

An Introduction to the Office of Naval Research and its Activities in Manufacturing and Shipbuilding

ONR(Office of Naval Research)에 대한 소개와 제조/조선분야에서의 역할

ONR(Office of Naval Research)

1946,8,1미국 의회가 설립 → 과학연구를 위한 최초의 연방 연구기관

· ONR의 연구 범위 및 조직

ONR의 과학/기술 분야: 정보, 전자, 감청/해양, 대기, 우주/엔지니어링, 재료, 물리학/기계학, 에너지/선박, 기계, 전자시스템 그 외: 인간 시스템, 해양군사전략, 산업 협력 시스템

International Field Office (IFO): 본사 런던에, 지사는 동경에, 아시아 태평양 지역에 걸쳐 국제 과학 기술을 다룸. 특히, 조선 관련 기술과 경영학에 관심을 둠

Naval Research Laboratory (NRL): 1923 설립된 해군 내 연구실이며 연구실장(Chief of Naval Research) 아래 3300명 중 1900이 연구원이며 절반 이상이 박사급임 기초연구분야로는 해양, 항공, 우주

· 산업/기업 프로그램(선박생산/제조)

비용절감을 최우선으로 하는 해군과 해병대, ONR의 통합 과학기술 프로그램으로 해군 시스템 제조법에 관심. 효율적인 해군 전투 기술의 가치와 전달을 위해 ONR의 산업/기업 프로그램부는 정부 산업과 먼저 손잡고 혁신적이고 비용을 절감하는 공학 설계와 제조 프로세스 개발을 추진



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주) 본 특별강연은 2001년도 춘계학술발표회시 발표된 것이며 추후 발표자가 원고를 보내온 것을 게재하는 것으로 편집위원회에서 그 내용을 요약 번역한 것을 첨부한 것임을 밝힙니다.

1. Manufacturing Technology Division (MANTECH)

· 목적 :

1. 위험부담과 사이클타임의 감소(R&D로부터 실제 생산에 이르는 주기) 2.현 해군 시스템의 생명 주기 극대화 3.산업 기반의 극대화

· 업무 :

1. 자기 지역에서 상주 전문가로 활동
2. MANTECH 프로그램 담당자에게 프로그램 형식을 갖춘 안내서 제공
3. 필요에 의한 생산 기술 솔루션 개발 및 설명 4.해군 관련 기관 및 산업에 컨설팅 서비스 제공 5.새로 개발된 생산 기술 변환 및 구현 지역별, 전문 분야별로 아래의 센터들이 있음.

(1) Gulf Coast Region Maritime Technology Center

- 운 영: University of New Orleans -위치: New Orleans and Avondale, Louisiana

- 포커스: 선박 설계와 생산 기술 예) 시뮬레이션 기반 설계

(2) Navy Joining Center

- 운 영: Edison Welding Institute -위치: Columbus, Ohio

- 포커스: 산학협동 재료 접합 개발 예) 금속, 비금속, 세라믹, 복합 재료

(3) National Center for Excellence in Metalworking Technology

- 운 영: Concurrent Technologies Corp -위치: Johnstown, Pennsylvania

- 포커스: Casting technology, Forming technology, Joining Technology, Powder metallurgy and ceramic materials, Surface treatment

(4) Best Manufacturing Practices Center of Excellence

- 운 영: ONR, the National Institute of Standards & Technology, the University of Maryland 공동 파트너쉽, -위치: College Park, Maryland

- 포커스: 각 산업에서 가장 효율적인 제조, 경영 지침 확인 및 보급 기술 전이 및 범용 제조

시스템 문제점에 해당하는 솔루션 추진

2. Product Innovation Division

혁신적인 관리 접근 방법을 개발, 비용절감 및 시스템 효율성을 개선, 비용예측 공학 설계를 통합하여 더 나은 통합 접근법을 구축, 비용 감안한 기술 투입과 다른 타입의 선박 설계 결정법이 특별한 관심사

- Decision analysis, Fuzzy logic, Multivariate optimization, Systems engineering, Engineering economics

3. Small Business Innovative Research

500 명 이하의 소규모 기업에 기술 개발 지원, 30가지 이상의 과학 기술 분야에서 해군의 필요사항을 제시, 기술분야에서 상당한 우위 독려. 용기, 추진력, 유연함을 가지고 있어 위험을 예측하고, 틈새 시장을 개척하며, 대기업에 부적합한 분야에서 경쟁 가능

