OPERATIONS RESEARCH:
"GOING UNDER THE SOUTH POLE IN A SUBMARINE?"

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Many of the techniques of operations research (OR) can be traced back through the history of scientific development. However, it is generally agreed that OR as a formal discipline began with the military services early in World War II. Teams of engineers, mathematicians, economists, physicists, psychologist and other natural and social scientists were assembled to solve some of the pressing supply, logistic and armament problems of the allies. The terms operations research, management science and quantitative analysis relate to a comprehensive body of knowledge designed to provide the decision maker with a quantitative perspective upon which to improve his/her decision-making process. The best definition of operations research is that it is "what operations researchers do," however a more descriptive definition is the application of quantitative (often mathematical) techniques to solve societal problems, in other words, <u>applied</u> <u>mathematics</u>.

Although the field is approximately thirty years old we find that it is still not widely known about or understood by the mathematical community, especially junior and senior high school teachers of mathematics. Part of this identification problem stems from the lack of a universally accepted name. In a business school the discipline is called quantitative analysis [not chemistry] or possibly management science. In engineering departments it may be called industrial engineering and finally in mathematics or statistics departments, operations research.

Recently a survey[1] of interest in attending an OR seminar [designed as an informational seminar] was sent to the junior and senior high mathematics teachers in the Cincinnati area. Of the forty nine (49) respondents: forty-four had never had a course in OR, seven said they were very interested, ten quite interested, fifteen not too interested and seventeen not at all interested in attenting seminars to learn more about the subject. Indicative of some of the responses to the question: "When you hear the term 'Operations Research,' what definition first comes to mind," are the following:

(1) "instruction for writing a thesis"
(2) "research to gather information about students successes and failures"
(3) "No idea"
(4) "Going under the South Pole in a Submarine"

In the sixties a degree in mathematics opened many doors, but in recent years the glamor has worn off and the mathematician is not perceived in that same exalted light. Edwin Spanier[2] wrote "It is my contention that universities and colleges are not doing a good job of educating the undergraduate in mathematics." He goes on to say, "most of the undergraduate mathematics majors are probably reasonably qualified to go on to graduate school in mathematics, but not for anything else. The demand that existed for mathematics majors in industry seems to have disappeared, and I fear this is because industry has learned that mathematics majors aren't as well trained for their needs as people with other majors." A recent survey[3] made by the Quantitative Analysis Department at the University of Cincinnati shows the value of an OR education in the job market. Responses by twenty-five of our recent graduates show work in OR related positions by over ninety percent of the respondents in positions starting from $700 to more than $1200 per month. More recent (1978) graduates have accepted offers of $15,000 to $19,500 per year to start. We are constantly besieged by companies seeking students with this kind of background, so the future market seems equally as bright.

Colleges and universities to a large degree foster the condition stated by Spanier by training the undergraduate mathematics major on the assumption that he or she will become an academic mathematician. The reason is clear, most of the College teachers followed just such a progression of undergraduate training through to a Doctorate. It is a track they know best and feel comfortable in counseling and encouraging students to follow. To a somewhat lesser degree secondary teachers are equally guilty. They see a student who is interested in developing analytic skills and encourage the student in the direction of mathematics without the thought of possible alternatives (e.g. OR) and subsequent employment possibilities (as evidenced by response to the questionnaires). It is encumbant upon each of you to find out how mathematics can lead to rewarding careers in business, engineering and the social sciences and encourage your students to be aware of other exciting avenues open to those with good quantitative skills.

In 1974, the Committee on Undergraduate Programs in Mathematics (CUPM) recognized this need for more emphasis and courses designed to respond to society's need for problem solvers. In their report to the American Mathematical Society, the following recommendations were made:

(1) inclusion of more applications in mathematics courses.

(2) require a course in modeling of all mathematics undergraduates.

(3) more problem-oriented courses as well as courses in model-building, computing, numerical analysis, statistics, probability and operations research.

So exactly what is this operations research and where can one find out more about it? Operation research is a very broad discipline which applies the scientific method to decision making. Its eloquence is derived from the fact that a host of seemingly unrelated problems are solvable by common techniques in the operations researchers "tool box." The primary tools in this box are:

(1) Linear Programming

(2) Network Analysis (including PERT/CPM)

(3) Inventory Theory

(4) Simulation

(5) Queuing Theory (waiting line theory)

(6) Dynamic Programming

(7) Nonlinear Programming

(8) Management Information Systems

(9) Statistics

(10) Classical Optimization (calculus)

A partial list of the many applications include:

(1) financial management

(2) wholesale and retail distribution

(3) professional sports

(4) airline reservation and scheduling

(5) criminal justice

(6) energy

(7) health care delivery

(8) environmental studies

(9) mass transit

To learn more about educational opportunities and careers in operations research, write:

Chairman, Education Committee
Operations Research Society of America
428 East Preston Street
Baltimore, Maryland 21202

No, operations research is not instruction for writing a thesis and it most certainly isn't "GOING UNDER THE SOUTH POLE IN A SUBMARINE."

References

[1]An interest survey for a seminar about OR given by the Univer- of Cincinnati, Spring 1978.

[2]Report to Committee on Undergraduate Programs in Mathematics, 1966.

[3]David Anderson, "Survey of Job Placement by QA undergraduates at University of Cincinnati, 1971-75.

TRIANGULAR RATIOS ON THE HUNDRED SQUARE

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The Hundred Square is a numerical array that is a rich source of number patterns. The discovery of these patterns involves both computational practice and the making of generalizations. Both of these are valuable activities in the study of mathematics.

Figures I and II display Hundred Squares with "nested isosceles right triangles" of increasing sizes drawn upon them. The innermost triangle contains no interior numbers. The legs of the isosceles right triangles are horizontal and vertical.