards and eight others, including five classification societies. The results of this study will be used to plan the direction of the panel. Based on this poll the following ten areas are considered important for future consideration:

1. Improve prediction of wake patterns.
2. Improve prediction of cavitation patterns.
3. Continue with development and verification of procedures for predicting bearing forces and blade loads.
4. Improve prediction and measurement techniques for hull forces.
5. Quantify the effect of propeller clearances.
6. Continue to quantify the effect of propeller blade skew on propeller-induced hull forces through systematic experiments.

7. Investigate the effects of sea state and ship motions on unsteady hull forces, bearing forces, and blade loads.
8. Investigate the effect of propeller partial submergence on unsteady hull forces, bearing forces, and blade loads.
9. Determine the effects of various types of propulsors on unsteady hull and bearing forces through theoretical analyses and experimental measurements.
10. Continue experimental and analytical work on hydrodynamic aspects of cavitation erosion.

Panel H-10: Ship Controllability

The objectives of this panel are broad, encompassing activities from design improvement projects utilizing equations of motion for theoretical models and tank and full-scale experiments to operater-oriented activities, including simulator training and standardization of bridge maneuvering data. Providing advice to regulatory agencies is also an important function of the panel.

The activities of Panel H-10 are as wide as the many aspects of ship handling. Present projects include a primer on the mathematical modeling of ship maneuvering (with example data sheets), a reanalysis of Eda and Crane's 1965 Series 60 parametric maneuvering study, contributions to the Joint International Maneuvering Program, a new full-scale investigation of the effects of rudder turning rate, development of a designer's manual on maneuvering, criteria for inherent and piloted ship controllability, and development of a proposed standard full-scale trials agenda. The last three efforts were presented in a paper at the 1983 Annual Meeting. This paper was encouraged by both the U. S. Coast Guard and the Design and Equipment Sub-Committee of the International Maritime Organization (IMO; formerly IMCO) as a forum for international comment on guidelines for achieving desired ship maneuvering characteristics. Previous panel papers have been presented at the STAR Symposiums in Washington, D. C. in 1975, and in Coronado, California in 1981. Other recently completed projects include an updating of the "Notes on Ship Controllability," the publication of a "Bibliography on Ship Controllability," and a vessel tracking study, including correlations with predictions, published in a broader Annual Meeting paper in 1979.

The members of Panel H-10 include a wide range of professionals employed by ship operators, shipbuilders, the Maritime Administration, U. S. Coast Guard, the Sandy Hook Pilots and Panama Canal Pilots Associations, educational institutions, naval architects and marine engineers, the U. S. Navy, Army Corps of Engineers, ship handling simulator facilities (CAORF and CARDIFF), ship model basins, marine consultants, and control systems analysts. Panel H-10 also maintains informal relationships with the International Towing Tank Conference Maneuvering Committee and the International Marine Simulator Conference.

Although the panel has many ongoing projects, it continually looks ahead. It is considering the effect of rudder rate on ship handling performance to see if increased rudder rates would be desirable for new ships.

Panel H-11: Flow Studies

The work of this panel emphasizes viscous effects, the resulting boundary layer, and possible stern flow separation. The modeling of these phenomena for full-scale prediction and the effects of roughness and fluid characteristics as modified by drag reduction additives are included. Emphasis is on the basic nature of the flow and on theoretical experimental treatment, but with a recognition of practical problems.

The panel has been exploring its role and the contribution it can make to the naval architectural community. The U. S. Navy is in the process of designing a large cavitation tunnel for installation at NSRDC, Carderock. A member of H-11 will represent SNAME on the review committee. Joint meetings of H-8 and H-11 will be held to review the facility plans, and some discussions on the project have already been held. Such cooperation between T&R panels and the U. S. Navy research programs has been a strength in the past, and will undoubtedly contribute to our future progress as well.

The T&R Committee has approved Panel H-11's proposal to survey and assess wake modeling and measurement techniques. In this task, the various techniques available for velocity field measurement will be identified and their conceptual bases described. The same will be done for techniques to model measured ship wakes in a water tunnel. The advantages and disadvantages of each method will be discussed. A contractor selected by Panel H-11 has submitted a statement of work to SNAME for approval. Work will start shortly.

The panel has been discussing the research projects being carried out by its members. These include boundary layer analyses for body-strut combinations, indirect methods of drag characterization, the effects of surface roughness on skin friction, propulsor cavitation, propulsor-body interactions, the effect of wing dams on riverboat tows, and barge bow "boiling" flow.

Hull Structure Committee

The objective of the Hull Structure Committee is to investigate, recommend, endorse, and promote research to advance the design and construction of safer, more efficient, more cost-effective, and more easily maintained ships and other marine structures.

Over the years a good working relationship has developed among the Society's Hull Structure Committee, the Interagency Ship Structure Subcommittee, and the Committee on Marine Structures, sponsored by the National Academy of Science. This arrangement has been beneficial in many aspects in that the Hull Structure Committee has generally been able to provide ideas and serve as a sounding board for a range of hull structure related projects, with the other committees controlling funding. Joint meetings among these committees have provided an insight into a wide range of research activities. Summaries of the status of each panel's work are provided in the following subsections.

Panel HS-1: Hull Loadings

Panel HS-1 has been involved primarily over the years with work associated with the Great Lakes. Several projects on the MV *Stewart J. Cort* were followed in great detail. This work included wave measurement surveys, damping, springing, wave measurement instrumentation test and evaluations, and seaway/structural analysis. In recent years funding limitations have reduced Great Lakes research, and prospects for future expansion are not bright.

Other areas that have received attention are those associated with evaluation of full-scale wave loads. Panel HS-1 also initiated a general bibliography of "hull loadings" papers hoping to determine which areas need special attention. Currently the panel is evaluating the need to assess the state of the art in extreme loads.

Panel HS-2: Impact Loading and Response

The objectives of HS-2 concern design recommendations for ships, other marine vehicles, and offshore structures subject to transient loads generated by collision or liquid interaction with the structure as in ship slamming, the carrying aboard of green seas, and the sloshing of liquid cargoes.

The primary interest of the panel stems from the continuing damage to ship structure caused by high sea states. Although

the total cost for such damage is not known, recently U. S. underwriters of hull insurance paid out in excess of $20 million annually for heavy-weather damage claims. Such claims included serious damage to hull structure, hatch closures, deck and superstructures, items of outfit and hull internals. In some instances bow and other structural sections have been carried away, exposing interior spaces and structure to forces of the sea they were not designed to withstand. Numerous examples can be cited of ship losses, often accompanied by loss of life.

Panel HS-2 has provided a forum for general discussion of slamming and impact phenomena, collected comprehensive literature on the subject, and formulated and guided investigations into the nature of these loadings and resulting responses. A Bibliography on Ship Slamming and Water Impact, Bulletin 2-16, published in 1968, is presently being updated. A limited survey of the subject, "Notes on Slamming," is being reviewed in preparation for publication in the near future. Full-scale data on the incidence of slamming and green water on deck are being evaluated to determine their statistical properties and value in defining the probability of occurrence and severity of these events. Such predictions could then be used with a reliable hull response monitoring and guidance system to supplement the judgment of ships' officers in operating their ships in severe seas.

There is a larger interest of the panel in the hull form characteristics of forward bottom and bow flare which are indicative of a vessel's propensity to slam and/or carry green seas aboard. Though section shape has been studied extensively, the distribution of shape over the forebody and its relationship to that propensity are not well understood. Future efforts of the panel will give attention to this aspect of the problem. Further, the new tools for analysis of fluid-solid interaction will be given close attention as to their applicability to the fluid impact-structural response problem.

Although much has been learned in the past few years regarding the generation of forces and responses in fluid-solid interaction, application of this knowledge in ship design and operation is still inadequate as witnessed by the annual payout for damages. It is the ultimate objective and goal of the HS-2 panel for formulate recommendations and guidance to alleviate this burden so long carried by ships on the world's oceans.

Panel HS-3: Stress Analysis and Strength of Structural Elements

Panel HS-3 has been involved with a number of projects over the past several years, including development of a *Structural Stability Handbook*, examination of ship flexibility and ultimate strength, and review of buckling and postbuckling of stiffened plates under combined loading.

The panel has spent the last year in reviewing aspects of the design of structural details. It is undertaking the development of analytic procedures for the details that will appear in the Ship Structure Committee's "Ship Structures Detail Design Guide" currently being developed.

Panel HS-4: Design Procedures and Philosophy

Under the Hull Structure Committee, Panel HS-4 has the broadest mandate. A structural design procedure must strike a balance between the needs of the design philosophy, construction, producibility, operations, maintainability, loads, material properties, strength, and response.

Structural design philosophy has to reflect the shipowners' philosophy for new vessel acquisition, including minimizing acquisition cost or the life-cycle cost, level of detail design to be reached prior to contracting with a shipyard, and time and money budgets for design. Purely structural aspects of the philosophy may include selection of primary material, type of framing system and shapes, and the extent of direct design procedures to be employed. For naval auxiliary ships, the design philosophy might include the extent to which commercial practices should be applied. The panel attempts to select tasks which could eventually lead to superior ships with appropriate structural integrity that can be built and operated efficiently. Special effort is made to address advanced technologies which are ready for introduction in design. A prime example of this is the application of reliability and probabilistic methods.

Recent and ongoing projects include:

- Preparation of the SNAME T&R Bulletin "Application of Probabilistic Design Methods to Wave Load Prediction."
- Economic study of ship framing systems (SNAME seed money project).
- Influence of contracting procedures on ship structural design and performance.
- Ship structural design and its impact on operating costs.
- Comparison of watertight bulkhead designs based on American Bureau of Shipping (ABS) rules, U. S. Navy Design Data Sheets, and ultimate strength.

Panel HS-7: Vibrations

Originally established as a task group under the "Dynamic Loading and Response" Panel of the Hull Structure Committee, the present Vibrations Panel was established in November 1967. At that time the HS-7 panel had three objectives:

1. To investigate the response of ship structures to exciting forces, and to develop recommendations which would lead to assured satisfactory vibration characteristics.
2. To recommend and support research toward an improved understanding of the response of ship structures to exciting forces.
3. To recommend publication of vibration design criteria and guides by the Society.

Over the years this panel has been especially diligent. Its first significant accomplishment was the publication of T&R Bulletin 2-10, "Code for Shipboard Hull Vibration Measurements" [6]. The Maritime Administration purchased an instrument package in September 1965 and began using it in shipboard trials shortly thereafter. Some 15 ships were tested by the Maritime Administration and the data were published by SNAME in the form of "Vibration Data Sheets."

After these accomplishments the program of HS-7 underwent a review. The objective agreed upon was "the development of a rational approach to the elimination of deleterious vibration in the design state of new ships." To accomplish this, the panel developed a Comprehensive Ship Vibrations Research Program for the consideration of the Society's Hull Structure Committee and the Interagency Ship Structure Committee. The plan encompassed a broad spectrum of disciplines and a diversity of effort by many groups. The plan included short-range, intermediate, and long-range goals.

In 1975 the Society published Code C-1, "Code for Shipboard Vibration Measurement" [7]. The new program called for the development of an improved instrumentation package to be completed within the next five years.

Code C-4, "Shipboard Local Structures and Machinery Vibration Measurements" [8] was published in 1976 and was followed by Bulletin 2-25, "Vibration and Noise Guidelines" [9] in January 1980. These two publications were considered extensions of the work carried out under Code C-1.

Parallel efforts were also underway on an international basis. A "Code for the Measurement and Reporting of Shipboard Vibration Data" [10] has been approved as an International Standards Organization (ISO) Standard. HS-7 panel members participate in ISO, and so assure that we stay in touch with worldwide developments.

During the period 1970 to 1975, several actions took place which influenced the development of a suitable design procedure to limit and control shipboard vibrations. These included preliminary design vibration design analyses of the DD963 and the El Paso liquefied natural gas (LNG) carrier during the initial design phases and full-scale vibration trials on both ships after launch.

The studies conducted on these ships, of widely differing design, indicated the feasibility of developing a rational preliminary design procedure. The studies also indicated areas of weakness as well as areas where modifications were required in past efforts, and areas where additional research was required.

Based in part on efforts of HS-7, the Advisory Committee for Ship Vibration Related Projects of the National Research Council prepared a draft of "A Proposed Five-Year Ship Vibration Research Program," which would culminate in a "Design Guide for Shipboard Vibration Control."

The ongoing effort of the Panel HS-7 is the development of "Guidelines for Analysis and Evaluation of Shipboard Vibration Data." Recent studies indicate that significant errors may be introduced by the use of fast digital electronic analyzers in conducting shipboard trials in accordance with the procedures defined in Code C-1. The first part of this study was completed in July 1982. This work received preliminary approval by Panel HS-7, which is in the process of compiling comments, and will be developed into a T&R Bulletin in support of Code C-1.

Panel HS-9: Materials

In 1982 four existing materials panels (Aluminum, Concrete, Fiberglass, and High-Strength and Alloy Steel) were consolidated into one Panel, HS-9. This year, Panel HS-9 completed an independent economic analysis of copper-nickel sheathing on two vessel hulls; a roll-on/roll-off (RO/RO) ship with a relatively short route, and a 360 000-dwt crude carrier. Both applications appear economically feasible using current prices.

As a result of the favorable outcome of the economic analysis, the panel is now seeking funding for five research projects considered necessary to satisfy owner and regulatory concerns for inspection standards and procedures, both for initial application and for special surveys.

The panel is also following application of high-strength/low-alloy steels to shipbuilding.

Panel HS-12: Instrumentation

The Instrumentation Panel of the Society is concerned with instrumentation related to ships and other marine structures. Objectives are:

1. To increase the safety and efficiency of operation of merchant ships, naval ships, and offshore equipment through response instrumentation.
2. To develop response monitoring instruments for the operational assistance of onboard personnel and to recommend ways of providing them with the technical understanding to properly interpret and use the data.
3. To build on currently applied methods and human factors concepts of display technology and theory, and to develop guidelines for their incorporation into shipborne systems.
4. To aid researchers through the establishment of guidelines for full-scale and model-scale measurement procedures and equipment.
5. To enhance vessel design methodologies through operational and research instrumentation.
6. To coordinate our activities with those of various hydrodynamic and hull structure panels related to operational and research instrumentation; for example, H-7's human factors assessment, H-10's maneuvering coefficient determination through system identification techniques, HS-1's loading calculators and onboard systems and springing research, and HS-2's transient response instrumentation projects.
7. To investigate the use of shipborne wave measurement devices for research and operations.

There are many project areas which the panel could investigate and either carry out projects or attempt to obtain sponsors. Current projects include development of a ship response monitoring instrument. This calls for the preparation of guidelines for a standard hull monitoring instrument with two or three responses, such as vertical and lateral accelerations or stresses. Among these responses, two will be common among all vessel installations, and the third will be an optional response selected by the owner on the basis of vessel type. The purpose of the standard responses is to provide the ship operator with some consistent responses to which he can relate as he moves from ship to ship. Recent efforts on this project include the assembly of an information package describing the Standard Response Monitor and a questionnaire to correspondents. The results of the questionnaire were coordinated, and from these, performance requirements were developed. In March 1983 the panel approved a prospectus for a contract to further develop this concept.

In the future the panel plans to address other topics, including:

1. Display techniques and methodologies that Panel HS-12 plans to examine include current display technology for aircraft to relate quantities of formation and alert functions. Comparison of these with the latest response displays may result in recommendations for changes and modifications to shipboard instruments.
2. Static loading calculators to validate the actual hull stress condition against the computed results from a loading calculator. This project would further investigate the potential application and use of such systems and provide guidelines for their development. A further application for this type of instrument would be as a monitor of transient peak hull loadings during cargo operations.
3. Considerations in stress/motions measurements planning where lessons learned from full-scale research programs, such as the need for a standardized planning checklist similar to the Sea Trials Code (C-3), could be used to optimize the data collection with mathematical model analysis.

Ships' Machinery Committee

The Ships' Machinery Committee studies shipboard equipment and machinery. In the past, this group has been particularly adept at responding to and anticipating the needs of the industry in this area; however, it is presently challenged as never before during a period of dwindling ship design and construction activity.

Presently, 12 panels consisting of approximately 200 participants perform the detail work for the committee. Panel chairmen are committee members and provide the necessary coordination and communication between it and the panels.

Each panel's objectives, a summary of recent activities, projects and accomplishments, and plans for the near future are outlined in the following subsections.

