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Golden Anniversary

Fifty years of graduate education in operations research at NPS produces 3,300 alumni worldwide

By David Schrady

The year 2001 marks the 50th anniversary of the graduate education program in operations research at the Naval Postgraduate School in Monterey, Calif. It was no accident that the School should have begun its program so early. The U.S. Navy established the first formal operations research organization in this country in the spring of 1942 and relied on operations research throughout World War II. In 1950, the Chief of Naval Operations directed that a program of study in operations research be created. The program began in August of 1951 with a class of nine students, and the first degrees were awarded in January 1953. The curriculum has been offered continuously since its initiation. There are more than 3,300 alumni representing all of the U.S. military services and those of 31 other nations.

Beginnings

Operations research has its origins in the study of military operations. The British, specifically the Operational Research Society, mark the year 1937 as the birth of operational research (they say operational, we say operations). Operational research began when, having developed radar, scientists were then asked to develop procedures for its use in a new, effective air defense system. This was research to improve operations and a new employment of the scientific method and scientific personnel. When war came, this innovation of tasking scientists to study operational military problems was extended to other areas of military operations.
These developments were watched on this side of the Atlantic by both the Navy and the Army Air Corps. In April 1942, after the United States entered the war, the U.S. Navy established the Antisubmarine Warfare Operations Research Group (ASWORG) under the leadership of Dr. Philip Morse, professor of physics and director of the Sound Project at MIT [1]. ASWORG was the first formal operations research organization in this country [2]. The Group developed tactics used in searching for submarines, devised plans for escorting convoys of ships, recommended the best depth setting for depth charges used against submarines, and contributed significantly to the ebb and flow of measures and countermeasures [3]. With the decline of the submarine threat, ASWORG was renamed the Operations Research Group (ORG) in October 1944, after expanding its studies to include strategic mining, anti-air warfare and other areas of naval warfare.

The use of operations research in World War II was considered by the Navy to have been quite valuable. In his final report to the Secretary of the Navy regarding the U.S. Navy in World War II, the Chief of Naval Operations, Fleet Admiral Ernest J. King, wrote that operations research "made it possible to work out improvements in tactics which sometimes increased the effectiveness of weapons by factors of three or five . . ." [4]. Admiral King also noted that the ORG would be renamed the Operations Evaluation Group (OEG) as more closely descriptive of its functions, and that he was taking action to ensure its uninterrupted
continuation into peacetime [5].

In 1950, the Chief of Naval Operations directed that an education program in operations research be established for naval officers. Rear Admiral E. E. Herrmann, the Superintendent of the Naval Postgraduate School (NPS), was instructed to set up a one-year curriculum in operations research at an appropriate civilian institution; MIT was suggested [6]. The Superintendent made inquiry to several civilian universities without finding any interest. In December 1950, he and the Director of the OEG, Dr. Jacinto Steinhardt, submitted a joint proposal that recommended the establishment of a six-term degree curriculum at the Naval Postgraduate School. Steinhardt, who had joined ASWORG in November 1942, helped design the initial curriculum [7]. After considerable discussion, the Chief of Naval Personnel approved the recommendation with the stipulation that the curriculum might have to be changed if it proved to be too difficult for the naval officer who had not specialized in higher mathematics [8]. The first class of nine officers began their studies in August of 1951. The curriculum was built on mathematics and the physical sciences, and emphasized the techniques that had been used successfully in wartime operations research. Professors W. Peyton Cunningham from the Physics Department and Charles Torrence from the Mathematics Department directed the curriculum. The only open literature available was Morse and Kimball's "Methods of Operations Research," published in 1950 as the unclassified version of their 1946 classified OEG report of the same title. Of course, since the curriculum was at the Naval Postgraduate School, the classified reports of the OEG and other sources were also used in the program of instruction.

Vice President Dick Cheney (right) visited the NPS in the early 1990s when he was
Secretary of Defense.

The first class graduated in January 1953. Experience gained with the first class led the Superintendent to propose a revised curriculum of eight terms. The expanded curriculum allowed incorporating an experience tour at a functioning operations research group, greater coverage of proven operations research methods, and inclusion of work on digital computers (an NCR 102A arrived at the School for use in instruction in 1954, and in 1961 the School received the first CDC 1601 machine produced).

The experience tour is a six-week period at roughly the midpoint of the curriculum in which students go off campus to an organization that does analysis to gain practical experience and assistance in developing their thesis research subject. Both the experience tour and the thesis are curriculum requirements to this day. While the degree has always been in operations research, the original name of the curriculum was operations analysis.

Growth of Operations Research

The journal *Operational Research Quarterly* first appeared in the United Kingdom in 1950. The Operations Research Group at Case Institute of Technology was created in 1952 and a two-week short course on operations research was given there in June 1952 [9]. The Operations Research Society of America was founded in 1952 and the first issue of the *Journal of the Operations Research Society of America* appeared in November of that year. The Institute of Management Sciences was founded in 1953 and its journal, *Management Science*, appeared in 1954. Professor Morse set up the Operations Research Center at MIT in 1955 [10]. Also in 1955, MIT and Johns Hopkins University gave their first degrees in operations research and Case Institute of Technology followed in 1957 [11]. Many regard "Introduction to Operations Research" by Churchman, Ackoff and Arnoff to be the first textbook in operations research [12]. It appeared in 1957, six years after the start of the NPS program.