- Clean energy[fuel cells],Hearing clearly in the noisy shallows, Computer-aided design software of MEMS

4. National Shipbuilding Research Program / Advanced Shipbuilding Enterprise (NSRP ASE)

미 조선산업의 효율성을 개선함으로써 해군 군함의 비용 절감. 해군이 자금 지원, 해군분야가 아닐 경우 공동연구로 금 지원, 연구결과는 개방하여 기업과 공유

- Ship production process technologies, Business process technologies, Product design and material technologies, Systems technology, Facilities and tooling, Crosscut initiatives, Welding, Surface preparation and coating, Environmental

ONR과 NSRP는 협력 선박건조에 필요한 사항을 교환. ONR은 선박건조 연구개발 프로젝트에 자원을 제공, 조선기술자 및 센터와 협업으로 이루어짐. NSRP ASE 프로젝트와 다른 연구를 통해 나온 논문은 매년 the Society of Naval Architects and Marine Engineers 주최로 열리는Ship Production Symposium에 발표, 논의.

5. ONR International Field Office (ONRIFO)

1940년 해군과학 연락기구 설립과 같이함. 1946년 ONR 설립. 1974년 Naval Research Tokyo 사무소가 일본 미 대사관에 설립. ONR IFO 일반 목표는 지구촌 과학 기술 연결 강화. ONR IFO는 연락기구를 통해 해외 과학자와 엔지니어들이 회의, 워크샵, 연구개발을 가능케 함

- Navy International Cooperative Opportunities in Science and Technology Program(NICOP), 국제 협동 연구개발 프로젝트, -Visit support Program: 해외 과학자와 엔지니어가 미국 연구실 또는 기관을 방문하여 아이디어 교환, 공동연구 개발, 테크닉과 연구결과에 대해 연구 -Conference Support Program: 국제 회의 및 워크샵 지원

6. IFO's NICOP Program

NICOP 지원을 받고, 미국 연구자와 해외 연구자들로 구성된 국제 프로젝트팀으로 연구 수행. 포커스는 새로운 국제팀을 구성 어려운 기술 문제를 해결. 일년에 한번 선발, 자금을 지원 받고 최고 3년까지 NICOP 지원을 받을 수 있음

- Naval architecture, shipbuilding(1순위)- Communications, command and control, computer science and electronics, optics, radar- Human factors, knowledge-based and learning sciences- Atmospheric and space sciences, oceanography, underwater acoustics- Materials science-Manufacturing technologies- Bio-sciences, medical)

ABSTRACT

The Office of Naval Research (ONR) coordinates, executes, and promotes the science and technology programs of the United States Navy and Marine Corps through universities, government laboratories, and nonprofit and for-profit organizations. ONR is active in basic research, applied research, and advanced technology development in a broad range of scientific and technical disciplines.

This paper provides an introduction to ONR and to

the shipbuilding-related efforts in its Industrial and Corporate Programs Department and International Field Office. ONR's shipbuilding activities focus on improving technology and manufacturing processes while reducing fleet costs. Approaches to the management of technology and innovation in naval shipbuilding are discussed, and opportunities and mechanisms for international collaboration in technical areas of interest to the international shipbuilding community are highlighted.

INTRODUCTION

The Office of Naval Research, established by Congress on Aug. 1, 1946, was the first permanent federal agency devoted to the support of scientific research. As the first organization of its kind, ONR developed policies and procedures 50 years ago that have become the organizational models for the National Science Foundation and other research agencies.

ONR continues to manage the Navy's scientific research resources. In 1992, its activities were expanded from basic research to also include applied research and advanced technology development. ONR maintains liaison with the scientific and engineering research communities both in the United States and abroad, and it supports research in nearly every major field of science and technology. This article will briefly describe some of the principles that guide its approach to the management of scientific and technological innovation. ONR's organization and scope are also reviewed. Then, the activities of the Industrial and Corporate Programs Department will be outlined. Finally, opportunities and mechanisms for international technical collaboration are discussed.