Panel M-15: Power Plant Economics

Over the years Panel M-15 of the Ship's Machinery Committee addressed problems with main propulsion machines and systems. The original efforts of the panel addressed the thermal aspects of shipboard power plants and resulted in the preparation of four bulletins on heat balance procedures:

3-11 Marine Steam Power Plant Heat Balance Practices (Revised 1973)
3-27 Marine Diesel Power Plant Performance Practices (1975)
3-28 Marine Gas Turbine Power Plant Performance Practices (1976)
3-36 Marine Steam Power Plant Heat Balance Practices (Reheat Supplement to 3-11) (1982)

Recent panel activities have continued to develop heat balance standards for marine power plants. Panel M-15 is now preparing such a bulletin for coal-fired marine steam power plants. In addition, the panel has broadened its scope by investigating the problem of objectively evaluating the economics of marine power plants and is now publishing a bulletin on marine power plant economics.

Panel M-16: Modernization of Propulsion Shaft Systems

The original objectives were established in the 1960's for propulsion shafting and bearing improvements. Further responsibilities for looking into propeller failures were assigned after an epidemic of breakage in the late 1960's and early 1970's. An additional task was added in the late 1970's—to provide a revision of T&R Bulletin 3-10, "Guide to Propulsion Reduction Gear Alignment and Installation." A number of T&R Bulletins dealing with various aspects of the propulsion shaft system have been published.

To foster developments in propeller design and application, the panel sponsored propeller symposia in 1975, 1978, 1981, and 1984. As a result of the symposia, four volumes of papers and discussions have been generated for use by government and industry.

T&R Bulletin 3-20, "Guide for Selection and Design of Line Shaft Couplings and Bolting," was revised by the panel to apply by shafts up to 40 in. in diameter, and was expanded to include metric (S.I.) units for shafts up to 1 m in diameter. The panel is now engaged in revising T&R Bulletin 3-10, "Guide to Propulsion Reduction Gear Alignment and Installation."

Proposed ASTM (American Society for Testing and Materials) Shaft Alignment Standards have been undergoing panel review, and comments will be submitted to ASTM Subcommittee F.25.11.

Panel M-16 is now considering the application of flexible couplings to ships' main propulsion shafting systems. A manufacturers' survey is currently underway and may result in the publication of technical information on this subject.

Panel M-17: Disposal of Shipboard Wastes

Subsequent to the 1963 edition of T&R Bulletin 3-33, "Guide for the Disposal of Shipboard Wastes," there was considerable progress in the related arts and sciences, along with a major increase in regulatory requirements. These two trends created a demand for an update. Panel M-17 completed this new edition, subtitled "Pollution Abatement by Ship Design, Equipment, and Operation," in 1982.

This guide is concerned with pollution abatement of the ship as a whole. There are many aspects of ship design, equipment design, and ship operation that, although not commonly identified as being associated with pollution control measures, are nevertheless significant in the overall antipollution effort. Examples are the design and construction of the hull, navigational aids, crew training and motivation, and operational and maintenance procedures. Not only the intact vessel should be considered (and the practical means to keep it intact), but also the damaged vessel, where pollution from leakage is a major problem. In such circumstances the wastes may be bunker fuel, lube oil, or other cargo.

In the summer of 1982 it became obvious to panel members from owners' service reports to the U. S. Coast Guard and equipment vendors that neither existing USCG regulations, nor certification requirements, nor the recommendations in our SNAME Guide were detailed enough to ensure satisfactory performance of the equipment or systems. To establish a forum that could create and issue more detailed specifications, though without SNAME legal responsibility, it has been agreed that all concerned should establish a new task group of ASTM Committee F-25 on Shipbuilding. The initiative for the formation of the task group, and the nucleus of the membership, came from Panel M-17, which will continue to cooperate closely with the ASTM task group.

Panel M-19: Ship Trials

In 1973, Panel M-19 completed updating, expanding and combining the four Society documents used in conducting sea trials into one publication, "Code for Sea Trials." Due to its widespread use, the Ships' Machinery Committee extended Panel M-19's charter to include the updating and expansion of the popular companion publication, "Code on Installation and Shop Tests," T&R Bulletin 3-8, which has been in print since 1960.

Panel M-19 was influenced by the following considerations in the selection of the format and content of the proposed update of "Code on Installation and Shop Tests":

- Alteration of the format from "code" to "guide."
- The need to include technological advances and ship design changes during the many years the code has been in print, notably in increased capacity and speed, decreased manning, more complex control and safety systems, and cargo handling systems.
- The use of cryogenic cargo systems, gas turbines and coal fuel, not previously covered.
- The desirability of having a guide which can be utilized by the Maritime Administration and the regulatory bodies and classification societies of the United States and other countries, as well as shipbuilders and owners anywhere.
- The wish to provide to the industry some of the more valuable lessons learned from ship component and system testing during the shop and installation phase.

The proposed new publication has been drafted, reviewed by industry, and is now in final review by the panel.

At the conclusion of this task, we envision that Panel M-19's charter will again be extended in order that the Ships' Machinery Committee can have input from that ever-important segment of industry activity. In addition, assignments relative to specific test and trial areas can be made as they are identified.

Panel M-20: Machinery Vibrations

In 1962 the Ships' Machinery Committee, at the direction of the T&R Steering Committee, formed a task group to review problems associated with longitudinal vibrations of main propulsion machinery systems. This task group became Panel M-20.

The early concerns were with thrust bearing stiffness, resonance changers, reduced line and propeller shaft stiffness, and the prediction of thrust bearing foundation stiffness. In 1972 the panel published T&R Report R-15, "Longitudinal Stiffness of Main Thrust Bearing Foundations," which discussed the approval for predicting the stiffnesses of the ship bottom structure and of the thrust bearing foundation structure. This report also included an annotated bibliography relating to the stiffness of thrust bearings and their foundations.

About this time, the emphasis of the panel changed to a general consideration of ship machinery vibration, and the name was accordingly changed to Machinery Vibrations. In 1976, T&R Code C-5, "Acceptable Vibration of Marine Steam

and Heavyduty Gas Turbine Main and Auxiliary Machinery Plants," was published.

Recently, the panel has concentrated on vibration monitoring as a method of evaluating machinery condition, primarily for preventive maintenance. A publication related to this is well underway.

Panel M-21: Automation of Ship's Propulsion Plant

The objective of Panel M-21 is to prepare ships' machinery plant automation guides and to keep up to date on ships' machinery automation.

There have been many developments in this field in the 14 years since preparation of the original guide T&R Bulletin 3-23. "Centralized Control and Automation of Ship's Steam Propulsion Plant." Panel M-21 has prepared a revised edition entitled, "Guide for Automated Ship's Steam Propulsion Plants." Major sections include Introduction, Propulsion Plant Types, Centralized Operating Requirements, Centralized Electrical Plant, Auxiliary Machinery, Testing and Trials, and Technical Documentation Requirements. This new guide, in addition to oil burning plants, will also cover gas and coal-burning plants. The new guide also presents considerably more detailed technical and design guidance than the old.

Panel M-21 also produced T&R Bulletin 3-29, "Guide for Centralized Control and Automation of Ship's Gas Turbine Propulsion Plant," published in 1978. Major sections are Introduction, Plant Types, Propulsion Control System Requirements and Implementation, Propulsion Plant, Ship's Service Electric Plant, and Auxiliary Systems. Both industrial and aircraft-derivative marine gas turbines are covered in this guide.

The maintenance of automated propulsion and auxiliary machinery has become a major problem due to reduced manning as a result of automation, as well as the more complex and sophisticated equipment now installed in ships. Approval and inspection by regulatory bodies is difficult if safety features and automated shutdown equipment in unattended machinery spaces are not properly maintained with a well-documented system. This has been addressed by the Maritime Administration in a special study, including the testing of actual maintenance systems aboard ship. This, along with other information supplied by the American Bureau of Shipping and the U. S. Coast Guard, has been considered in preparing "Automation of Ships' Propulsion Plant Maintenance Guide." All section drafts have been completed and the guide is being edited. Section titles are Introduction, Functions and Requirements of Maintenance Management Systems, Procedures, Maintenance and Test, Documentation of Maintenance and Repair Preformed, Spare Parts Support, Optional Features, and Test Procedure and Checklists. This guide should assist the shipowner, ship operator, and the design engineer in determining the degree of maintenance required for a particular class of ships in a given operating situation.

Panel M-24: Marine Fuel Systems

Panel M-24 was organized in the mid-1970's to assess the handling of fuels aboard ship and to formulate recommendations and guidelines for their most efficient use in main and auxiliary powerplants. It has also been an objective of Panel M-24 to keep up to date regarding trends in fuel quality and other fuel industry developments.

The panel was tasked to study the impact on ships' machinery of the growing interest in coal. This project concentrated on steam plants, for which coal-firing technology was well known. The use of oil/coal slurries or coal-derived liquids was not included in the study.

The completed T&R Bulletin 3-35, "Utilization of Coal As a Marine Fuel," was issued in 1982. This bulletin provides a practical and useful guide for the owner, designer, or operator considering the overall aspects of a coal-fired steamship.

At the present time the panel is considering the following subjects as potential projects:

—Consideration of the need for more accurate fuel quantity measurement when bunkering.

—A booklet for engineers of motorships, covering fuel blending, testing, and handling, that would summarize data available from a broad range of sources.

—Typical marine fuel characteristics that would serve as the basis for various equipment design calculations.

—General guidelines for the design of slow and medium speed diesel fuel handling systems.

—General guidelines for handling petroleum coke/oil (pet-coke) fuels.

Panel M-25: Performance of Ship Machinery Materials

This panel's aim has been to improve the performance and reduce the cost of ship machinery through the selection and use of proper materials. Recent efforts have been directed toward materials associated with seawater systems. Emphasis was placed on the interchangeability of materials from one country's specification to another's. This work culminated in the publication of T&R Bulletin 3-31, "Guide for Material Specifications Cross-Index for Seawater Systems," in 1980.

The panel is currently reviewing corrosion prevention during ship construction, weight reduction through material substitution, and use of plasma spray coatings.

Panel M-26: Boiler Operations

The aims of this panel were to provide guidance and make recommendations to shipbuilders, shipowners, and designers on various aspects of boiler design, manufacture, and operations.

Panel M-26 was originally formed in 1972 to investigate what might be done to lower the incidence of furnace explosions and superheater damage associated with boiler start-up.

A report was issued in 1977 as T&R Report R-23, "Considerations for the Prevention of Furnace Explosions and Superheater Damage in Merchant Ships' Boilers During Light-Off." It provided guidance to designers and shipbuilders on the proper design precautions necessary in a machinery plant to prevent damage to the boiler and superheater during light-off. In addition, guidelines for operation and maintenance were provided so that the operator could continue to expect safe start-up throughout the life of the ship.

In 1978 the panel reconvened to consider the preservation of boiler components and erected boilers because of increasing lag times between the delivery of the boiler components to the shipyard and their actual installation and operation. T&R Bulletin 3-30, "Guidelines for the Preservation of Marine Boilers and Boiler Components," published in April 1980, provides general recommendations to marine boiler designers and manufacturers, shipbuilders, and ship operators. If complied with, it will reduce the possibilities of mechanical damage and corrosion to the boilers prior to ship delivery.

In June 1980 the panel reconvened to study the recent activity of shipowners around the world and in the United States in burning coal, which had become relatively inexpensive compared with oil fuel. The 1982 T&R Bulletin 3-34, "A Guide for a Coal-Fired Boiler System," discussed guidelines for the handling of coal and ash and the burning of coal, primarily on a moving bed stoker grate. The guide also gave fuel characteristics for designers to enable them to properly design for a specific coal.

The next panel project is the development of "Guidelines for the Use and Application of Marine Waste Heat Boilers." At

present, there are no general guidelines for marine waste heat boiler system use or application. The outline for the guide now being developed has the following major headings: Steam Generator System Configuration, Selection of Heat Transfer Surface, Gas Side Cleaning Requirements, Recommended Water Treatment Processes, Design Features, and Turbogenerator Systems.

In the future the Boiler Operations Panel will likely consider the following two items:

1. *Alternate fuels*—The Maritime Administration and private industry are funding research into slurry fuels such as coal-oil and coal-water mixtures. This consists of grinding coal or coke to a fine consistency and mixing it with a liquid. When the liquid is oil, usually in the ratio of about 40 percent coal or coke to 60 percent bunker "C," the resultant slurry can be pumped and burned through existing fuel oil burners with only minor modifications to the fuel handling systems and burner tips. For a coal-water mix, the ratio is usually 30 percent water to 70 percent pulverized coal. There is some loss in boiler efficiency, but this is minor when considering the savings in fuel cost. All indications at present are that these slurries will burn satisfactorily in boilers. However, it is now time to gain shipboard experience over extended time periods so that long-term effects can be evaluated.

2. *Emulsifications*—Recent studies have shown that emulsified fuels show a greater combustion efficiency (that is, carbon conversion) than present-day steam atomizing burners. Water content in the fuel up to 9 percent seems to result in improvement of overall boiler operation. The combustion improvements have generally been accompanied by reports of improved efficiency. In the case of boilers, an improvement in the fireside cleanliness, a reduction in particles emitted, a reduction in high-temperature slagging, and reduced soot-blowing requirements may be expected. High efficiency improvements noted are due to minor explosions of the water droplet in the fuel particle, creating a very fine fuel spray which enhances combustion.

Panel M-27: Machinery Noise

The 1978 T&R Program brochure stated:

> Panel M-27 (Machinery Noise) is a relatively new panel . . . devoted to the reduction of noise, both air and structure borne, from machinery. It is currently researching what has been done to attenuate noise in the machinery itself and other methods such as flexible mountings. M-27's work will result in a report on this subject.

In January 1983 that work was published by the Society as T&R Bulletin 3-37, "Design Guide for Shipboard Airborne Noise Control." This book of 350 pages is likely of a greater scope than that envisaged when the panel was established. After a number of false starts and much discussion, the panel found that it would be of little use to limit its attention to the machinery itself, or even its mounting. The control of noise requires a systems approach, a "system" including sources of noise, transmission paths, and the listener. The resulting design guide addresses the noise control plan, including a methodology for prediction, and then goes into detail on source levels, transmission paths and treatment methods.

Future projects of Panel M-27 depend, in part, on the industry's response to this guide. A possible future project might be a noise measurement guide.

Panel M-29: Piping Systems Cleanliness

Panel M-29 is preparing a series of guidelines for the definition, measurement, and procedures to achieve piping systems cleanliness during all phases of shipbuilding and ship repair, from material procurement to vessel delivery. Each guideline will be limited to a specific piping system and will result in procedures which are both technically and economically acceptable to all segments of the industry. Each guideline will be self-contained.

A format for the guidelines has been prepared and several are in preparation by the panel.

Panel M-30: Marine Lubricants

Panel M-30 was organized in 1980 for the purpose of (1) assisting the Naval Sea Systems Command in a program to reduce the numbers of lubricants required to be carried aboard naval vessels to service hull, mechanical and electrical (HM&E) equipment, and (2) determining if a bulletin containing a recommended practice for marine lubricants and lubricating systems would be of use to ship operators and designers.

A survey of the HM&E lubricants requirements for two new classes of naval ships revealed 44 specifications covering 83 grades or types of specification and 18 more proprietary lubricants for a total of 101. Panel M-30 reviewed the specification lubricants in conjunction with representatives of the Naval Sea Systems Command (NAVSEA) and agreed on the need for 32 specifications with 36 grade or type specification lubricants. Military Handbook MIL-HDBK-267(SH), "Guide for Selection of Lubricants and Hydraulic Fluids for Use in Shipboard Equipment," was issued covering the agreed-upon lubricants.

The panel obtained a complete listing of Navy Stock Numbers (NSN) for lubricants from the Naval Petroleum Board. This list contained 343 specification and 145 nonspecification items. Many were only changes in quantity or packaging. The listing was corrected to determine the actual number of specification lubricants. Some 88 specifications and 155 grade/type lubricants were represented. The Naval Petroleum Board supplies lubricants to all military activities. Thus, the 56 specifications not included in MIL-HDBK-267 may be required in applications other than HM&E equipment. Since application data were not available, no overall substitution listing could be made by Panel M-30.

An updated listing of proprietary lubricants showed some 95 items of interest. NAVSEA has been obtaining lubricant property data on the lubricants. Panel M-30 will review the proposed substitutions when information becomes available.

A survey has been prepared to determine the level of interest in the marine operator community in a recommended practice for marine lubricants and lubricating systems. If there is sufficient interest, the panel will undertake the preparation of such a report.

Ship Technical Operations Committee

The Ship Technical Operations Committee (STOC) is composed primarily of ship operators, naval architects, marine engineers and marine suppliers. Their responsibility is the day-to-day operation of ships. Research is generally oriented toward short-range objectives of a practical form needed by the operators. Longer-term, more fundamental research is generally recommended to other committees for consideration. The STOC presently consists of nine panels covering areas currently of interest to the operating segment of SNAME. Specific aims, objectives and activities of the STOC panels are outlined in this section.

Panel O-21: Ship Operating Efficiency

This panel consists of approximately a dozen members, most of them affiliates of West Coast shipping lines, and meets about eight times a year. It provides a forum for the exchange of information on technical and managerial developments di-

rected at increasing the efficiency and economy of ship operations.