As the field of operations research developed, so did the curriculum at NPS. Linear programming, inventory control, queueing theory, game theory and war gaming were added to course work in probability and statistics, search theory, underwater acoustics and electromagnetic radiation. Throughout the 1950s an interdisciplinary committee of Physics and Mathematics faculty administered the curriculum, and its focus was on the development and evaluation of tactics and systems. A large percentage of the theses written were classified. Through the years the curriculum benefited from input from graduates and sponsors. The program has always enjoyed a close coupling with its clients, sponsors and alumni. Applications were, and still are, emphasized to ensure
relevance and bridge the gap between theory and the real world. The master's degree is the terminal degree for the vast majority of military officers. It is appropriate, then, that the NPS master's degree in operations research is robust; it includes an internship (the experience tour) and independent research (the thesis).

By 1960 it was apparent that operations research was growing in importance and that a more appropriate arrangement should be made for the faculty teaching the curriculum. The Department of Operations Research was created in 1961 with Dr. Tom Oberbeck from the Mathematics Department as its first chairman. Dr. Jack Borsting, also from the Mathematics Department, succeeded Oberbeck in the summer of 1964. Under Dr. Borsting, the department grew to 47 faculty members by the end of its first decade, in response to the rapid growth in the number of students. In the summer of 1965, Dr. Robert F. Rinehart, from the Mathematics Department at Case Institute of Technology, became the Provost of the Naval Postgraduate School. Dr. Rinehart had been one of the pioneer operations researchers as a member of the ASWORG.

With the arrival of Robert McNamara and the "Whiz Kids" to the Department of Defense in 1961, systems analysis became a centerpiece of defense decision-making. Systems analysis combined quantitative analysis and economic analysis while attempting to determine the cost effectiveness of defense programs. Both the Operations Research Department at NPS and the Navy acknowledged this paradigm shift. Economists were hired and economics/systems analysis courses displaced many of the physics courses that were still in the curriculum. The name of the curriculum was changed to operations research/systems analysis. Also in this time period, the Navy found that it was unsuccessful in many of its arguments with Secretary of Defense and re-evaluated its decision-making processes. One result of this re-evaluation was the establishment, in 1966, of the Systems Analysis Division of the Office of the Chief of Naval Operations. The first officer to head this division was Rear Admiral Elmo Zumwalt (later Chief of Naval Operations, 1970-1974). The Systems Analysis Division (today the Assessment Division) became the sponsor of the curriculum at the Postgraduate School, an arrangement that remains in place.

Initially, the student body was composed entirely of naval officers. In its second decade of operation, the curriculum was opened to Army, Marine Corps, Air Force, Coast Guard and international officers. In the late 1960s, the Army sent large numbers of officers to the program and it became their primary source of educated analysts. While over the years 99 percent of NPS students have been enrolled in the master's program, a doctoral degree program was authorized in 1971. To date the Department has graduated 28 Navy, Army, Air Force and international officers with a doctorate in operations research.
In the late 1970s, then Chief of Naval Operations, Admiral Thomas Hayward, re-emphasized tactical competency — this led to renewed interest in tactical analysis. The curriculum again adapted to its clients' interests. There was a reduction in systems analysis content in order to re-emphasize tactical analysis. It was a rebalancing of the original emphasis on tactical analysis and the mid-1960s emphasis on systems analysis. The curriculum name was changed back to its original name, operations analysis. In 1986, a second curriculum leading to the Master of Science in operations research was created. The Deputy Chief of Naval Operations (Logistics), Vice Admiral Thomas Hughes, who is an NPS operations analysis alumnus, sponsored it. This curriculum, operational logistics, shares the core courses of the operations analysis curriculum. Today, operations research is used widely and at a number of levels in the U.S. Navy and the other military services and defense agencies. At the headquarters level, the Navy uses operations research in modeling and simulation, warfare capability assessments, requirements determinations, investment balancing, manpower modeling, recruiting, cost analysis and inventory management. In the Fleet, operations research is used in exercise reconstruction, battle experiments, campaign analysis, war gaming, strike planning, logistics support planning, readiness and tactical analysis.

Today, the Naval Postgraduate School curriculum involves courses in computation, probability, statistics, data analysis, optimization, stochastic processes and simulation, as well as military operations research courses such as combat modeling, search and detection, war gaming, joint campaign analysis and others. In addition to required course work, the program includes a six-week experience tour and requires a thesis [13].
Through September 2000, there are 3,340 alumni of the graduate education programs in operations research at the Naval Postgraduate School: 1,928 U.S. Navy officers, 583 U.S. Army officers, 306 U.S. Marine Corps officers, 38 U.S. Coast Guard officers, 23 Department of Defense civilians, 9 U.S. Air Force officers and 453 officers of the armed services of 31 other nations. Some of the theses written have resulted in the revision of tactics, initiation of the development of new systems, and the documented savings of tens of millions of dollars. The impact of these officers on the quantitative analyses, decision-making and leadership of their military services has been remarkable.

References

1. In a letter dated Jan. 27, 1942, at the start of the German U-boat campaign in the Atlantic, Capt. Robert B. Carney recommended that an antisubmarine warfare group be established within the Atlantic Fleet. The Antisubmarine Warfare Unit of the Atlantic Fleet was established on March 2, 1942, under Capt. Wilder Baker. A month later, with Dr. Morse and six other civilian scientists on board, the Unit took the name Antisubmarine Warfare Operations Research Group, ASWORG.


8. Story, p. 68.


11. Symonds, p. 95.


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