

Naval Engineering

Alternative Approaches for Organizing Cooperative Research

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The naval engineering program of the U.S. Navy Office of Naval Research (ONR) is facing serious limitations in supplying the creative talent and know-how—as well as the management—for broad-based, “total ship systems” research programs. ONR therefore asked the Transportation Research Board (TRB) of the National Research Council (NRC) to investigate and evaluate alternative approaches for organizing and managing cooperative research programs in naval engineering.

ONR supports naval engineering science and technology development to enable the Navy to build and operate an effective and capable fleet; ONR also must ensure that the research results are useful in the design of advanced naval warships. This mission requires ONR to

- ◆ Define research goals and themes,
- ◆ Support innovative and high-quality research, and
- ◆ Ensure the continuing availability of the necessary human resources.

In calling for the TRB study, ONR stressed the need to promote innovation, incorporate total systems concepts in naval engineering, and involve all stakeholders—government, industry, and academia—in decision making. ONR programs should attract talented researchers and enable stakeholders to collaborate and guide the research process.

Under the auspices of the Marine Board of TRB, the NRC convened the Committee on Options for Naval Engineering Cooperative Research (see sidebar, page 45). The committee heard extensive presentations from experts in government, academia, and industry with a variety of perspectives on cooperative research organizations. After the presentations, the committee undertook an analytical examination of the goals, objectives, and attributes of successful and effective organizational models for research.

TRB Special Report 266: *Naval Engineering: Alternative Approaches for Organizing Cooperative Research* presents a synthesis of the information gathered by the committee, along with the committee’s analyses. The

committee evaluated the basic organizational concepts inherent in the current ONR system, which employs the individual investigator approach, as well as three selected models with venues for cooperative research. The committee then identified the advantages and disadvantages of each model. Finally, the committee commented on features in each model that satisfy the goals and objectives of revitalizing the field of naval engineering and improving ship design and production.

Goals and Objectives

ONR has two overall goals for naval engineering cooperative research: (a) to maintain and develop human capital and (b) to revitalize naval engineering and improve ship design and production. To compare approaches for organizing naval engineering research, the committee defined these two goals in terms of specific objectives and sets of attributes.

The key objectives embodied in the goal of ensuring an adequate supply of human capital for advanced naval ship systems design and production include attracting students, attracting and retaining faculty, providing continuing education opportunities, and fostering the development of “total ship engineers.” Naval engineering graduates and practicing professionals need to approach ship design, development, and production and construction from the total ship point of view, to meet the challenges of the future. The concept of total ship engineer, therefore, must be infused into the education and professional development of future naval engineers.

The second goal requires that the U.S. ship design community revitalize its ability to accomplish creative new research and to support higher-performing, cost-effective designs and more innovative ship systems engineering. In addition, research results must be transferred to the next stage of technology development and be incorporated into ship designs.

Organizational Models

After reviewing an array of organizational models and proposed approaches, the committee focused on core strategies for organizing cooperative research programs. The individual principal investigator model

used by ONR for most of its research programs became the base or reference model for discussions and evaluations. The committee selected three cooperative models that represent three different organizational approaches and that incorporate the features of most existing and proposed models.

- ◆ The professional society or community of practitioners model,
- ◆ The consortium model, and
- ◆ The project-centered model.

The committee assumed that all three models would (a) coordinate the contracting functions for individual projects funded by ONR and (b) propose annual research themes, present them to ONR for approval, and then contract for and manage the individual projects.

The professional society model is directed by the community of practitioners in the field, usually organized into professional societies, such as the American Society of Naval Engineers or the Society of Naval Architects and Marine Engineers. In this model, the professional society establishes a research council, typically a not-for-profit organization, to organize and manage the research program. The council is made up of representatives from the various stakeholders, with an administrative support staff, and with composition and leadership designed to achieve balance. Committees drawn from the society's membership perform tasks to support the research council.

The organizational structure of the consortium model relies on a permanent entity, or center, for the management of research, education, outreach, and technology transfer. Typically, a director leads the consortium with support from an administrative and contract management staff and reports to an executive committee of stakeholder representatives. To solicit input and disseminate information, the executive committee establishes affiliate committees, advisory boards,

industrial liaison groups, and outreach specialists.

In the project-centered model, an executive council similar to that in the consortium model establishes research themes and handles the processing and review of proposals. The council is permanent but rotates membership. The council chair provides the principal leadership for the committee and oversees a small administrative support staff. Additional input on research themes is handled via workshops and open forums, through professional society committees, or by industry associations.

The project-centered model usually focuses on large, multidisciplinary projects. For each project, a technical review committee prepares requests for proposals, evaluates the proposals, and assesses performance. The technical review committee disbands when the project is completed or terminated. Individual project organizations are added as projects are approved and funded, but disband when completed.

Findings

Evaluation of Models

The committee evaluated each model on the basis of how well it appeared to accomplish the ONR program goals and objectives. The evaluation of the selected models led to the following general findings.

Baseline Model

The committee found that the individual investigator model is excellent at promoting innovation and can continue this function as a part of any future naval engineering research program. However, the model is inadequate in meeting all of the program objectives. Cooperative organizational models have the greatest potential to remedy deficiencies in the current system.