Panel O-21 is now developing the following bulletins:

1. Propulsion Monitoring Instrumentation for Shipboard Energy Conservation.
2. Residual Fuel Oil Handling and Combustion Guidelines.
3. Shipboard Energy Audits and Personnel Motivation.
4. Economics of Maintaining Hull Propeller Surface Smoothness.

In preparation for the development of the preceding Item 4, this panel is sponsoring research, at the University of Newcastle-Upon-Tyne, on the relationship between propeller roughness and ship operating costs. The principal objective is to answer the question, "Is it worthwhile to polish propellers in service and if so, to what standard?" The investigators will calculate the power penalty resulting from a variety of typical propeller roughness configurations. This work will be directed toward the larger oceangoing ships such as tankers, containerships and bulk carriers, and will simulate as closely as possible the realistic operating conditions of ships with deteriorated wetted surfaces. The results of this research will indicate potential benefits of propeller maintenance procedures for in-service propellers which have a measured distribution of roughness.

In October 1983, funding for O-21 was approved by the T&R Steering Committee for a project to identify and evaluate the economic benefits of stern bulbs. This work will be performed by Webb Institute of Naval Architecture.

All of the panel's work is directed toward the practical problems faced by today's shipowners. The T&R Bulletins produced by the panel are written to be of immediate utility to shipowners. They contain a minimum of mathematical formulae and a maximum of engineering management guidelines based upon experience.

Panel O-23: Ships' Paints

This panel has been actively involved in the reviewing of texts for revised surface preparation specifications as published by the Steel Structures Painting Council (SSPC). Numerous drafts were reviewed and comments offered since the originally published updated versions were considered by the panel to be insufficiently rigorous for reference by the marine industry without extensive additional qualifying remarks in governing contract documents. As a result of Panel O-23's and others' objections the published specifications have been withdrawn and new, improved, versions are in the final stages of the approval process. The panel is continuing a strong involvement in this process.

To counter the possibility of unacceptable SSPC specifications being adopted, O-23 also cooperated with the Ship Production Committee's Panel O23-1 (surface preparation coatings) to write alternative marine industry standard surface preparation specifications should the availability of alternative specifications be necessary. The ultimate goal is to have suitable specifications available to recommend to ASTM for adoption as marine industry standards. This will be a long-term effort, but one of considerable value.

Related to the foregoing, Bulletin 4-9, "Abrasive Blasting Guide for Aged or Coated Steel Surfaces," is now out of print. The bulletin has numerous color photographic reproductions of various grades of steel which have been blasted to varying degrees and has been used as a visual surface preparation standard by the industry, particularly for repairs. The panel is updating the text to incorporate the new SSPC definitions (when and if adopted and accepted) and adding new photographs preparatory to reissuing the bulletin.

Panel O-23 is also in the working draft stage of preparing a guide on the extension of service life of tank coatings. This guide will cover all aspects of petroleum cargo and water ballast tank coatings, from selection of materials, through application and inspection, to maintenance. It is the panel's contention that optimizing these aspects of tank coating will lead to longer useful lives of applied coatings.

Panel O-25: Life Support Systems

This panel investigates the problems of survival and survival equipment both on and under the sea surface.

After several years' work, the panel recently completed Technical and Research Bulletin R-27, "Performance Recommendations for Marine Lifesaving Systems." A review of current lifesaving systems in use on ships, this publication makes recommendations for improvement in the areas of debarkation, survival, detection, and retrieval. The purpose was to inform designers about life support systems, and to assist national and international agencies in the development of regulations. This bulletin was provided to the U. S. Coast Guard in support of the Society's Advisory Public Service Committee's efforts.

The panel is now completing a review of standards for construction of lifeboats. This is the first complete review for aluminum and steel construction carried out since the late 1940's. We hope this review will be used by the U. S. Coast Guard and other regulatory agencies to modernize their requirements.

Panel O-31: Cargo Handling

This panel's objectives are to assist the marine industry in defining problems and needed research in cargo handling technology and equipment, cargo stowage, and the influence of cargoes on ship and terminal design. Numerous reports and studies have been carried out within the panel and several have been published. The current effort is focused on publication of "A Guide to the Selection of Shipboard Container and Trailer Restraint Systems." The long-range outlook includes work in the development of a marine cargo stowage manual and a glossary of crane identification terminology and nomenclature.

Panel O-34: Computers

This panel was originally created to foster the application of computers to marine industry problems. With the computerization of the industry well advanced, other panels have taken the lead in addressing specific tasks and applications. Recent activity has focused on the collection and dissemination of computer programs for hand-held calculators. A future agenda is being prepared and may include standards for computer data exchange.

Panel O-36: Economic Analysis of Marine Transportation Systems

Panel O-36 commenced operations in 1977 with a survey of the industry to determine what directions to pursue relative to cost data and their use. Responses indicated a strong interest in data on ship construction capital costs, ship maintenance and repair costs, and ship operating costs along with a general interest in the techniques for analyzing the economics of alternative shipping systems. By 1982 the panel had developed and published a T&R Bulletin, "Guide to Sources of Data on the Cost of Construction and Operation of Merchant Ships."

In the fall of 1982 the panel jointly sponsored with the New York Metropolitan Section the very successful Ship Costs and Energy Symposium. Of the 26 papers presented, 13 were addressed specifically to construction or operating cost areas. A blue ribbon panel on shipbuilding and ship operating costs was also featured.

Also, in April of 1983, the panel held a seminar and workshop

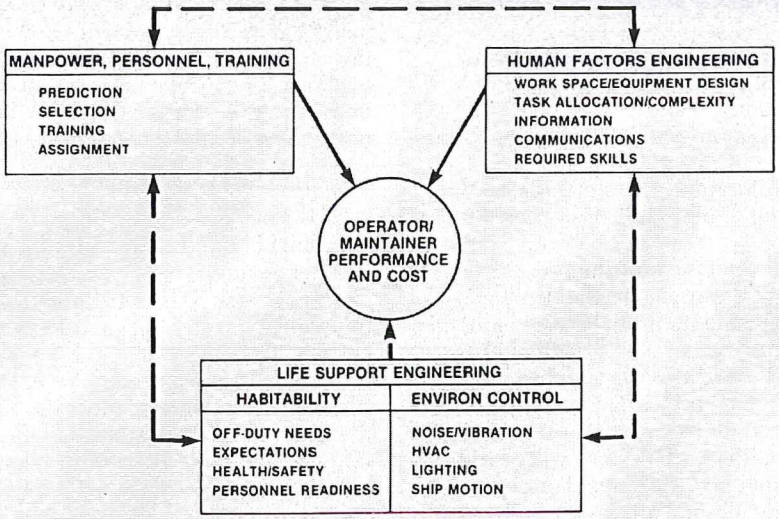

Fig. 3 Relationship among personnel performance/ship operating cost and the three main aspects of human factors

on the Techniques of Shipbuilding Cost Estimating. An attendance of 85 demonstrated a strong interest in the area. The panel continues to embrace the broad area of economic analysis of marine transportation systems, but now with increased emphasis on how the economic factors affect design and operation.

Panel O-37: Heating, Ventilating and Air-Conditioning Design

In June 1971, Panel O-37 was formed to prepare a guide for the design and calculation of heating, ventilation and air-conditioning (HVAC) systems aboard ship. Technical and Research Bulletin 4-16, "Calculations for Merchant Ship Heating, Ventilation and Air Conditioning Design," was published in August 1980. The bulletin was prepared by the most knowledgeable people in the marine HVAC field and the result is a very useable guide.

After completing this, the panel set out to standardize and update T&R Bulletin 4-7, "Thermal Insulation Report." This Bulletin was first published in 1963. At that time it was recognized that various insulating systems were needed at different boundaries to minimize the energy required to keep interior spaces at their design conditions. This is even more critical today with fuel being the highest component of a ship's operating costs. The proper insulation system is a passive method for maintaining a comfortable environment for the crew while controlling fuel costs.

Bulletin 4-7 described various types of insulation systems. Many of these are no longer used in ship construction since certain materials are no longer available, are prohibited from use, or have been superceded by less expensive methods. There are also new systems available. With modern computer techniques it is possible to quickly revise the tables of Bulletin 4-7, which list the overall coefficient of heat transmission for the many types of insulation systems, and compile a new report.

Webb Institute of Naval Architecture is preparing the computer program to calculate the *U*-factors. In order to be sure that the formulas yield satisfactory results, six different types of insulation systems will be tested, including bare steel, the *U*-factor of which is generally agreed upon. Two exterior types will be tested on different structural panel configurations. Two engine room systems, a bulkhead and an overhead panel, and an exterior panel with an exposed flange stiffener complete the list. Testing will be done using the ASTM-C236 hot box method. The panel is now seeking a facility where the tests can be accomplished within the budget of the project.

Future plans are to review ventilation problems in cargo holds of RO/RO vessels.

Panel O-38: Human Factors

Panel O-38 has been established to provide expertise in the application of human factors in ship design. The panel addresses the problem of integrating the human operator and maintainer with a mechanical/electronic system. Its work is divided into three categories:

1. Manpower, personnel, and training (MPT), which is concerned with the availability, selection, training, and assignment of personnel to operate and maintain systems.
2. Life support engineering, which is concerned with the operator/maintainer's health, safety and readiness, and also involves habitability design and environmental control.
3. Human engineering, which is concerned with the design of systems and equipment to insure they can be easily operated and maintained by the personnel in the system.

Figure 3 shows how each factor affects personnel performance and ship operating cost (solid arrows) and how it can affect other human factors (broken arrows).

The panel develops guidelines to be used in the design and operation of manned commercial and military marine systems, applying the principles of engineering, behavioral science, training, and management.

Recently Panel O-38 has been preparing, or has had under consideration, 23 guidelines addressing the following subjects pertaining to ship design and operations:

1. General Habitability
2. Illumination
3. Facilities Maintenance
4. Color
5. Vibration
6. Personnel Services
7. Noise
8. Outfit and Materials
9. Medical Facilities
10. Administration
11. Heating, Ventilating & Air Conditioning
12. Leisure Systems
13. Food Service

14. Ergonomic Standards
15. Manning
16. Institutional Factors
17. Rules and Regulations
18. Deckhouse Design
19. Navigation
20. Safety
21. Sanitary Spaces
22. Communications
23. Union Requirements.

Each of the above guidelines is being prepared by the membership of the panel, each member being responsible for drafting one or two bulletins. Panel membership includes commercial vessel operators, commercial and naval ship designers, shipbuilders, outfitters, human factors researchers, and educators.

Due to the broad coverage of this panel, close coordination with other panels and committees is essential.

Panel O-39: Fleet Management Technology

The purpose of this panel is to explore opportunities which may lead to the technological advances in management of marine operations. This includes cataloging computer-aided management techniques, reviewing research efforts in marine management, and providing a forum to explore areas of ship operation which offer technological advances.

The panel activities recently have included:

1. Initial publication of selected marine-related computer-aided management techniques.
2. Technical support to the Maritime Administration in MarAd's Fleet Management Technology Research and Development Program.
3. Solicitation and review of potential solutions for specific problem areas in marine operations.

The panel plans to continue these efforts for the immediate future.

Ship Production Committee

One of the newer committees, Ship Production, was formed in early 1970 to focus efforts on research and development to improve productivity in shipbuilding. Mr. D. M. Mack-Forlist chaired the initial meeting attended by 16 members affiliated with eight shipyards, an academic institution, a naval architect, the Navy, MarAd, and the Society. Seven panels were established in 1971. Today ten panels guide a research program known as the National Shipbuilding Research Program (NSRP) through cost-sharing contracts between the Maritime Administration and shipyards which sponsor each of the committee panels. Each panel is assigned a full-time employee by the sponsoring shipyard with responsibility under the Ship Production Committee and MarAd for the technical and administrative management of the panel's program.

The National Shipbuilding Research Program, as funded by industry and government via MarAd-industry cost sharing contracts, is executed through the Ship Production Committee as shown in Fig. 4.

The Ship Production Committee is unique in that it does not draw monies from the Society's Technical and Research Fund as do the other T&R Committees. The SPC receives recommendations from its panels regarding proposed work and evaluates proposals on the basis of technical and economic merit. The resulting package of proposed projects, representing an industry consensus, is submitted annually to MarAd. Government funding follows, to the extent allowed by available budgets, via cost-sharing contracts with those sponsoring shipyards.

It should be noted that while NSRP-Government funding is

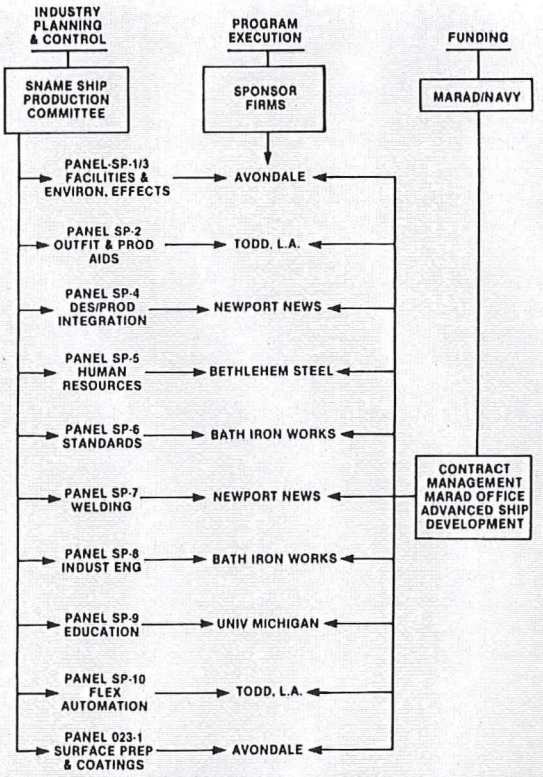

Fig. 4 Conceptual organization chart for the National Shipbuilding Research Program

through Maritime Administration contracts, 50 percent of that funding in fiscal years 1982 and 1983 was made available by the Navy. It is anticipated that this arrangement will continue. Government funding for each fiscal year is listed in Table 1.

After the first two years, the program stabilized at a relatively static level of funding until the last two years. In the early years nearly all projects of merit having parties willing to sponsor them could be funded. This was not the case later. The 1983 SPC-approved projects, with sponsors identified, would have required in excess of $8 million, or nearly twice the available government funds. It is obvious that industry has recognized the need for increased work in production technology and is willing to dramatically increase its commitment.

Mr. Ellsworth Peterson, president of Peterson Builders, Inc., guided this committee through a period of great activity from 1975 until 1983. Before a successor was selected a Blue Ribbon Committee was appointed to assess the organization and op-

Table 1 NSRP funding history

Fiscal Year	Funding ($ millions)
1971	0.7
1972	1.8
1973	2.3
1974	2.4
1975	2.3
1976	2.4
1977	2.7
1978	2.6
1979	2.6
1980	3.3
1981	2.6
1982	4.4
1983	4.4

eration of this committee. Mr. Hans Schaefer, president of Todd Shipyards, chaired it and delivered an extremely useful assessment, including recommendations, in December of 1982. After consideration by the T&R Steering Committee and the Society's Executive Committee, revised guidance was provided to SPC to assist in its restructuring to more effectively implement a growing National Shipbuilding Research Program.

One aspect of this restructuring was the establishment of an Executive Control Board. Its primary purpose is to provide policy guidance and direction as well as to review and evaluate proposed projects and recommend the most useful ones for government funding. Membership on this board is limited to six senior members from participating shipyards, one member from a design agent, one from an educational institution and nonvoting advisors from the Navy and MarAd.

The most vital tasks being addressed by the main committee include the continued development and maintenance of a long-range plan; consideration of an expanded role in the Navy's Manufacturing Technology Program; and consideration of initiatives aimed at the shipbuilding industry's supplier base with emphasis on efforts to:

- shorten lead times,
- acquire engineering data early in the design and construction cycle,
- enforce the application of innovations from other industries,
- improve and maintain quality, and
- establish acceptance standards.

The constituent panels have each been active to the degree deemed necessary to improve shipbuilding productivity. The panels and their work are briefly described as follows:

Panel SP-1: Shipyard Facilities and Environmental Effects

The objective of this panel is to assist U. S. shipyards in reducing cost of construction through the development and implementation of efficient equipment and facilities and improved work flow arrangements. The program addresses all phases of ship construction, including fabrication, assembly erection, outfitting, and required shipyard services. The program also includes environmental effects involved in facility expansions and modifications, operations, and ship production from a regulatory point of view.

Completed projects of all Ship Production Committee panels are listed in the Appendix. The following lists titles of projects currently in progress:

1. Ishikawajima Harima Heavy Industry (IHI) Survey of ASI and the Development of a Long Range Facilities Plan.
2. Pipe Shop Implementation—Phase II.
3. Implementation of IHI Technology at ASI.
   a. Production Planning and Scheduling
   b. Design Engineering
   c. Computer Application
   d. Accuracy Control
4. Web Line Feasibility Study.
5. Implementation of Process Lanes.