SCIENCE AND TECHNOLOGY MANAGEMENT PRINCIPLES DEVELOPED BY ONR

A small group of naval officers who had worked in

naval research during the Second World War invented ONR and the modern principles of research management in the late 1940's. Much of their inspiration came from Vannevar Bush who directed U.S. scientific research during the war and wrote an influential report, "Science, the Endless Frontier" in 1945 to guide the formulation of the nation's post-war approach to science policy.

Based on the demonstrated failures of technical research conducted during the war by closed societies such as Germany, Bush and the early ONR leaders pioneered an open and institutionally pluralistic national science policy for America. The system was well suited to both science and democracy.

ONR depends primarily on its program officers for the selection and management of specific research projects. ONR program officers are encouraged, as a matter of policy, to be active researchers and to play a leadership role in the scientific and engineering communities. Program officers are given broad discretion in the selection of external projects for support and are then held responsible for their results.

One of ONR's early program officers, the oceanographer Roger Revelle, formulated five typically curmudgeonly rules for ONR to follow - *Guiding Principles for Evaluating Research Proposals*:

1. Emphasis should be on the merit of the scientific approach. Navy relevance will follow.
2. If the proposal emphasizes Navy relevance, turn it down.
3. If it's fewer than \$5,000, fund it.
4. No peer review. It leads to the lowest common denominator. (That is, the lowest common denominator in a mission agency. Peer review works fine for the National Science Foundation, for example.) Rely on good program managers.
5. Long-term individual and institutional support are essential if a field is to survive and grow.

With due allowance for inflation and comptrollers'

discipline, this is roughly speaking how ONR has done business since the organization was established.

Many Nobel Prizes have been awarded for ONR-sponsored research. ONR's ability to identify and exploit highly significant research opportunities is legendary, and ONR initiatives have included some of the most significant research conducted in the world.

This is evidenced by the fact that since 1946, 46 individuals have been awarded the Nobel Prize for work funded in part by ONR. The staff of the Naval Research Laboratory in Washington, D.C. (whose parent organization is ONR) includes a scientist who has received the Nobel Prize for research that he conducted at that facility.

ONR SCOPE AND ORGANIZATION

The Office of Naval Research is headquartered in Arlington, Virginia. Within this organization are six science and technology (S&T) departments and an International Field Office (IFO). ONR is also the parent organization of the Naval Research Laboratory.

ONR manages an annual budget which totals almost \$1.5 billion. Some 75 percent of ONR's research funding goes to universities, non-profit institutions, and private industry - organizations outside the Department of Defense.

ONR's six science and technology departments. These are listed below. The activities of ONR 33 and 36 are of particular interest to naval architects and shipbuilders and are further broken down by divisions.

- Information, Electronics, and Surveillance
- Ocean, Atmosphere, and Space
- Engineering, Materials, and Physical Sciences
- Physical Sciences
- Materials
- Mechanics and Energy Conversion
- Ship Hull, Mechanical, and Electrical Systems

- Human Systems
- Naval Expeditionary Warfare
- Industrial and Corporate Programs
 - Manufacturing Technology
 - Product Innovation
 - Corporate Programs
 - Small Business Innovation Research

ONR International Field Office (IFO). This activity is headquartered in London with a branch office in Tokyo. The Tokyo office covers international science and technology throughout the Asia/Pacific region and is particularly concerned with shipbuilding-related technology and management sciences.

The Naval Research Laboratory (NRL). NRL was established in 1923 and is the Navy's in-house scientific research laboratory. NRL is a field command under the Chief of Naval Research and has approximately 3,300 personnel of which 1,900 are research staff with nearly half of these having doctorate degrees. They address basic research issues concerning the Navy's environment - sea, sky, and space.

THE INDUSTRIAL AND CORPORATE PROGRAMS DEPARTMENT – SHIPBUILDING AND MANUFACTURING

Because cost effectiveness is a top priority for the Navy and Marine Corps, ONR's integrated science and technology program interests include consideration of the manufacturing methods used to build naval systems. With value and the delivery of effective naval combat technologies in mind, ONR's Industrial and Corporate Programs Department stimulates advantageous government-industry partnerships and promotes the development of innovative, cost-effective engineering design and manufacturing processes. Department activities of particular interest to technology managers in shipbuilding firms are discussed below.