Cooperative Research Models

All three models for cooperative research organizations were found to be capable of meeting all of the ONR program objectives. With regard to human cap-



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TABLE 1 Summary of Cooperative Research Organizational Models and How Well They Meet Objectives

	Baseline Model	Professional Society Model	Consortium Model	Project-Centered Model
<i>Human capital objectives</i>				
Attract students	Medium	High	High	Medium
Retain and attract new faculty	Medium	Medium	High	Medium
Provide continuing education	Low	High	High	Medium
Foster total ship engineers	Low	High	High	Medium
<i>Naval engineering design objectives</i>				
Create new research opportunities	Low	Medium	High	Medium
Promote innovation	High	Medium	High	High
Ensure research useful to ship design	Low	Medium	High	High



The National Naval Responsibility Initiative in Naval Engineering established the government-managed Center for Innovation in Ship Design in October 2002. The center fosters a collaborative environment for experienced naval architects from academia, government, and industry to work with students and junior naval architects in innovation cells, addressing the Navy's high-interest design issues. The innovation cells encourage learning through mentoring. The Center for Innovation in Ship Design is the focal point of ONR-supported research at naval engineering schools and is supported by the naval acquisition community.

ital and naval engineering and design objectives, the consortium model was found to be better than the professional society model, but both were significantly better than the project-centered model. Table 1 shows how each of the three models fulfills the stated objectives. The absolute ranking of the models, however, depends on the relative importance ONR accords to each objective.

Evaluation by Objectives

The committee found that the three cooperative research models had the following attributes for meeting certain specific objectives:

- ◆ Both the consortium and project-centered models encourage innovative research. However, to implement the research into innovative ship design, the Navy and other stakeholders must overcome the organizational tendency to resist change—for example, using a new technology for ship acquisition.

- ◆ All of the models encourage research useful to advanced ship technology and design development. However, the consortium and project-centered models involve a higher degree of stakeholder participation and therefore have a higher probability of meeting the Navy's needs.

- ◆ Total ship engineers develop through a combination of a formal total ship design curriculum and hands-on design experience in multidisciplinary projects. With any model, the ability to foster total ship engineers depends on the opportunities available to all stakeholders to obtain the necessary formal education in total ship design and hands-on design experience.

Merits of the Models

The committee found that each of the three cooperative research models had the following merits:

- ◆ The professional society or community of practice model excels in meeting the need to develop human capital. This model can be particularly strong in attracting and retaining students, in supporting continuing education and training programs, and in fostering the education and development of total ship engineers—since these are the principal missions of naval engineering professional societies.

- ◆ The consortium model is well suited to meeting all the human capital development and naval engineering design objectives. Its success in meeting these objectives will be determined principally by the leadership of the consortium and its ability to represent and balance the needs of the various stakeholders.

- ◆ The project-centered model can excel in promoting innovation in naval engineering design, as well as research in ship design and production. This strength stems from the model's strong, large-scale, interdisciplinary project focus, which encourages participation and collaboration by the key stakeholders.

Hybrid Models

Desirable features and attributes of the models may be combined to create hybrid models. Hybrid models may maximize the performance of the research organization in meeting program objectives, but generally increase the complexity of managing the research enterprise. For example, the individual investigator model may be embedded into any of the three cooperative models, or both the project-centered and individual investigator models may be incorporated into the consortium or professional society models. The committee did not evaluate these hybrids but noted that such combinations are available to a creative manager.

Operational Considerations

Management Issues

Mechanisms for the contracting, management, and oversight of cooperative research organizational models can allow ONR to meet the Navy's needs without adding significantly to its current management burden. In particular, annual reviews—part of all models—allow for directing the research themes toward

successful and pertinent results, as well as providing flexibility to meet future challenges. These management mechanisms, however, need to be reviewed and evaluated to ensure that they fit the model selected.

Research Agenda

The process and manner of setting the research agenda is a fundamental issue. The committee found that in a true cooperative program, all the major stakeholders have a shared interest and shared ownership in the research agenda. To be successful, the organizational models must provide a structure and mechanism to allow appropriately balanced representation and input from stakeholders into the research agenda.

Host Location

The location of the research organization host is important. The choice of venue can have a strong impact on all stakeholders, especially academia, because of the small size of the naval engineering community and the dependence of each institution on the Navy for funding. Careful consideration should be given to the choice of location, to establishing and maintaining an appropriate balance of participation from all the stakeholders, and to rotations in the membership of the governing body.

Merit Reviews

To be successful, merit review of the research in all models should take place at three stages: when the proposal is approved, annually during the course of the research work, and when the project is completed. A merit review panel should be carefully balanced to ensure that innovative, high-risk ideas are not lost and that the results address the Navy's needs.

The small size of the naval engineering community, however, also will affect the merit review process—the number and variety of quality research institutions are limited. This necessitates resourcefulness in assembling a qualified and conflict-free group of individuals with balanced biases as reviewers for research proposals, progress, and outcomes.

Executive Council

Balance in the leadership of the executive council, or governing body, is critical to promoting cooperative work. The leadership of each of the three cooperative research organization models that the committee reviewed would be vested in an executive council. Strategies for establishing the size, composition, tenure, leadership, and decision-making process of this council will affect the overall success of the organization and the research and development programs it manages. The representation of the principal stakeholders on the council will affect the degree to which

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the constituencies are served, as well as the philosophy, priorities, and direction that the research program will follow.

Perception of Balance

The committee found that it is inherently difficult for the stakeholders to collaborate because they do not have a record of cooperative work and their governing bodies have few continuing relationships. Therefore, any new cooperative research organization should develop the needed collaborative process from the beginning.

In addition, the perception of balance is often as important as actual balance. For example, if the headquarters of a consortium is located at one of several universities, companies, or laboratories that are in competition for resources, the perception of imbalance in favor of that organization is inevitable. Steps to offset this perception would need to be included in the organizational structure and operations planning.

Education

The educational objectives of ONR are important to long-term success, and each model has some attributes that will contribute to the objectives. The project-centered model could be expected to have little or no direct impact on education without special or additional efforts. The individual investigator model probably would have a moderate impact on the education of naval engineers. The consortium model, however, has potential to promote educational objectives, as does the professional society model, but effectiveness depends on the individual proposals.