Projects being considered for the future are:

1. SP-1-83-01 Nesting and Marking System.
2. SP-1-83-02 Crane Analysis.
3. SP-1-83-03 Metal Forming System.
4. SP-1-83-04 Fitting and Welding Cylinders.
5. SP-1-83-05 Group Technology/Flow Applications in Shops—Phase 1.
6. SP-1-83-06 Portable Flushing System for Shipboard Piping System Cleaning.
7. SP-1-84-01 Computer Software Requirements for a Semi-Automatic Beam Line.
8. SP-1-84-02 Staging in Floating Docks and Graving Docks.
9. SP-1-84-03 Computer Software Requirements for a Semi-Automatic Webline.
10. SP-1-84-04 Unit Manipulator.
11. SP-1-84-05 Utility and Electrical Service for Ships at Piers.

Panel SP-2: Outfitting and Production Aids

The objectives of this panel are to address technological improvements in shipyard operations. The panel's scope of work has ranged from subjects such as weather protection, nondestructive testing, and alignment with lasers, to its more recent efforts in the transfer and documenting of the Japanese methods through the use of Ishikawajima Harima Heavy Industries of Japan as a research subcontractor.

SP-2 is now pursuing the following efforts:

1. Hull Planning to Facilitate Outfitting—This project is being performed in cooperation with IHI and will describe the hull planning techniques utilized by IHI to allow full implementation of zone outfitting.
2. Standards for Electric Cable—The objective of this project is to develop a performance standard for marine cable and a test specification to evaluate cables for shipboard use.
3. Production Process Planning and Engineering—In cooperation with IHI this project will describe the logic, principles and procedures of production engineering methods required for zone-oriented, integrated hull construction and outfitting.
4. Outfit Design—Performed in cooperation with IHI, this project will design methods required for effective zone outfitting.
5. Tank Sealing with Coating Materials—Evaluate the effectiveness of coating materials as sealants for pinholes in order to achieve tank tightness.
6. Product Oriented Material Procurement—Performed in conjunction with IHI, this will describe various methods for ordering and procuring outfit materials in the same zone sequence as the zone-oriented, integrated hull construction, outfitting and painting.
7. Contract Negotiation for Technical Matters—This project, being performed by IHI, will identify and describe the technical matters affecting the building strategy which should be incorporated in a shipbuilding contract. When they are so included, start-up is more rapid and other troublesome issues are avoided.
8. Role and Development of Middle Management—IHI will identify the roles of college-trained shipbuilding engineers or managers, particularly as heads of shops, and their relationship to productivity improvements. Recommendations specific to U. S. shipyards will be included.
9. Design Modeling—This project, about to be assigned to Hitachi Shipbuilding & Engineering (HSE) of Japan, will describe unique HSE techniques developed to produce highly sectionalized design models. The model sections facilitate camera access needed for three-dimensional photogrammetric digitizing. Thus, design modeling, which is best for creating complicated machinery arrangements, can be used in conjunction with computers, which are best for managing the data associated with detail design and material definition.

In the future SP-2 has plans underway to consider the following:

1. U. S. Shipbuilding Accuracy (Phase I)—A book which will provide shipyard managers, regulatory agencies, and shipowners with the accuracies normally achieved in the U. S. shipbuilding industry, expressed as standard ranges and tolerance limits. The book would serve as a reference document in shipbuilding contracts and as the basis for negotiation when

other than normally achieved accuracy is specified. Phase I will be limited to midships or parallel midbody.

2. Zone-Oriented Scheduling—A manual describing the scheduling techniques required to support just-in-time production of the various interim products as needed for zone-oriented, integrated hull construction, out-fitting, and painting.

3. Indices for Monitoring Man-hours, Progress and Productivity—A book of indices for identifying normal man-hours spent, progress, and productivity consistent with implementation of process flows that feature group technology. The book will also describe how the indices are used and by whom.

4. Product Work Breakdown Structure (PWBS) for Ship Overhauls—An illustrative book containing the logic, principles and PWBS applied to ship overhauls.

Panel SP-4: Design/Production Integration

The panel's work is based on the premise that initial planning and design are the predominant determinants of final costs, construction time, and quality. The panel studies the ship detail design and planning efforts, integration of those efforts into the production process, and the tools involved. The work of this panel is closely coordinated with the activities of the Ship Design Committee.

Panel SP-4 is presently engaged in the following efforts:

1. Design for Production Manual—Phases I & II

2. Group Technology Parts Classification and Coding System, Phases I & II—The project, when complete, should accomplish the following:

- serve as a companion to and further clarify the NSRP publication "Product Work Breakdown Structure,"
- provide insight into implementing group technology in shipbuilding,
- provide the basics of a classification and coding system that will be usable by a broad spectrum of the industry, and
- provide a tool that will augment and expand current Computer Aided Design/Computer Aided Manufacturing (CADCAM) utilization in U. S. shipyards.

3. Research Standard Software Tools—This project will assess the areas of automation in the shipbuilding industry, develop scenarios for future CADCAM configurations, and provide recommended cost-effective software tools for use in integrating the islands of automation.

4. Computer Aided Process Planning (CAPP)—This study examines computer-aided process planning programs in use in U. S. industry, determine their suitability to the shipbuilding environment, and recommend a CAPP program based on existing technology. If no suitable CAPP system is found, a shipbuilding CAPP System Specification will be prepared.

Future possibilities include:

1. Design for Production Manual—Phase III.
2. Study of Required Content/Format of Engineering Documentation.
3. Information Flow Requirements for Design and Procurement Processes.
4. Interface Impacts, System to Zone Transition.
5. Develop Specification Driven Pipe Arrangement and Detail Drawings.
6. CADCAM Review and Project Identification (if necessary, pending 1983–1984 ITT Research Institute project results).
7. Investigate Photogrammetry Techniques to Reduce Drafting.
8. Development of Computerized Design Data Output.
9. Investigation of Design/Planning Organizations.
10. Design/Production Integration Study Using Existing Ship as Role Model.
11. Review of Drawings for Producibility.
12. Change Control.

Panel SP-5: Human Resources

Over the past year there have been extensive discussions about the need for a new panel. As of this writing it is apparent that Panel SP-5 will be established to consider the fundamental matter of human relations in the context of productivity improvement.

The shipbuilding industry is extremely labor-intensive. Heretofore, we have concentrated on engineering and technological innovations in the quest for productivity improvement. In addition to these areas, far greater attention needs to be applied to the human element in production. The concept of quality circles was an early recognition of this need. Employee involvement with all its ramifications will be the concern of the Panel on Human Resources. Worker concern and commitment, with constructive dialogue between labor and management, can result in substantial productivity gains. This new panel represents an exciting initiative by the Ship Production Committee.

Panel SP-6: Standards and Specifications

The objective of this panel is to identify, recommend for funding through the National Shipbuilding Research Program, and accomplish priority projects in the field of standardization. Outputs from Panel SP-6 are intended for industry-wide application. When the output of an SP-6 project results in a draft standard, the document is submitted to ASTM Committee F-25 as a prospective national standard. The document then begins its cycle through the rigorous consensus process. This process is independent of the SP-6 program.

In an effort to expedite the creation of a base of U. S. National Shipbuilding Standards, our Society's president, John J. Nachtsheim, urged the use of the SNAME membership as a source of sound technical review in a rapid conversion of Military Specifications into commercial standards.

Early in 1983, the T&R Steering Committee voted to participate in reviewing, evaluating, and converting selected Navy documents to ASTM commercial shipbuilding standards. The Steering Committee established SNAME Panel SP-6 on Standards & Specifications as the SNAME focal point in this program.

Since the Steering Committee's action, significant progress has been made. After several meetings of a small group of representatives from the Navy, SNAME, and ASTM, a subcommittee was formed in May 1983, within the framework of ASTM Committee F-25 on Shipbuilding Standards, to coordinate the Navy Document Conversion Program. This subcommittee, ASTM F-25.94 on Navy Documents, acts as the overall coordinator among NAVSEA, SNAME, and ASTM.

The Naval Sea Systems Command has technical responsibility for some 4000 MIL-SPECS and 3500 Standard Drawings. Some 35 percent of these documents are out of date and may need extensive revision. There are also hundreds of these Navy documents which may not need to be MIL-SPECS or Standard Drawings where commercial substitutes already exist. The term "Navy Documents," as used herein, means military/federal specifications/standards/handbooks, NAVSEA standard and type drawings, and other similar and related publications intended to be converted to ASTM standards.

Taken together, these facts have an adverse impact on the productivity of the industry, productivity which could be greatly increased if commercial standards could be used in military work.

The objectives of this program are to examine the technical requirements contained in selected Navy documents, evaluate their content in light of current commercial practices, assess the

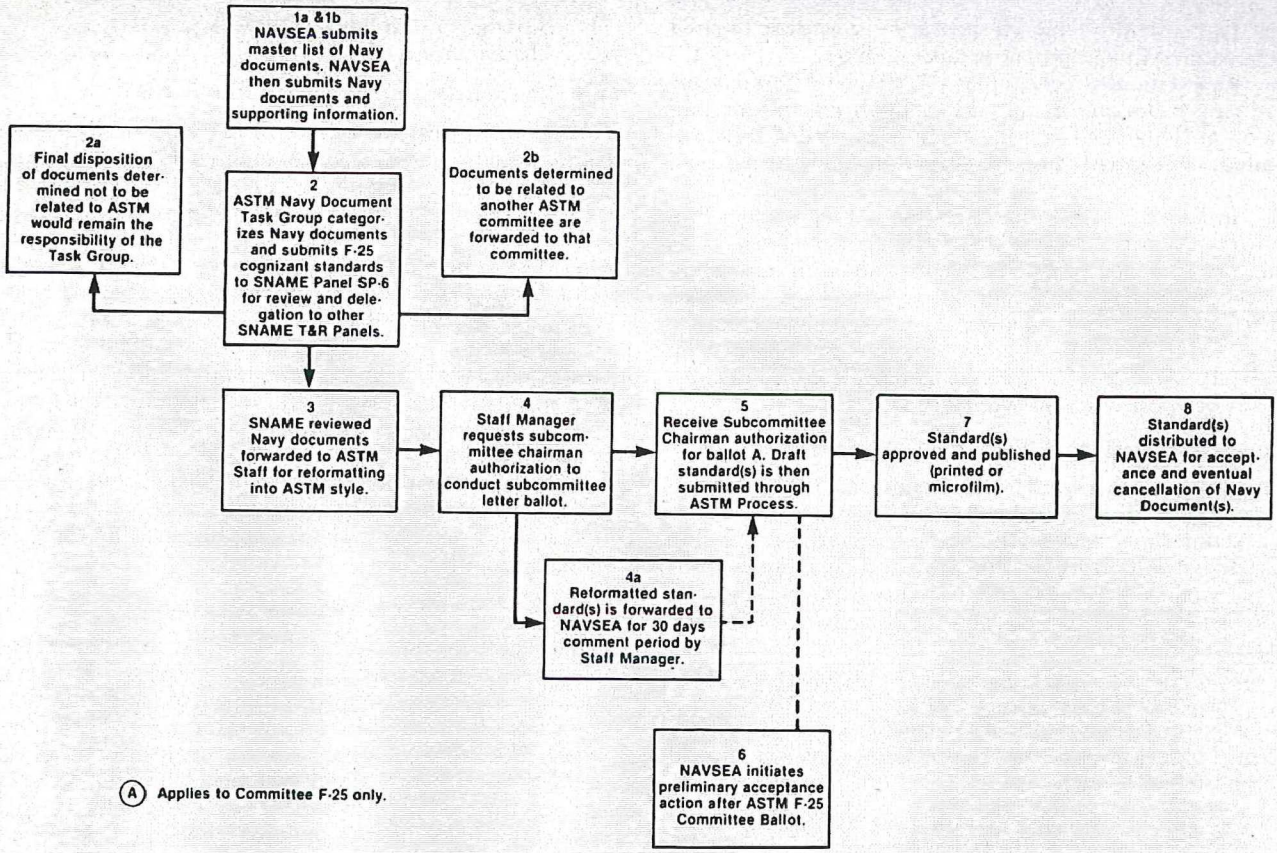

Fig. 5 Process diagram for the Navy Document Conversion Program

potential for conversion to commercial standards, make specific recommendations for changes that would bring the documents in line with commercial practices, and provide the rationale for these changes, which will form the basis for an ASTM conversion.

The best technical expertise available within SNAME will provide an avenue for obtaining the technical review which will start the process. As candidate Navy Documents are identified, they will be forwarded to the SP-6 panel chairman, who will obtain SNAME inputs. These inputs will then be provided to the cognizant ASTM subcommittee responsible for processing the document within the regulations of ASTM. A thorough technical review will be conducted during the process of ASTM balloting which, when complete, will yield a National Shipbuilding Standard that will encompass the needs of the Navy, U. S. Coast Guard, and industry. The standard should result in reduced costs, shortened design times, and reduced inspection and approval requirements. Additionally, the original MIL-SPECS will be cancelled upon acceptance of the new ASTM standard by the Navy. Since all aspects of the selected Navy documents will be extensively reviewed in ASTM's voting process, emphasis for SNAME voluntary review activities is placed upon identification of major areas that need attention, which, if highlighted early in the process, will shorten the overall development time of the ASTM standard.

Figure 5 depicts the step-by-step process of the Navy Document Conversion Program.

In the future, Panel SP-6 plans to continue the Navy Document Conversion Study, and initiate efforts such as

1. Cableway Standards for Surface Ships.
2. Standard Practice for the Selection and Application on Marine Deck Coverings.
3. Analysis of the Impact of Navy Specifications on Shipbuilding Productivity.
4. Continuing Tasks for Development of Draft Standards for ASTM F-25 Consideration.

Panel SP-7: Welding

This panel's objective is to make U. S. shipbuilding more competitive by increasing the productivity of welding operations. This is done by providing a forum where representatives of the various shipyards may meet as a cooperative body to address the welding needs of the industry.

A large number of projects are currently in progress. These are:

1. Evaluation of the Unimation, Inc. "Apprentice" Robot
2. Evaluation of the Cincinnati Milicron T3 Robot
3. Plastic Weld Models for Visual Acceptance Reference Standards
4. Fitting and Fairing Devices Study
5. Acceptance Standards for Welds Not Covered by Classification
6. U.T. Equipment Development
7. Multi-Consumable Guide Electroslag Welding
8. Tracking System for Automatic Welding
9. Aluminum Welding
10. Low Moisture Electrodes
11. Cored Wire for Submerged Arc Welding
12. Bulk Welding of High Strength (80–100 ksi) Quenched and Tempered Steels
13. Tracking System for Automatic Welding—Phase II
14. Prototype, Automatic Tack Welder for Shapes

Future efforts will likely include the following:

1. Design and Planning Manual for Cost-Effective Welding.
2. Robotic Arc Welding Technology—Phase I will write a specification for a robotic welding system suitable for shipbuilding requirements. Subsequent phases will canvas the market for availability of equipment and obtain, test and evaluate the system as required.
3. Review Automated UT Recordable Inspection Projects.
4. Substitute Eddy Current Inspection for Magnetic Particle Inspection for Ferrous Surface Flaws.
5. Evaluate Benefits of New High Strength Low Alloy (HSLA) Steel.
6. Determination of Hydrogen in Weldments.

Panel SP-8: Industrial Engineering

This panel assists U. S. shipyards in the development and implementation of an improved industrial engineering capability. Two items have guided development of panel projects:

1. The application of methods engineering techniques to develop shipyard labor standards. The Maynard Operation Sequence Technique (MOST system) was used in the phased development and application of labor standards. Participating shipyards applied the programs in specific agreed-to areas. Shipyards involved in the program were as follows:

Bath Iron Works
NASSCO
Peterson Builders
Newport News Shipbuilding
Bay Shipbuilding
Sun Shipbuilding
Bethlehem Steel

2. Parallelling the program just described is a coordinated industrial engineering education effort. This was directed toward three levels of shipyard management, as follows:

1980—A series of 15 management briefings, "Industrial Engineering Applications in Shipbuilding," for upper management.

1980/81—A series of two-day Production Control Workshops for middle-level managers based on the 1979 NSRP publication, "A Manual on Planning and Production Control for Shipyard Use."

1981—A Methods Engineering workshop developed and presented to industrial engineers and production planners; the first level of problem solving. Materials and background necessary to teach a short course in shipyards were provided.

Projects for the future include:

1. Improved Planning and Shop Loading in Shipyard Production Shops.
2. Shipyard Training Packages for Industrial Engineering Procedures.
3. Methods Engineering Workshops.
4. Standard Data Pilot Project for Shipyards.
5. Optimal Use of Industrial Engineering Techniques in Shipyards.
6. Analysis of Manpower Estimating and Control Procedures.