Manufacturing Technology Division. This group manages the Navy Manufacturing Technology (MANTECH) Program, whose goal is to increase the cost effectiveness of naval systems by engaging in manufacturing research that addresses the entire system life cycle including design, production, operations, and disposal. Specific program objectives are:

- Reduce the risk and cycle time associated with the transition from R&D to full-scale production by developing and implementing advanced manufacturing processes and systems.
- Extend the life of current naval systems by providing manufacturing technologies to support their maintenance, repair, and overhaul.
- Strengthen the industrial base by providing maximum dissemination of the results of all MANTECH projects and best manufacturing practices.

The Navy MANTECH program has established Centers of Excellence (COE's) for the purpose of providing focal points for the development and technology transfer of new manufacturing processes in a cooperative environment with industry, the university community, and Navy facilities and laboratories. These Centers of Excellence are the principal means for deploying MANTECH program initiatives. Within its field of expertise, each Center's basic job is to:

- Serve as the resident expert in its area.
- Provide guidance to the MANTECH program director in program formulation.
- Develop and demonstrate manufacturing technology solutions for identified requirements.
- Provide consulting services to naval industrial activities and industry.
- Facilitate the transfer and implementation of newly developed manufacturing technologies.

Four of these Centers are of particular interest to international commercial shipbuilders:

- **Gulf Coast Region Maritime Technology Center**

- *Operated by:* University of New Orleans.
- *Location:* New Orleans and Avondale, Louisiana.
- *Focus:* Ship design and production technologies, including simulation based design.
- *Two example projects:*
 'Large scale fiber-Bragg-grating sensor system for shipboard damage monitoring.'
 'Development of erection beam fabrication tools.'

• **Navy Joining Center**

- *Operated by:* Edison Welding Institute
- *Location:* Columbus, Ohio.
- *Focus:* Works collaboratively with industry and university researchers to develop materials joining. Typical project thrusts include metallic, non-metallic, ceramic, and composite materials. Related technologies are also researched.
- *Two example projects:*
 'Distortion and accuracy control'
 'Gas tungsten arc welding flux for increased penetration'

• **National Center for Excellence in Metalworking Technology**

- *Operated by:* Concurrent Technologies Corp.
- *Location:* Johnstown, Pennsylvania.
- *Focus:*
 - Casting technology
 - Forming technology
 - Joining technology
 - Powder metallurgy and ceramic materials
 - Surface treatment
- *Three example projects:*
 'Optimized commercial steels for naval surface ships'
 'Optimized HSLA-65 welding procedures for fabrication of naval ship structures'
 'Manufacturing technology for submarine structures'

• **Best Manufacturing Practices Center of Excellence**

- *Operated by:* a partnership between ONR, the

National Institute of Standards & Technology, and the University of Maryland.

- *Location:* College Park, Maryland.
- *Focus:* A national resource to identify and disseminate the most effective manufacturing and business practices in a number of industries. Promotes technology transfer and solution of common, industry-wide manufacturing problems.

In addition to the Centers of Excellence, the Navy MANTECH program is funding a major initiative aimed at improving the supply chain management process. This project is known as 'Supply chain practices for affordable Navy systems', or SPANS for short. The goal is to take advantage of the integrated supply chain practices and information technologies currently being adopted in the private sector, and deploy those technologies in the Navy's industrial base.

Product Innovation Division. To shipbuilders, the element of this division's work that is of interest is the development of innovative management approaches for working with industry to improve cost and systems effectiveness. One of this division's programs is researching new ways to integrate engineering design with cost prediction to build a more integrated approach to systems engineering. Of particular concern are the cost implications of technology insertion and other types of ship design decisions. Areas being worked include:

- Decision analysis
- Fuzzy logic
- Multivariate optimization
- Systems engineering
- Engineering economics

Small Business Innovative Research. In America, new ideas, new technologies, and whole new industries are continuously created through the initiative of creative, independent innovators who form small start-up companies based on technological innovation in product and process. In the early 20th century, Henry Ford's small business

firm built a global industry by originating the theory and practice of automobile mass production. More recently, the software firms of California's Silicon Valley have become well-known examples of this process.

The Navy actively seeks to capitalize on the ability of small business firms to develop new ideas. The Small Business Innovation Research (SBIR) Program supports technological development at small businesses of 500 people or less. These firms have the opportunity to address naval needs in more than 30 science and technology areas. SBIR encourages innovative advances in technology at small firms that have the courage, drive, and flexibility to assume risks, develop niches, and generally compete in areas less attractive to larger firms. The Navy's annual SBIR funding typically exceeds \$100 million.