Panel SP-9: Education

This panel develops and maintains educational programs relating to the latest technology on ship production and planning. Specific areas of concern are skilled trades training, pre-entry professional training, and middle-management refresher training. A video tape library has been established to assist shipyards in training their employees.

Being one of the newer panels, SP-9 has most of its initial work still underway. It includes the following:

1. Curriculum and Faculty Development.
2. Ship Construction Textbook and Support Material.
3. Survey of Shipyard Training Needs.
4. Conference on Human Resource Development.
5. Short Course on Advanced Technology.
6. Course on Surface Preparation and Coating.
7. Shipyard Orientation for Skilled Trades.
8. Survey of Industry Middle Management Training Needs and Capabilities.
9. Technician Skills Training.
10. Multi-Yard Apprenticeship Program.
11. Continuing Education for Management.
12. Develop Ship Production Curricula for Industrial Engineers.

Further initiatives will include:

1. Establishment of a Professional Journal on Ship Production.
2. Microfiche Library Service.
3. Video Lecture Course on Basic Naval Architecture for Trade Schools.
4. Improving Communication Skills of Shipyard Workers.
5. Evaluation of European Craft Training Concepts.
6. Video Course for First Line Supervisors.
7. Indoctrination Program for New Employees.
8. Instruction Syllabus for Course on Design for Production (with SP-4).

Panel SP-10: Flexible Automation

This panel conducts research and coordinates the efforts of other panels in the area of flexible automation, defined as "The combination of reprogrammable single and multifunctional manipulators and fixed function machines integrated with conventional fabrication and assembly techniques for optimizing the performance of the manufacturing process."

Initial projects include:

1. Robotic Welding Cable Manufacture, Inspection and Repair.
2. Development of a Plan to Introduce Flexible Automation Into the Shipbuilding Industry—Phase I.

In the near future the following projects will commence:

1. Marking of Plate Cut by CNC Burning Machines.
2. Development of a Plan to Introduce Flexible Automation into the Shipbuilding Industry—Phase II.

Panel O-23-1: Surface Preparation and Coatings

This panel deals with the materials, tools, and techniques of marine surface preparation and coatings. It works closely with STOC's Panel O-23 to link the operators with shipbuilders in a very important area.

Current projects include:

1. Rust Compatible Primers.
2. Reclamation of Mineral Abrasives.
3. Abrasive Survey and Specification.
4. Edge Preparation Standard—Phase II.
5. Marine Coating Performance for Different Ship Areas—Phase III.
6. Adaptation of Japanese Pre-Fabrication Priming Procedure to U. S. Shipbuilding Methodology: Feasibility Study.
7. Zone Painting Method: Design and Planning Manual.
8. Overcoating of Inorganic Zinc Primers for Immersion Service.
9. Calcite Coating of Tanks—Phase II.

10. A Comparative Cost Analysis: Application of Waterbase and Solvent Type Coatings.
11. Cost Analysis: An Industrial Engineering Study of Incremental Cost for Surface Preparation and Coating in New Ship Construction.
12. Surface Preparation and Coating Training Program.
13. Performance Testing: Marine Coatings.

Future efforts will address:

1. Work Planning for Shipyard Surface Preparation and Painting.
2. Standardized Certification and Testing of Weld-through Primers.
3. The Effects of Contaminants on Tank Coating Performance.
4. Flame Sprayed Metals: Application Costs.
5. Automated Painting of Pipe Pieces, Hangers and Other Small Parts Feasibility Study.

Marine Systems Committee

Worldwide trends, including the increasing scarcity of food, fuel, and minerals, are prompting increasing use of the oceans for activities other than transportation and warfare. The 1960's saw increased recovery of petroleum from the continental shelf, mining of ocean bottom minerals, fishing, and the development of means for generating energy from the oceans. One result was the creation of many offshore platforms other than ships. These activities involved the same industries that have traditionally supported ocean transportation and warfare—that is, ship designing and shipbuilding. And the new systems were created through the arts of the naval architect and marine engineer. The first formal recgonition of this trend by the Society came in 1963 when the T&R Steering Committee decided "to create an ad hoc ocean research advisory committee of the T&R organization."

Coincident with this increase in the offshore industrial activities, there was an increase of interest in hydrofoil and surface-effect vehicles. These vehicles demand close attention to weight and to the integration of the hull structure with the propulsion and control systems. In fact these vehicles are more akin in their design to aircraft than to ships. The SNAME T&R reaction to this growth in new technological directions was the formation of three ad hoc advisory groups within the T&R Steering Committee. These were concerned with (1) hydrofoils, (2) surface-effect ships (SES), and (3) ocean engineering. Their activities were summarized in Thiele [4].

The Ad Hoc Ocean Research Advisory Committee became the Advisory Group on Ocean Engineering (AGOE). During its tenure the group made many recommendations to the T&R Steering Committee. Notable among the recommendations was the need for three new SNAME T&R panels: (1) Marine Resource Exploitation Systems, (2) Submersibles, and (3) Positioning and Mooring Systems. More particulars on the AGOE work may be found in "The Society of Naval Architects and Marine Engineers and the Conquest of Inner Space" [11].

Siting the three new panels under the existing committees proved unsatisfactory. A Marine Systems Committee was the proposed solution and a task force was appointed in October 1969 to "... develop details, information, and mode of operation of the new committee and to propose nucleus membership for the committee and its panels." Extensive groundwork had been completed by the AGOE and other advisory groups during the previous 3½ years, so the report came quickly in March 1970, and the Marine Systems Committee (MSC) held its first meeting that June.

The MSC is somewhat different from the earlier SNAME committees because the substance of its activity is almost totally applied technology. No scientific research is conducted and little technology developed. Instead, the activity of MSC entails primarily innovation and engineering development. For this reason the workload is sensitive to the flux of nationwide industrial activity, and panel activities increase and decrease correspondingly.

The MSC has formed 11 panels from its beginning in 1970 to the present. Five panels were established along with the committee. They covered MS-1 Advanced Surface Craft, MS-2 Submersibles, MS-3 Mobile Ocean Platforms, MS-4 Anti-Pollution Systems, and MS-5 Marine Resources Exploitation Systems. At the second meeting of the MSC, three more panels were established: MS-6 Salvage and Rescue Systems, MS-7 Towing and Barging Systems, and MS-8 Special Cargo Systems. More than a year later, in September 1971, MS-9 Ocean Engineering in Frigid Environments, was established. Increasing attention to ocean energy systems over the years finally resulted in the establishment of Panel MS-10 Ocean Energy in November 1975. Finally in June 1977 the Fishing Systems Panel, MS-11, was established.

The MSC and its predecessor, AGOE, have made a number of technical contributions. Notable among these was a study of the transport of liquefied flammable gases, especially LNG and LPG (liquefied petroleum gas). This started with an early recognition of the problem in 1970 and continued for eight years covering both the special cargo systems and the salvage and rescue aspects. An MSC ad hoc committee produced a *Metric Practice Guide* that was published by the Maritime Administration. In addition to this, the panel studied several Seagrant projects and gave advice to the National Council on Marine Resources and Engineering Development, and the National Ocean Survey.

The research and development under the MSC covers the design, construction, operation and maintenance of systems and their components, so it is usually difficult to study the parts without attention to the whole. Only MS-10, Ocean Engineering in Frigid Environments, is likely to generate applied research separate from system development.

The panel summaries are given in the following subsections.

Panel MS-1: Advanced Surface Craft

The panel was originally chartered as the "High Speed Surface Craft" panel of the Marine Systems Committee. The intent was to assemble a group of people who could address the problems of ships and crafts operating at speeds over 35 knots. As it became evident that the work of the panel would include ships whose speed range in certain forms would be below that, the name was changed to the "Advanced Surface Craft Panel."

From the beginning this panel undertook a wide range of activities, including the sponsorship of technical papers and advanced ship meetings and symposia, preparation of publications pertinent to advanced technology ships, and assistance to the services in developing criteria for assessment of such technologies. Salient among these were continuing bi-annual symposia, some held in conjunction with the American Institute of Aeronautics and Astronautics (AIAA). The publications prepared by the panel included "A Glossary of Terms for Advanced Surface Craft" and "Operating Cost Formula for Advanced Surface Craft." Both have enjoyed wide acceptance in the field.

Since 1980 we have seen a marked reduction in the use of advanced technology, including the demise of the technically successful Navy Surface Effect Ship Program (formerly JSESPO). However, there are some projects offering chances for proof of these emergent technologies. These include the Navy's PHM hydrofoil squadron, the acquisition of the LCAC

hovercraft in production quantities, and the Coast Guard's acquisition of three high length to beam ratio SES cutters. All of these programs have personnel active on Panel MS-1.

The panel is initiating two projects to promote these advances. The first is the development of a technical handbook derived from the Advanced Naval Vehicle Concepts Evaluation (ANVCE). This unclassified version should be of use to ship designers who wish to make initial selections from all available ship types. The panel is preparing a comprehensive outline to be used in the preparation of the handbook. The scope of the work includes (1) an overview detailing performance characteristics and selection rationale; (2) air cushion vehicles, covering both full skirted and sidewall type (included here will be design principles, requirements, system sizing and performance estimation; (3) hydrofoils, both fully submerged and surface piercing; (4) planing craft, prepared by or in conjunction with the Planing Boat Panel; and (5) small-waterplane-area twin-hull (SWATH) and catamaran displacement ships. The "military worth" section of the ANVCE study will not be included.

The second near-term effort is the next symposium for these technologies. Emphasis of this meeting will be on the systems required for ships of these types. This emphasis on systems is appropriate in that the basic ship technologies are fairly well established and an impediment to their use is the need for modified or different systems in their operation.

One long-term project, in the early planning stage, is the development of trial standards for advanced ship types. These will be sorely needed as the commercial ships now under construction or planned for near-term starts become available and require trials codes.

Panel MS-2: Submersibles

Panel MS-2 is currently engaged in the completion of a long-term book project. Major manned submersible activities, that is, design construction and operation, were carried out over the 15-year period 1965–1980. Since the latter part of the 1970's design and construction activity has been significantly reduced. To capture and retain a measure of this disappearing submersible design expertise, the SNAME Submersible Panel started a submersible vehicle system design book.

Over the past few years the chapter topics have been determined and volunteer authors have written most of the technical content. Chapter structure is currently:

1. The Design Process
2. Characteristics and Development of Submersibles
3. The Environment
4. Materials
5. Hydromechanical Principles
6. Structural Principles
7. Submersible Systems
8. Support Systems
9. Submersible Design and Operation Safety Considerations

The book material is in the final technical review and editing cycle.

The use of manned submersibles has fallen off due to increasing numbers and capabilities of remotely operated vehicles (ROV). The future role to be played by the MS-2 panel in the ROV area has yet to be determined. After completion of the submersible design book, the panel will review its charter and objectives.

Panel MS-3: Mobile Ocean Platforms

Panel MS-3 provides a study and research group within the offshore petroleum industry to focus on ocean and offshore engineering needs, particularly regarding mobile platforms. The group has focused on a problem of immediate interest to a large number of members, that of stability of semisubmersible drill rigs. An ambitious research program was formulated involving model tank tests of a semisubmersible subjected to overturning forces of wind, mooring forces, and wave forces, plus the additional dynamic effects of waves. It was decided at the outset to try to support research activities of Panel MS-3 through contributions of companies involved in the offshore business. This policy has worked well and is continuing.

The first research project undertaken consisted of wave tank tests of two semisubmersible models at Stevens Institute of Technology. This work was supported by 14 companies and cost approximately $60 000.

A number of valuable findings resulted from these tests. Perhaps the most significant was that waves did not tend to capsize the semisubmersible model even with approximately zero *GM*. The high freeboard and inherently large reserve buoyancy of the semisubmersible caused it to resist capsizing even in the presence of steep, breaking waves combined with wind force and the overturning couple caused by the vessel overrunning its downwind anchors after the upwind anchors were released. The findings of this work were reported first in two papers presented before the Offshore Technology Conference in 1974 and 1975, both entitled "Experimental Study of Stability Limits for Semisubmersible Drilling Platforms," by Numata and Michel and Numata and McClure, respectively. A more comprehensive report presented to the Society's 1976 Annual Meeting was "Assessment of Stability Requirements for Semisubmersible Units" by Numata, Michel, and McClure.

Analysis of the model tests pointed up the need for improved methods of determining wind forces and moments on full-scale semisubmersibles and jackup rigs. Accordingly, a program was undertaken to conduct wind tunnel tests and compare results with standard calculation methods. An extensive multi-year program was formulated including testing of a jackup rig followed by testing of a semisubmersible. A target of $80 000 was established for the total program. Although the fund-raising effort took several years, the amount was exceeded by contributions from about 20 companies and organizations, including oil companies, engineering companies, the American Bureau of Shipping, and the U. S. Coast Guard. Approximately $115 000 was collected. Panel MS-3 formulated a detailed outline of a program for jackup rig testing and, after receiving proposals from U. S., Canadian, and overseas wind tunnels, awarded a contract to Texas A&M University.

Wind tunnel tests of the jackup rig model were performed in 1979 and 1980. The experimental results and a limited amount of analysis were reported in a paper presented to the Offshore Technology Conference in 1981 by David J. Norton of Texas A&M and Christian V. Wolff of Reading and Bates, entitled "Mobile Offshore Platform Wind Loads," OTC No. 4123.

A follow-on contract was awarded to Texas A&M University for tests of a semisubmersible rig. In order to compare results with conventional calculation procedures, the U. S. Coast Guard and Det norske Veritas prepared calculations using methods common to the Coast Guard, ABS, and Norwegian Rules. Tests were conducted during 1981 and 1982. During 1983, extensive analysis was performed to compare test results with the analytical methods.

The results of the total wind tunnel test series and data analysis will be presented before the Society in a separate paper at this, the 1984 Annual Meeting. The authors are Dale Reid of Exxon Production Research and Michael Macha of Texas A&M University. The panel and the Marine Systems Committee are also investigating preparation of a T&R bulletin incorporating the results of the tests and analysis program.

With the extensive experimental and analytical stability work

behind it, the panel is considering fundamental questions of stability requirements and stability criteria. This is taking two forms. One of the current programs is to analyze stability from an historical point of view to document actual practice. Another group will study the interaction of wind and waves to gain a better understanding of the effects of the environment on semisubmersible drill rigs.

The panel now numbers approximately 34 people involved in offshore oil exploration and production, including personnel from oil companies, drilling contractors, service companies, classification societies, and engineering companies.

Panel MS-4: Anti-Pollution Systems

The Anti-Pollution Systems Panel topics include:

1. Oil spills and chemical spills
2. Discharges from tank cleaning
3. Solid wastes and wet wastes
4. Dredging and ocean mining
5. Thermal pollution
6. Waterfront deterioration

Consideration was limited to systems that are external to ships such as port facilities and spill control equipment.

The panel prepared a questionnaire regarding shoreside reception facilities, to serve as an aid for their development in the United States. This questionnaire was sent to numerous port authorities, including coastal and inland ports. The 25 responses were summarized by USCG personnel. An interpretation of the results was attempted by the panel chairman, but proved difficult in view of the incongruity of the responses. Only general conclusions were reached; that is, that the majority of U. S. ports had little or nothing in the manner of fixed shoreside reception facilities, and that shipboard wastes were typically handled by private contractors who hauled them away to shoreside disposal sites. In most cases, this arrangement was satisfactory to the local port authority.

Although MS-4 has been inactive since 1980, recent acceleration of developments of open-water recovery systems, arctic systems, chemical spill systems, and the use of dispersants is reawakening attention. MSC is considering restaffing this panel.

Panel MS-5: Ocean Resources Exploitation Systems

Panel MS-5 was established to direct attention to the interdisciplinary technical and operational aspects of the commercial utilization of ocean mineral and other resources, excluding oil and gas, but including fisheries.

Its early work included a survey of institutional and industrial marine resources research programs and activities; a survey of marine underwater power plants; and panel discussions on potential topics of interest which included technology transfer in ocean engineering from government sources, an analysis of three-phase flow in marine risers, a determination of the environmental limitations of shipboard-mounted mineral dressing equipment, a survey of advanced approaches to fishing and aquaculture, at-sea transfer of mineral cargo, offshore port facilities for mineral cargo transfer, development of an economic model of ocean mineral exploitation, and determination of influences of the environment on marine mining as well as the impact of mining on the marine ecosystem.

Recently marine mineral industrial interest has declined severely. The panel is now monitoring the activity of the U. S. Government and marine scientists to assess the extent of the polymetallic sulfide deposits recently discovered in the U. S. Exclusive Economic Zone.

Panel MS-6: Salvage and Rescue Systems

Panel MS-6 has maintained a close liaison with the Marine Technology Society's Marine Salvage and Towing Committee to preclude duplication of efforts.

Initial major tasks undertaken were the study of:

1. Salvage of liquefied gas tankers.
2. Nuclear ship salvage.
3. Large tanker salvage.

The nuclear ship salvage efforts were limited to becoming familiar with special features of the only U. S. commercial nuclear-powered ship, NS *Savannah*, since it was apparent that the Navy would take care of their own. A running file was kept, and one member continued to monitor the subject for the panel.

The Tanker Salvage Task Group reviewed past tanker salvage cases and postulated credible future accidents. A dominating feature of these ships was their rapid growth in size during the 1960's and early 1970's. The panel concluded that the greatest need was some guidelines for use by owners, masters, and casual salvors describing what they might expect and initial action to take when a casualty occurs. The panel worked with and had extensive input to a "manual" that was produced by the Oil Companies International Marine Forum (OCIMF) and has since run through two editions under the title *Peril at Sea and Salvage—A Guide for Masters*.

The panel undertook a major effort in exploring special problems that could be encountered by salvors when encountering a liquefied gas carrier casualty. More questions were raised than answers available; hard information was sometimes hidden behind the proprietary label. In the early 1970's the subject was highly sensitive. The panel and industry could not reach agreement as to what was a credible accident, let alone the maximum credible accident. Finally, after several years of effort the panel's attention to the problem was deferred in view of the Marine Board (National Research Council) initiation of a project to study hazardous cargo in the maritime environment. The Marine Board was a more appropriate forum for addressing problems of this type. Two Marine Board Committees eventuated: Hazardous Cargos, followed by National Salvage Posture. The panel was quite active in supplying input to and workers for these two efforts. Both are now complete.

Throughout its history, MS-6 has kept itself up to date with salvage techniques, policies, and requirements. As an example, the panel reviewed the National Aeronautics and Space Administration's (NASA) early plans for salvage of the Space Shuttle Booster rockets.

Since 1980, the panel has been primarily involved in rewriting the U. S. Navy *Towing Manual*. This has been a major task with funding through Society headquarters, using a grant from the Navy.

The future does not lack projects that beg for SNAME attention. To cite a few:

1. Salvage ship characteristics.
2. Rescue ship characteristics.
3. Towing connections.
4. Bollard pull measurement/criteria/standard.
5. Extension of work published in paper "Modern Analytical Techniques in Salvage Engineering Using Portable Computers" given at the 1983 SNAME Annual Meeting.

Panel MS-7: Towing and Barging Systems

Perhaps the biggest development in this areas in the last decade is the advent of integrated tug/barge systems. Otherwise there have been few major advances since the Kort-nozzle concept for propulsion. The technology of tugs, towboats, barges, and flotillas still leaves considerable room for improved engineering design.

Over the years the panel has considered a potpourri of

subjects. These include the connecting systems to be used between towboat and barge, and between barges, the towing arrangements, transverse stability requirements, barge designs for adequate stability/safety of the offshore tugs, economics of the integrated tug/barge systems, manning requirements, arctic towing, energy conservation versus configuration of the tow, speed and maneuvering, double-skin barges, structural failures of barges, accidents and bridges, and finally, the maneuvering of the tow. All of these subjects offer opportunities for the designer and the operator to improve these systems. Although some believe there is a need and substantial technological opportunities for R&D under the aegis of MS-7, repeated efforts have failed to marshall an effective panel for towing and barging systems.

Finally it was decided that the panel should be reduced to the status of a monitor, who is now a member of the MSC.

Panel MS-8: Special Cargo Systems

Panel MS-8 is concerned with those cargoes for which marine carriage poses special design or operational problems: cryogenic cargoes, high-temperature cargoes, high-pressure cargoes, hazardous materials, and slurries. The MS-8 panel comprises representatives of shipbuilders, shipowners, and operators, the Maritime Administration, American Bureau of Shipping, the U. S. Coast Guard, and others.

As a result of the worldwide interest in transporting liquefied natural gas, much of the panel's work in the 70's focused on the carriage of this product. One guide, the "Gas Trials Guide for LNG Vessels," was completed and published. A second guide, the "Liquefied Gas Cargo Systems Guide," is in draft form.

The "Gas Trials Guide for LNG Vessels" provides definitive information on the preparation of an LNG vessel for gas trials and the conduct for those trials. The guide covers procedures for drying and inerting, cold-testing of deck machinery and piping, displacement of inert gas and cooldown of the tanks, LNG handling, boil-off handling, warm-up, and gas-freeing. Additionally, there is a section addressing potential problems that may be encountered with the first full load of LNG.

The purpose of the "Liquefied Gas Cargo Systems Guide" is to provide future designers of liquefied gas carriers with the results of practical experience gained in previous testing, construction and operation of these vessels.

Panel MS-9: Ocean Engineering in Frigid Environments

After several years of promoting papers and meetings, and otherwise serving as a coordinating center for technology, the panel conducted an industry survey to identify those research projects which were most necessary to improve operations in the Arctic. Potential research areas identified were a catalog of all full-scale icebreaking resistance data; a compilation of all tests that include maneuvering data; delineation and standardization of sea ice strength test, both full scale and model scale; and the creation of a reference document addressing icebreaking technology. Several of the projects which were undertaken by the panel were based on this survey.

The panel completed a document entitled "Ice Pressure Ridges—A Bibliography," which contained, as far as could be ascertained, all technical papers referring to ice pressure ridges. This compilation was done by the staff of the Arctic Institute of North America, under contract to SNAME. A useful inclusion in the document was a listing of the most "dog eared" references as used by 20 of the best known researchers in this field. This provides aid to those perhaps just entering the field, or who wish to learn quickly, in the form of a concise list of the most important references.

In 1983 the committee began a guide to the ice-worthy ships of the world, using a one-page-per-ship format. This is intended to be a reference document for designers and operators. It is planned that each sheet will display, in addition to the main physical characteristics of the vessels, other useful factors including hull waterline angles, ratios of power, propulsion plant description, any unique features, performance in ice, and sources of supplementary information. The format of the data page is being circulated to panel members for their comments.

The committee is very close to completion of Phase I of a program entitled "Added Ship Resistance from In-Plane Ice Pressure," which considers the effect of an ice sheet in augmenting the resistance of a ship in transit. This phase was analytical in nature. The U. S. Coast Guard, MarAd, and Petro Canada augmented SNAME sponsorship. The analytical results are not complete in themselves and in Phase II the panel will investigate this phenomenon further by initiating a series of model tests. In these tests the in-plane pressure will be varied and the augmentation of resistance monitored. The mechanism of applying the pressure has not yet been decided, and the various model testing tanks have been approached for their suggestions.

We hope to synthesize much of the information from these projects into a reference document as suggested in the earlier survey. This latter document will be addressed directly to the designers and constructors of ice-worthy ships and will attempt to present information in an easy to use and concise format. Document planning and project funding are now underway. Each chapter will be written by an author of recognized standing in the subject. A list of potential authors has been developed.

The industry is now poised for the operational phase of Arctic operations, having completed much of the research and development stage. It is now time that information and results obtained during the investigative stages be made available to the shipyards and constructors for their translation into the new generation of vessels required for the move to year-round operations in the ice-infested waters of the polar regions.

In the future there will be other work. A T&R Bulletin entitled "Ice Engineering in the Marine Environment" is envisioned along with a study of marine structures in the ice for which a state-of-the-art review has been done.

Panel MS-10: Ocean Energy Systems

The first efforts of MS-10 were focused on ocean thermal energy conversion (OTEC). At the start there was little government support for OTEC. Most of the work consisted of paper studies conducted by universities supported by small grants from the National Science Foundation. This was followed by a period when research was conducted on various developmental aspects, such as collecting heat-transfer data, evaluating cycle fluids, and obtaining site specific environmental data. The panel assisted the Department of Energy (DOE) by participating in technical meetings to publicize the value of ocean thermal energy.

Subsequently, appropriations for OTEC have been reduced again and projects already underway are progressing slowly. The panel reluctantly came to the conclusion that there was no useful work they could do that was not being done by others. In July 1980 the panel chairman asked the committee chairman to terminate the panel. This was done but the chairman remained as a monitor member of the MSC.

Panel MS-11: Fishing Systems

Panel MS-11 is concerned with rebuilding of the U. S. fishing fleet, effective participation in the 200-mile Fisheries Conservation Zone, and efficient, safe vessels and equipment.

The panel identified six areas for their initial effort:

1. A roll monitoring device.

2. A vessel seakeeping study.
3. A review of freeing port criteria.
4. Icing criteria for U. S. vessels.
5. Fishing vessel fuel utilization.
6. Fishing techniques.

Of these, three were funded. Studies were conducted on seakeeping, fuel utilization, and icing criteria.

The fuel utilization study was expanded and in October 1981 a Fishing Industry Energy Conservation Conference was held in Seattle, Washington. This conference brought together international participants and authors. Sixteen papers on various subjects were presented. The technical report "Fishing Vessel Fuel Utilization Study" has been completed and was published by the National Marine Fisheries Service.

The seakeeping study "Seakeeping of Fishing Vessels" is under review by the T&R Committee. It is expected that the report will be issued as a T&R report in the near future.

The study of icing criteria is also still under review, but it should be completed and published in the near future.

The committee is currently considering new areas for research.

Ship Design Committee

The Steering Committee concluded that there was a definite need for a Ship Design Committee to fill a gap in the T&R program. The Ship Design Committee (SDC) met for the first time in October 1982. Its members include shipbuilders, design agents, and people from academia and government. One of the members was an official liaison from the Ship Production Committee to help insure coordination of efforts between the two committees.

During its initial operations, the SDC:

- established its charter,
- developed a list of standard products of contract design,
- identified a list of research efforts which would assist shipbuilders in developing detailed designs in response to ship specifications,
- assisted the Ship Production Committee in its development of a *Design for Production Manual*, and
- investigated the need for panels in the areas of computer supported desing, weights engineering, and stability.

The general charter of the SDC is the design process from the development of requirements to, but not including, production. The introduction to the charter reads:

> Ship design is a process, preceding production, during which designers and engineers; using resources such as prediction and analysis methods, model tests, computer programs and data banks, working within guidelines and constraints such as design criteria and various regulations; translate customer requirements into products: the drawings and specifications needed to build the ship. The Ship Design Committee will concern itself with all of these elements and their interactions with the overall objective of improving the quality of the products of design and reducing the time and cost required to create them.

It was quickly decided that the most critical transfer of design information and responsibility was at the end of contract design. Therefore, the committee set out to develop a list of standard products (that is, reports, drawings and specifications) of contract design. We recognized that each ship acquisition is different, but that a standard list of products would serve as a useful baseline from which the specific ship's list could be developed. The list has been circulated widely in the industry and over 25 sets of comments have been received. After careful review the final list will be published.

It also became evident during the committee's discussions that there were technology gaps and other design tool deficiencies which were not being addressed by existing research or development programs. The members of the committee submitted descriptions of problem areas. These were then grouped to conform to the committees under the T&R Steering Committee and distributed to the chairmen of those committees for their consideration. The response was favorable and several of the problem areas are expected to be pursued. The Ship Design Committee has continued to discuss this subject area and is now considering the usefulness of establishing the collection of such problem areas as a permanent function within the Ship Design Committee. The committee is also considering the use of foreign-developed technology.

Based on a disciplined approach, the committee is gradually establishing panels to consider specific topics in ship design. All are relatively new and are in the process of establishing their agendas. Presently the panels include:

SD-1 Weight Engineering
SD-2 Computer Supported Design
SD-3 Stability

The Computer Supported Design Panel already is addressing two areas:

- The exchange of data between CAD (Computer Aided Design) systems.
- Coordinating with the NAVSEA 05 CAD research program to define the best government-industry approach.

Small Craft Committee

There has long been a perception by members of the small craft industry, both commercial and recreational, that our Society was oriented primarily toward the designers, builders and operators of large commercial and naval ships. This perception was held despite a number of excellent technical papers on small craft which were presented over the years at national as well as local section meetings, and the sponsorship of special symposia addressed to the design and construction of small craft.

These concerns, expressed at a meeting of the Southeast Section of the Society, resulted in the formation of an ad hoc committee on small craft in 1982. A major recommendation of that committee was that a Small Craft Committee should be established within the Society's Technical and Research Organization to provide a focal point for technical matters of interest and concern to the small craft industry. The recommendation was favorably acted upon by the Technical and Research Steering Committee in October 1983.

Initially, the Small Craft Committee includes Panels SC-1 Planning Boats and SC-2 Sailing Craft and Ships, both of which have been transferred from the Hydrodynamics Committee. When the objectives of the committee have been clearly developed, consideration will be given to the transfer of related panels such as MS-1 Advanced Surface Craft and MS-11 Fishing Systems and/or the establishment of other panels as necessary to address problems related to technical matters of concern for both commercial and recreational useres and builders of small craft.

Panel SC-1: Planing Boats

The objectives of this active panel remain system oriented in that the hydrodynamics, materials, and structures of high-speed planing craft are included. The membership includes builders and operators as well designers. Semi-planing boats as well as fully planing boats are included, but not hydrofoil or air cushion vehicles.

The panel's meetings include technical presentations on such topics as materials used in small craft, or full-scale stress measurement instrumentation. The panel is working on several T&R-sponsored projects, including one on resistance in a sea-

way. Work on a small craft design textbook is well underway; all authors have been selected. A Power Boat Symposium is planned, and development of details is progressing well.

The panel is considering assembling a list of computer programs for use by small boat designers which would increase the utility of the small craft design textbook. A project on means for controlling the quality of off-the-shelf components, especially the tolerance of small craft stock propellers, is also under consideration.

Panel SC-2: Sailing Yachts and Ships

Panel SC-2 also is a systems-oriented panel. Its goal is the improvement of the sail-propelled craft, from all points of view. These include hydrodynamics, hydrostatics, structures, materials and construction of hulls, sails and rigging, and the performance and safety of cruising and racing small craft and sail or sail-assisted ships.

Panel SC-2 has adopted a style of meeting format and a range of subject material which has proven popular so that panel membership is both large and active. Panel meetings are targeted toward special subjects selected by panel consensus. Typically, 30 members and invited guests attend a minisymposium with presentations, written material, and provisions for question and discussion time. Subjects of recent meetings have included Commercial Sail, Small Craft Industry and the Law, Advanced Materials & Construction, Computers/Electronics, and Scantlings. The panel also meets in conjunction with the various Sailing Yacht Symposia to hear and discuss those papers in more detail than is possible at the public sessions.

Current research projects underway are related to the hydrodynamics of hulls and keels, rig forces and hull structure. The panel has participated in a special joint investigation with the United States Yacht Racing Union aimed at improving safety from capsizing in severe waves. The results of this research are now beginning to point out means of dealing with this important safety issue. The panel looks to a future of increasing use of sail-propelled craft of all types and sizes for profit and pleasure. Safety, especially in the small craft, is expected to be a continuing concern requiring much sophisticated research. Inclusion of some coverage of sail assistance in merchant ship design at the educational institutions will be urged, and the possibility of a small sailing craft design text remains on the horizon.

Activities of T&R Steering Committee

In order to better provide technical and policy guidance to the technical committees and panels, the T&R Steering Committee occasionally establishes ad hoc committees to review certain areas. In the past several years ad hoc committees were created to review the need for technical committees on ship design and small craft. As discussed earlier, new committees have been established in both of these areas, and the ad hoc committees were dissolved.

Recently the T&R Steering Committee recognized that the energy element of vessel operating costs was outstripping both the escalation rates and absolute values of nearly all other ship-connected expenses.

The committee, through a group of its maritime energy-oriented experts working as an ad hoc committee, addressed a number of areas with potential for reducing shipboard energy expenditures. These encompassed basic hull and propeller design, machinery components and cycle design, hull coatings, ship operations, the use of primary fuels, alternative fuels, and nonconventional sources of energy. T&R Report R-28 is the product of this effort. It presents the Society's assessment of ongoing and potentially useful programs of relevance to the marine energy problem. The emphasis was placed on programs expected to yield results within a five-year period.

These short-term projects were recommended primarily for use by appropriate panels of the T&R organization's technical committees and panels in formulating their technical and research programs over the next several years. In addition, the report has been provided to the Society's Advisory Public Service Committee for distribution to government agencies engaged in maritime research. The report does not provide answers to the future, but it summarizes the status of research now and provides an expert assessment of what questions need further study, and what areas offer the greatest potential for improvement in the next five to ten years.