Some examples of recent SBIR projects:

- 'Clean energy' (fuel cells)
- 'Hearing clearly in the noisy shallows'
- 'Computer-aided design software of MEMS'

National Shipbuilding Research Program / Advanced Shipbuilding Enterprise (NSRP ASE). This program is focused on reducing the cost of Navy ships by improving the effectiveness of the U.S. shipbuilding industry. It receives funds from the Navy, which are then matched, and in some cases exceeded, by industry to fund collaborative research. Results are openly shared across the industry. The activities of the NSRP ASE are carried out through panels:

- Ship production process technologies
- Business process technologies
- Product design and material technologies
- Systems technology
- Facilities and tooling
- Crosscut initiatives
- Welding
- Surface preparation and coating
- Environmental

ONR and the NSRP cooperate to connect the shipbuilders' needs, as identified in the NSRP Strategic Initiative Plan, with the technical capabilities of the Centers of Excellence (see above). ONR then provides funding for shipbuilding R&D projects done collaboratively by shipbuilders and Centers.

Papers describing the results of NSRP ASE projects (as well as other research efforts) are publicly reported and discussed at the annual *Ship Production Symposium* held under the auspices of the Society of Naval Architects and Marine Engineers.

This year's symposium is scheduled for June 13-15, 2001 in Ypsilanti, Michigan. This is an international conference and I would like to encourage Korean naval architects and shipbuilders to attend and participate.

ONR INTERNATIONAL FIELD OFFICE (ONRIFO)

ONR IFO dates back to 1940 with the establishment of a naval scientific liaison office at the U.S. Embassy in London. This group assisted with coordination of Allied science and technology research during the war. In 1946, when ONR was established, the London office became ONR Branch Office London.

In 1974 ONR established the Office of Naval Research Tokyo at the U.S. Embassy in Tokyo. By 1981 the mission of this office was expanded to include all of Asia and the office was moved out of the Embassy.

Today, the London and Tokyo offices operate as a unified International Field Office headquartered in London.

ONR IFO's general purpose is to enhance global science and technology connectivity. It identifies opportunities for mutually beneficial, collaborative research projects involving U.S. and overseas participants working together on a problem of common interest.

To this end, ONR IFO maintains liaison with overseas

scientists and engineers through visits, conferences, workshops, and research. ONR IFO operates several programs designed to assist in this work:

- Navy International Cooperative Opportunities in Science and Technology Program (NICOP). These are international collaborative R&D projects that receive sponsorship from ONR IFO. The program is described below.
- Visit Support Program - supports visits by overseas scientists and engineers to U.S. laboratories or institutions to exchange ideas, develop collaborations, and discuss techniques and findings.
- Conference Support Program - supports international conferences and workshops.

IFO'S NICOP PROGRAM

Projects that receive NICOP support are carried out by an international project team consisting of U.S. researchers and researchers based in another country, both parties working together toward a common technical goal. The focus is on putting together new international teams to tackle challenging technological issues. Projects are selected for funding once per year and may receive NICOP support for up to three years.

ONR IFO will consider NICOP requests in all disciplines but is particularly interested in the following areas:

- Naval architecture, shipbuilding (#1 priority)
- Communications, command and control, computer science and electronics, optics, radar,

- Human factors, knowledge-based and learning sciences
- Atmospheric and space sciences, oceanography, underwater acoustics
- Materials science
- Manufacturing technologies
- Bio-sciences, medical

CONCLUSION

I would like to conclude by expressing my sincere thanks to the Society of Naval Architects of Korea for inviting me to present this paper. As a lifelong Naval Architect I am naturally very well aware of Korea's outstanding capabilities and accomplishments in shipbuilding-related science, technology, and management. Accordingly, I consider the opportunity to present at this meeting to be a great honor.

My colleagues and I at ONR International Field Office Asia are convinced that there are a multitude of technical and economic problems that could be very effectively advanced through joint U.S./Korean projects and we look forward very much to working with our Korean colleagues to meet these challenges together.

ACKNOWLEDGEMENT

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Gaffney, Paul G., Fred E. Saalfeld and John F. Petrik. 'Research in a mission agency.' *PM*, Nov-Dec 2000.