Prime consideration was given not only to project applicability to energy reduction, but also to reliability, maintainability and simplicity in implementation. The committee's specific recommendations were to foster, carry out, extend and promote projects in the following five priority areas:

1. Large, slow-turning, low vibration signature propellers and improved matching stern lines and aperture configurations.
2. Reduction of propeller roughness and the measurement and maintenance thereof by surface finishes, coatings, waxes, and polishing techniques, both in and out of the water.
3. Treatment and handling of degraded marine fuels for diesels along with engine component improvements to handle a wide range of these fuels and permit their efficient combustion in high, medium, and slow-speed engines.
4. Laboratory and onboard testing of coal/oil and petroleum/coke mixtures as a means to reduce the conventional petroleum content of fuels, thereby introducing readily available low cost alternative fuels in liquid form.
5. Crew motivation to permit better operational awareness and maintenance of factors affecting fuel use.

In a similar vein, a number of the Society's members suggested that the Society should review the stability and subdivision requirements presently invoked for cargo ships. The T&R Steering Committee established another ad hoc committee to review the issue of establishing such minimum criteria. We recognize that the establishment of such criteria is not within our purview. However, as professional naval architects and marine engineers, the T&R Steering Committee unanimously endorsed the desirability of establishing a minimum international standard of subdivision and damage stability. The ad hoc committee has prepared a draft standard which has been circulated to representatives of industry and government for review and refinement. The final approved draft will then go to the cognizant regulatory body or classification society for presentation before the appropriate international forum. Once again, this ad hoc committee has been dissolved, having completed its work. Follow-up and further support will be provided by the new Stability Panel established by the Ship Design Committee.

These efforts represent an aspect of T&R activity that combines the technical expertise of the Society with a level of social responsibility to improve the regulatory requirements on ships and focus future research in the most productive areas.

Recently the structure and content of cooperative government-industry R&D in ship operation was investigated by the National Academy of Science's Marine Board. The results have been published [12], and one possibility considers a role for SNAME somewhat similar to the Ship Production Committee's role with the National Shipbuilding Research Program. STOC already provides advice and assistance to MarAd. This role could be expanded if the need, the funding and the request for assistance are all forthcoming.

What of the future?

Vice Admiral E. L. Cochrane spoke of the extraordinary growth in commitment and panel membership between 1946, when 14 members were involved, and 1954, when 118 were participating. Today 1300 volunteers continue to exemplify that same high level of professionalism and dedication to expanding the art and science of naval architecture and marine engineering. Growth continues as new panels and committees are established. Likewise, when a panel has outlived its usefulness it is dissolved. Yet overall the program has expanded its bounds consistent with the general expansion of knowledge in the world.

The T&R Program is many things to many people. For some it provides a forum for the collegial exchange of progress in science. For others it is an opportunity to concentrate collective experience to solve practical day-to-day problems. It is also a concentration of collective technical expertise which can be mobilized to address problems of great importance to our Government. In the past, some have suggested that the Society, through its T&R Program, can lead the way toward reestablishing the preeminence of U. S. shipbuilding and ship operations. The cold reality is that without substantial financial support and a focused national maritime policy our technical advances will provide only modest improvements in U. S. shipbuilding and operations.

At present the T&R Program fulfills most of the known needs of the Society's members for voluntary research and technical developments. In the future this should continue to be true. It is hoped that the T&R Program will be challenged to assist in the reestablishment of U. S. shipbuilding and ship operations as a world leader. The capability is present, the desire is present, all that remains is for our nation's leaders to issue the call for assistance. As we await that call the Steering Committee will work with the Advance Planning Committee to make those contributions possible within our limited funding. The advice and suggestions of all members is continually sought to help steer the truest course in the pursuit of knowledge.

References

1 Cochrane, E. L., "The Technical and Research Committees of the Society of Naval Architects and Marine Engineers," TRANS. SNAME, Vol. 62, 1954.

2 Tiedemann, H. M., "The Society's Technical and Research Program," TRANS. SNAME, Vol. 69, 1961.

3 Thiele, E. H., "The SNAME Technical and Research Program of 1969," TRANS. SNAME, Vol. 77, 1969.

4 Miller, Richards T., "The Technical and Research Program of the Society—An Update," *Proceedings*, SNAME Spring Meeting/STAR Symposium, 1980.

5 *The 1982 Technical and Research Organization and Procedures Manual*, SNAME, New York, 1982.

6 "Code for Shipboard Hull Vibration Measurements," SNAME T&R Bulletin No. 2-10, June 1964.

7 "Code for Shipboard Vibration Measurement," SNAME T&R Code C-1, Jan. 1975.

8 "Shipboard Local Structures and Machinery Vibration Measurements," SNAME T&R Code C-4, 1976.

9 "Ship Vibration and Noise Guidelines," SNAME T&R Bulletin 2-25, Jan. 1980.

10 "Code for Measurement and Reporting of Shipboard Vibration Data," ISO D-P 4867, International Organization for Standardization, Sept. 1979.

11 MacCutcheon, E. M., Jr., "The Society of Naval Architects and Marine Engineers and the Conquest of Inner Space," *Marine Technology*, Vol. 7, No. 1, Jan. 1970.

12 *Ship Operations Research and Development—A Program for Industry*, Committee on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, D. C., 1983.

Appendix

Completed Projects of the Ship Production Committee

Panel SP-1: Shipyard Facilities and Environmental Effects

1. Material Handling Equipment Study—Vols. I & II—1973. NTIS No. PB262 048 (Vol. 1); PB262 049/AS (Vol. 2).
2. Feasibiity Study of Semi-Automatic Pipe Handling System and Fabrication Facility—1978.
3. Feasibility Study on Development of an Economical System for Cleaning Dry Docks Prior to Flooding—1978.
4. Requirements Report, Computer Software System for a Semi-Automatic Pipe Shop—1980.
5. Beam Line Feasibility Study—1981.
6. Long Range Facilities Planning:
   - Todd Pacific Shipyards Corp., Los Angeles Division—1981.
   - National Steel and Shipbuilding Company—1982.
   - Peterson Builders, Inc.—1982.

Panel SP-2: Outfitting & Production Aids

1. Frame Spacing, Alternate Shapes for Longitudinals, and Wider Plates for Productivity—Aug. 1973.
2. Cost Effectiveness Study of Weather Protection for Shipbuilding Operations (two volumes)—April 1974.
3. Shipbuilding Alignment with Lasers—April 1974.
4. Use of Scale Models as a Management Tool—May 1974.
5. NDT: Low Cost Alternatives to Film Radiography—Aug. 1974.
6. Electric Cable Splices—June 1976.
7. Photogrammetry in Shipbuilding—July 1976.
8. Fiberglass Reinforced Piping for Shipboard Systems: Discussion of Results from the Navy's Investigation of Filament-Wound Fiberglass Pipe—Aug. 1976.
9. Rectangular Vent Duct Standards—May 1977.
10. Plastics in Shipbuilding—Aug. 1977.
11. Pipe Couplings—Feb. 1978.
12. Special Structural Shapes: Factors Affecting Usage in U. S. Shipbuilding—July 1979.
13. Outfit Planning—Dec. 1979.
14. Improved Tank Testing Methods—Jan. 1980.
15. Sternframe and Hawsepipe Alternatives—March 1980.
16. Multiplexing—Sept. 1980.
17. Product Work Breakdown Structure (PWBS)—Nov. 1980.
18. Photogrammetric Dimensioning of Ships' Engine Room Models—March 1981.
19. Process Analysis via Accuracy Control—Feb. 1982.
20. Pipe Piece Family Manufacturing—March 1982.
21. Energy Usage and Conservation in Shipbuilding—April 1982.
22. Line Heating—Nov. 1982.
23. Revised Product Work Breakdown Structure (PWBS)—Dec. 1982.

Panel SP-4: Design Production Integration

1. *Proceedings* of a Design Production Integration Conference and Workshop, two volumes. Published Feb. 25, 1981. Includes technical presentations by Inter-

shipping Consultants, Ltd., A & P Appledore, Ltd., Grumman Aerospace, Inc., and IHI Marine Technology Co., Ltd. as made at a workshop in Atlanta, Ga., Jan. 18–21, 1981.

Panel SP-7: Welding

1. Investigation of Welding Processes for Low Temperature Applications.
2. Applications of Plasma Arc to Bevel Cutting.
3. Mechanized Gas Metal Arc Welding of Light Plate.
4. Applicability of Laser Welding to Ship Production, Volume II. NOTE: This was a follow-up to previous flat position laser welding tests under optimum conditions. In this program, welds were formed with nonperfect fitup between plasma cut surfaces and between surfaces deliberately mismatched to provide a varying joint gap and out-of-position welding conditions.
5. Property and Productivity Improvements in Electroslag and Electrogas Welding.
6. Ceramic Weld Backing Evaluation.
7. Extension of E7024 Electrode Application in Shipbuilding.
8. Shelf-Shielded Flex-Cored Wire Evaluation.
9. Shielded Metal Arc Welding (SMAW) Ceramic Weld Backing Evaluation—Final Report.
10. Study Mission to Japan.

Panel O23-1: Surface Preparation and Coatings

1. Handbook of Small Tools for Blasters and Painters.
2. Practical Shipbuilding Standards for Surface Preparation and Coatings.
3. Marine Coating Performance for Different Ship Areas.
4. Cleaning of Steel Assemblies and Shipboard Touch-up Using Citric Acid.
5. Shipyard Marking Methods.
6. Training Courses for Blasters and Painters and Student Handbook.
7. Standard Procedure for Determining Volume of a Solid.
8. Evaluation of Near Solventless Coatings for Marine Use.
9. The Feasibility of Calcite Deposition in Ballast Tanks as a Method of Corrosion Control.
10. Procedural Handbook of Surface Preparation and Coatings of Tanks and Closed Areas.
11. Survey of Existing and Promising New Methods of Surface Preparation.
12. Evaluation of Waterborne Coatings for Marine Use.
13. Cathodic Protection/Partial Coatings vs Complete Coating in Tanks.
14. Surface Texture (Profile) Measurement.
15. A Descriptive Overview of Japanese Shipbuilding Surface Preparation and Coating Methods.
16. Zone Painting Method.
17. Edge Preparation Standard—Phase I.
18. Surface Preparation: A Comparative Analysis of Existing Standards; A Proposed Marine Standard.

Discussion

Philip Poullada, Member

Mr. Kiss and the participating membership who prepared this paper are to be congratulated on a fine presentation of the current and future activities of our Society's Technical and Research Program. The large amount of useful and timely information presented is typical of the work produced by this program.

The paper is complete in its description of the work of all T&R panels and committees; however, I feel one important aspect of the T&R Program has been left out. The Society operates an "Under 28" program, administered by our national headquarters in New York. Basically, this allows less experienced SNAME members to participate in T&R activities whether or not they would otherwise be asked to serve on a particular panel. Any younger SNAME members who are willing to contribute their knowledge, time and effort to the T&R Program should contact SNAME Headquarters in New York to apply as an "Under 28" member to whatever panel interests them. Valuable contributions can be made and a highly beneficial exchange of information can take place through an "Under 28" member. For example, quite often a group of individuals working in a particular field finds that the more experienced members of a team cannot spare their time to interact with a SNAME T&R panel. In such a case a younger ("Under 28") member of the team may be more easily spared, and can serve as a liaison between the technical activity and the appropriate T&R panel.

We also must not overlook the fact that many important research activities are currently being led by younger members of the Society. The "Under 28" Program gives them the chance to become involved in our Society's T&R activities.

As the marine industry continues to change, the "Under 28" Program will continue to help the SNAME Technical and Research Program keep pace with the future.

Trevor Lewis-Jones, Member

Mr. Kiss and in fact all the volunteer members are to be congratulated on an extremely accurate and up-to-date description of the Technical and Research Program. As I wrote in one of our news releases—this paper alone is well worth the registration fee to this Annual Meeting.

As Manager of Publications and Technical Programs for the past ten years, I have sat on most of the committee meetings and have had, I feel, a unique experience in seeing the development and dissemination of maritime research. During this period, the Society has published a total of 45 reports and bulletins covering all areas of marine engineering and naval architecture.

Early in the paper, Mr. Kiss mentioned the *T&R Procedures Manual.* To give a bit of color, this was first written in 1975 on a card table on the porch of a Block Island cottage. After endless revision by myself, Bob Mende and Dud Haff, it finally came to light in 1976. The refined 1982 manual, the one we are using now, is largely the result of efforts by Phil Poullada, the Technical Coordinator at the time, and Mr. Kiss. It has proven to be a very useful document in the organization's day-to-day efforts.

Finally, a count of mailing labels, with the duplications removed, revealed a total membership in T&R of 1045 as of August 8, 1984, which should be changed from the 1300 mentioned on the third and fourth pages of the paper.

Edwin J. Petersen, Member

As the immediate past chairman of the Ship Production

Committee (SPC), I will confine my remarks primarily to that committee and the related National Shipbuilding Research Program (NSRP). But first I think it is important to note that the paper highlights the need for dissemination of information on the work undertaken and lists the various means by which T&R Program results are distributed. Indeed, the program can only be as effective as the communications link between the panels carrying out the various projects and the potential users of the results. For this reason, many recent SPC initiatives have been directed toward improving dissemination of information. These include establishment of a microfiche library of NSRP reports, sponsorship of an annual technical symposium, and publication of a new *Journal of Ship Production* (the first issue to be distributed in February 1985) all under the leadership of Panel SP-9 on Education and Training.

Over the past 13 years the National Shipbuilding Research Program, under the direction of the SPC, has methodically introduced scientific shipbuilding methods in the United States that have produced dramatic results in terms of reduced cost and time needed to build and repair ships. Once adopted, the system is irreversible and mandates constant improvement of the ship production process.

The U.S. Navy will be the principal beneficiary of the program for years to come. I believe that benefits on the order of one-half billion dollars per year will soon be realized in Navy ship acquisition and repair programs as a result of the improved methods now in place. To achieve the equally dramatic further improvements that are still available requires that the top officials of the U.S. Navy and the shipbuilding industry fully understand, and then make, the changes in the ship design, procurement, and contracting process that are necessary in order to exploit the full potential of these improved methods.

The Ship Production Committee and its ten technical panels, working together, stand ready to assist in meeting this challenge under the leadership of the new chairman, Mr. Jesse Brasher of Ingalls.

Jesse W. Brasher, Member

Mr. Kiss has referred to this program as "middle aged" and "dynamic." I like that and would like to add one of my own that must be true if the program is to remain "dynamic"; that is, "mature."

During the past few years the Ship Production Committee has, under the leadership of Mr. Ellsworth Peterson and most recently Ed Petersen, been faced with numerous changes. These have included a major change in the type ship being constructed in our shipyards, a vanishing domestic commercial market, a disassociation with IREAPS, the formation of new panels, the formation of an Executive Control Board and, of course, changes in the chairmanship of the committee. These are but a few of the changes and, to the sensitive ear and eye, more changes are in the wind. In the midst of all these changes of the past and those in effect today, the committee and its technical panels have not lost sight of its primary mission; that is, the advancement of the science (and sometimes art) of shipbuilding. It is only if one is mature can the dynamics of change be managed intelligently. I am confident that in the future this mature, if not middle-aged, committee can step up to its challenges as it has in the past.

The Ship Production Committee has representatives from about 30 different industry, government and academic entities. Its real work is achieved through its ten technical panels. The typical panel has 15 to 20 representatives from different industry, government, or academic institutions. The committee and the panels represent national interests geographically, economically and institutionally.

In the recent International Symposium "Maritime Innovation—Practical Approaches '84" in New York, Mr. Ed Petersen, then chairman of the Ship Production Committee, noted some of the highlights of the past year and emphasized the quiet revolution that has been taking place in the U.S. shipbuilding industry in the past few years. I would like to share these with you:

HIGHLIGHTS OF THE PAST YEAR

- Carried out ambitious research program
- Reconstituted SPC to strengthen top level guidance and direction
- Activated Human Resources Innovation Panel to implement human resources projects
- Finalized Long Range (Shipbuilding Productivity Improvement) Plan
- Accelerated Standards and Navy Document Conversion Effort
- Completed groundwork for coordination of Navy's Mantech Program with NSRP
- Initiated *Journal of Ship Production*

The revolution to which Mr. Petersen referred has not been highlighted in the local newspaper; however, should they have taken note the headlines would have read something like this:

"Sample" Headlines:

ZONE LOGIC REVOLUTIONIZES NAVAL SHIP DESIGN PROCESS

NAVY OVERHAULS REAP BENEFITS OF ZONE-ORIENTED REPAIR

- Lower Cost
- Higher Quality
- Shorter Schedule

U.S. NAVY GETS MORE BANG FOR ITS BUCK THROUGH SCIENTIFIC SHIPBUILDING METHODS

Table 2 National Shipbuilding Research Program, SNAME/Ship Production Committee technical panels and representatives

Panel	Description	Panel Chairman	Program Manager	Sponsoring Organization
SPC	Ship Production Committee	J. Brasher	...	Ingalls Shipbuilding
SP-1/3	Fac. & Environmental Effects	R. Price	R. Price	Avondale Shipyards
SP-2	Outfitting & Prod. Aids	L. D. Chirillo	L. D. Chirillo	Todd Pac. Shipyards-L.A. Div.
SP-4	Design/Production Integration	F. B. Barham	F. B. Barham	Newport News Shipbuilding
SP-5	Shipyard Org. & Personnel	F. Long	M. Gaffney	Bethlehem Steel
SP-6	Standards	J. R. Phillips	J. R. Phillips	Bath Iron Works
SP-7	Welding	B. C. Howser	M. I. Tanner	Newport News Shipbuilding
SP-8	Industrial Engineering	J. R. Phillips	J. R. Phillips	Bath Iron Works
SP-9	Education	H. M. Bunch	H. M. Bunch	University of Michigan
SP-10	Flexible Automation	J. B. Acton	J. B. Acton	Todd Pac. Shipyards-L.A. Div.
SP-023-1	Surface Prep. & Coatings	J. Peart	J. Peart	Avondale Shipyards

- Lower Cost
- Higher Quality
- Earlier Delivery

ACCURACY CONTROL PUTS DEMING TO WORK IN U.S. SHIPYARDS AT LAST!

U.S. SHIPBUILDING COSTS PLUMMET AS SHIPYARDS APPLY GROUP TECHNOLOGY

At this time, this critical time, in the shipbuilding industry's history, the Ship Production Committee intends to build an even stronger more effective program from the solid foundation it has already built.

R. M. Nutting, Member

[The views expressed herein are the opinions of the discusser and not necessarily those of the Department of Defense or the Department of the Navy.]

This paper will serve as a benchmark reference of the organization and activities of the Society's eight Technical and Research committees and 54 panels.

The paper should more fully discuss committee funding. It gives the cost of operating the program (exclusive of administrative costs) at about $50K a year, except for the Ship Production Committee, which is funded separately. The Society's *Technical and Research Procedures Manual* states that this funding is only for seed money or pilot projects to be followed by outside support. The amount and source of this support is generally not discussed. A compilation of this support would be enlightening. A similar accounting of the non-renumerated contribution of the 1300 professionals who volunteer their efforts, many in near anonymity, to the various committees, panels, and projects would help explain the full scope of this program.

The paper makes reference to 25 projects underway, but they are not listed. There is some discussion of ongoing panel work but it is difficult to differentiate individual projects. The Appendix to the paper contains a list of the completed projects. A similar list of current projects would be most helpful for ready reference.

The introduction very correctly points out that the depressed state of commercial shipbuilding in the United States makes a T&R Program all the more urgent, and that breakthroughs could return the advantage to the U.S. maritime industry. To achieve this we need even greater monetary and volunteer support in the future.

The Navy and Marad have provided about $4.4 million annually through the National Shipbuilding Research Program and the Society's Ship Production Committee. NAVSEA also contributes considerable time and expertise to the work of Panel SP-6 "Standards" and the collateral work of the ASTM Committee on Shipbuilding (ASTM-25), converting many of our specifications to commercial standards. This effort has moved slowly partly due to insufficient SNAME volunteers to review the documents. There is a call out for more volunteers and we at NAVSEA are gearing up to review the proposed changes in a timely manner.

A minor comment: Figure 1 under "Ship Design Committee" omits Panel SD-3 "Stability" described later in the paper.

Mr. Kiss and the participating membership should be commended for their vital contribution to our understanding of the complexities of the Technical and Research Program.

Frank Sellars, Member

I would like to update the activities of the Hydrodynamics Committee since this paper was written. A significant area has been joint efforts with other T&R Committees to address common problems. A joint project with the Hull Structure Committee has just been launched to develop a rugged and reliable shipborne wave height sensor. This project is a good example of the seed money factor the Society's T&R program provides. It is anticipated that the relatively modest Society funding will be augmented by a factor of ten with funds from the U.S. Government's Ship Structure Committee.

Another joint activity has been a recent meeting with the Ship Design Committee to discuss hydrodynamic research applications to ship design. Several apparent gaps were identified; for example, towing and mooring arrangement and design appears to fall in between established committees. In another case computer programs are available to determine hull wakes but they haven't been applied to the ship design process. A joint project to cover this area is being considered.

The Hydrodynamics Committee panels continue to initiate new research. Additional projects undertaken recently are (*a*) Analysis of Non-linear Ship Motions in Episodic Waves, (*b*) Examination of Safety Factors in Propeller Fluctuating Forces, and (*c*) Development of a Rational Approach to Propeller Manufacturing Tolerances.

Edward M. MacCutcheon, Member

This excellent paper gives a comprehensive coverage of the SNAME T&R Program. It tells what is occurring and what may be expected in the near future. For the far future I believe that the SNAME T&R Program offers a much greater potential for the United States than the paper portrays.

The population of the earth is expanding at an exponential rate and with it the demand for food, housing, and the amenities of life. In contrast, the earth's resources—energy, clean water, clear air, food, and minerals—are dwindling. We are in the ultimate demand/supply conflict in a global sense. There is no question about the nature of the problem, just the magnitude.

On a more immediate scale the United States is engaged in an ever-intensifying techno-economic contest with other nations of the world. Technology is becoming more and more complex, and it dominates the competition for products, sales, and markets. Nations having lower standards of living are entering the high-technology world market and giving the United States stiff competition because of their lower labor rates. We are already running hard to stay abreast in the economic race, but our increasing trade deficit indicates we must try harder. Again the direction is clear; and we are already in the race.

The United States is gifted with top scientists, top professionals, a heritage of fine craftsmen, and an educated populace. The ocean-oriented industries share these endowments and can play a major role in a national effort to stay abreast of the future. Transportation and warfare are not the only activities to be conducted at sea. There are many other opportunities for the United States to introduce advanced technology. They include the harvesting of food, energy, minerals, and drugs from the sea.

For several years the Federal Government has been cutting back on the research and development which it sponsors. This means we are losing the major sponsor of the foundational science and technology essential to competitive ocean industries of the future. Figure 2 of the paper shows the SNAME T&R Program at the hub of all national ocean-oriented R&D activity. Obviously the T&R program is not a real hub today, but what about realizing the "hub" role for the future?

As we pass the apex of our national life style, most of us will want our children and grandchildren to enjoy some of the plenty we have enjoyed. I feel that SNAME must lead the ocean-oriented industries into the type of multimillion dollar R&D program required to enhance our national destiny.

Eugene Schorsch, Member

This thorough paper documents that the output from our T&R Program is rich, diverse and comprehensive. Should we do more? In what area and how?

Leadership requires that our research be applied. We should be concerned if the final results of our labors, from conception through research, engineering, construction and operation, are not American activities. That is an essential part of the definition of leadership. Efforts of American minds and labor must be in evidence.

I think our naval efforts are in reasonable health. The Ship Production Committee program funded at $4 million is excellent. The expenditure of $50 000 per year for the remaining seven committees is meager. The commercial sectors need more attention.

The offshore industry is still clearly led by the United States but there are storm clouds. U.S. preeminence is being affected by North Sea developments and increasing inroads by overcapacity foreign shipyards into construction for the petroleum industry. Geographic considerations play a role, but they are secondary to the larger effect of wage disparity between American and foreign labor.

For the petroleum industry, the merchant marine and for future offshore industries, we should be tackling with a sense of urgency the research problems that can lead to rapid large-scale application. Construction at the forefront of technology requires research. The converse is often not true. Fine research efforts do not usually lead to immediate construction opportunities. With the intensity of foreign competition fine research alone is not enough.

When private industry invests in research it does so with profit in mind and not usually with the intention of sharing for the common good. Our competition, the Japanese, for example, are more cooperative in such matters. They decide through private and government discussion what areas must be researched to win the future and they go ahead and do it. When our Government invests in research it does so with the intention of not favoring one business entity over another. For our future opportunities, we have to find a way to meaningfully apply the resource of our 1300 members in the SNAME T&R Program. In doing this, when private funding is involved we have to assure that private interests are preserved and when Government funding is involved we have to assure equal benefits to all. The T&R Steering Committee has wrestled with how to achieve a greater impact but so far unsuccessfully. We have not found the answer but there is a need.

The need is rooted in two facts of life. They are (*a*) the large disparity in wages between American and foreign labor, and (*b*) that technology is transferable. Because of these two facts our survival demands a continual development effort at the forefront of technology. We know that foreign competitors with lower wage rates will always stay hard on our heels. To be successful we must move swiftly to apply our technology to almost immediate construction opportunities. Delay only facilitates technology transfer.

The important thing is that a major portion of our T&R effort must be directed to programs requiring construction and research which our citizens can perform. If we do not do *both*, then over the long term our research ability will follow construction overseas.

Survival of our commercial industry requires a full court press in every area. Research closely linked to timely construction is part of the solution.

Ellsworth L. Peterson, Member

Having been a part of the Ship Production Committee for the past ten years I would like to make a few comments on the side effect of this worthwhile program.

People make things happen—or not happen. When this SPC program started there were a lot of people who didn't want to share their ideas with others—soon the U.S. yards were made very aware it was not each other they should be concerned with. The Scandinavian yards were on top; the Japanese were coming on strong; the Italians were improving in the systems—NC, CAD/CAM, etc. The U.S. yards started reviewing the significant improvements made by these foreign shipyards. Marad helped with Autocon to get the U.S. yards into CAD/CAM, NC lofting, etc. Marad sponsored trips to Japan and papers were given on Japanese technology in shipbuilding. Classes were held at the University of Michigan. Soon U.S. yards were improving their facilities and the panel members were touring each other's yards and the people at the panel levels had someone to talk to on their specific problems. Many improvements in shipyards are in place and doing their job well.

I only wish that the customers—Marad, Navy and shipowners—who have had ships built in the past five to eight years would realize that shipyards and their people have come a long way in the past 10 years. The current capabilities of U.S. yards which have picked up on the practices of the Ship Production Committee have made them leaders in this country's shipbuilding and going strong.

My compliments to the program managers and panel members who made it happen!

C. L. Long, Member

The Ships' Machinery Committee is one of the older committees of the SNAME T&R Program. Today it has 14 panels. Figure 1 of the paper shows only 12 panels. The two new panels established since the paper was prepared are:

- Electrical Panel
- Diesel Engine Panel

In addition, Panel M-21 (Automation of Ships' Propulsion Plants), will be taking on a slightly new makeup of personnel to address a new task of looking into centralized control and automation of ship's diesel propulsion plants. The paper Mr. Kiss presented covers the work of the 12 established panels. Let's look briefly at the two new panels.

The Electrical Panel is taking on the initial task of developing guidance for electrical cable installation. But it is my feeling that this is just the tip of the iceberg. As an example, electrical issues related to modular construction are tough ones, such as the use of connectors for connecting electrical wires at module connection points. Another potential subject might be the study of an integrated electric ship, where propulsion with integrated ship service power would be addressed. Also, EMI issues, which are more specifically related to naval construction, are important.

The Diesel Engine Panel has a task to do a literature search, initially directed primarily toward medium-speed engines, to identify operational and installation problems. Again, it is my feeling that once this panel gets formed, the tasks will exceed the time available to carry them out. Already contact has been made with SP-6 to look at ways of providing a helping hand with diesel engine standards. Also, this panel is going to be very useful in guiding other Ships' Machinery Committee Panels on diesel engine support system studies; examples could be the Fuels Panel, Vibration Panel, or Automation Panel.

What is the Ships' Machinery Committee's contribution to our profession? One way, perhaps, of answering that question would be to look at the codes, bulletins and T&R reports on sale through our Society which were contributed by this committee. I will not list them, but 25 are available for purchase. Many are the standards within our industry; for example:

"Code for Sea Trials"
"Marine Steam Power Plant Heat Balance Practices"
There are others.

What can you expect in the immediate future? The Ships' Machinery Committee expects to have eight new or updated bulletins published within the next six months. They are:

- "Coal-Fired Marine Steam Power Plant Heat Balance Practice"
- "Marine Power Plant Economics"
- Revised 3-20, "Guide for Selection and Design of Line Shaft Couplings and Bolting"
- Revised 3-8, "Guide for Shop and Installation Tests"
- "Guidelines for Shipboard Preventive Maintenance Using Vibration Monitoring"
- Revising 3-23, "Guide for Automated Ship's Steam Propulsion Plant"
- "Automation of Ship's Propulsion Plant—Maintenance Guide"
- "Guidelines for the Use and Application of Marine Waste Heat Boilers"

Other activities in which the Ships' Machinery Committee is involved are:

- SNAME representation on the American Gear Manufacturers Association's new Standards Committee B-6
- T&R ad-hoc committee to look at the area of crew motivation in regard to energy conservation practices and disciplines
- Fluidized bed tests at Webb
- ASTM F-25 standards

ASTM standards may be a most important emerging work. F-25/SP-6 work has been supported by Panels M-16 and M-17. I foresee contributions by all Ships' Machinery Committee Panels. The procedures for getting SNAME T&R Committee panels involved have not yet fully developed. They need to be. If we are going to have marine standards, let's make sure these standards are developed by the expertise within our profession.

The Ships' Machinery Committee welcomes and solicits recommendations for work which will help our profession and the marine industry as a whole.

Norman O. Hammer, Member

[The views expressed herein are the opinions of the discusser and not necessarily those of the Department of Transportation or the Maritime Administration.]

As everyone knows, it is easy to accomplish most objectives with prevailing conditions such as a large dedicated staff, plenty of financial resources, and no outside interferences. The remarkable thing about the Society T&R Program is that so much has been accomplished with volunteer professionals, extremely limited financial support, and priorities so low on the totem pole that the work is frequently under the pole at the bottom of the hole. My discussion will therefore not single out the work of any particular panel or committee, but rather concentrate on the topics of "challenge" and "motivation" because it is precisely these aspects that must be addressed if we are going to face the tasks ahead.

It should come as no surprise that merchant shipbuilding activity is at a record low in the United States today. What is past is past! But if there is a lesson to be learned, it is that we cannot focus solely on short-term objectives, and criticism of today's activities without corrective action will not solve the problems of tomorrow. What is needed is a renewal of energy and dedication to advancing the state of the art and returning to some of the fundamentals established by our forerunners: dedication to the basic work ethic, less emphasis on legal ramifications, and a shift from the short-term quick results philosophy to a long-term integrated approach.

The lack of long-term planning and consideration for tomorrow is typified by one common problem today, namely, a low level of attendance at T&R meetings and all-too-frequent less than full support by some sponsoring companies or agencies. We all recognize the need for improving our technology and addressing the problems facing our industry. The challenge therefore is not only to get the best people active in the T&R Program, but also to develop and instill in these people the spirit to keep them active and creative to the maximum extent possible.

Motivation is another key aspect that needs to be discussed. There are numerous examples of what highly motivated individuals or groups can accomplish. The remarkable T&R Program accomplishments have been achieved because of "spark plugs" in the various panels and committees.

Therefore, if the T&R Program is going to move forward, it must be sustained by people and the recognition that over the long term we cannot advance without a commitment today. Therefore, the "challenge" is not only to change our perspective from a short-term to a long-term approach, but also to try to locate and gather the really "motivated" people into the Society T&R Program who will make things happen!

Naresh M. Maniar, Member

It is essential that periodically the vice president of the SNAME T&R Program present an update on the activities at the Annual Meeting. In addition to being informed on the T&R activities through this comprehensive paper, it is hoped that the readers will gain an appreciation of the effort necessary on the part of many conscientious members to make a success of a very large and complex T&R voluntary organization.

Historically, projects and tasks undertaken by T&R panels are conceived by the panel members themselves. They do not have to necessarily comply with established guidelines or be approved by the committee under whom they appear in the T&R committee organization unless seed money funding is involved. Expressing it another way, T&R operations are conducted essentially "bottom up." "Bottom up" programming and task identification has resulted in isolated products, useful as they may be, that emerge when they do. The products get limited publicity and, therefore, limited applicability unless they eventually appear as T&R Bulletins. It is feared that this approach does not earn the T&R organization the appreciation and the support it deserves from the industry. In view of the foregoing, it is suggested that the T&R committee programming be revised to make it basically user oriented with some practical compromise of "top down" and "bottom up" management approach. The emphasis has to be on the word basically since it is not intended to frustrate the initiative of individual panels and fundamental researchers which is, of course, very necessary.

I wish that the paper had added a short yet separate section on the problems that beset the T&R panels. Due to the economic condition of the marine industry, attendance at panel meetings and the time contributed to the accomplishment of tasks, in general, have steadily dropped to a level that gives grounds for concern. SNAME needs to make a special plea to the heads of government agencies and private companies to convince them of the benefits to their companies due to the participation of their employees in T&R activities even in these difficult business times. Unless the T&R organization has cooperation from the highest level of the industry, its future may be uncertain.

Richards T. Miller, Member

In adding my comments to those of other invited discussers of this paper on the Society's T&R Program, I will offer two general observations which parallel those of Ron Kiss and then