FIRE COMPANY RELOCATION AND THE FUTURE OF APPLIED OPERATIONS RESEARCH

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FIRE COMPANY RELOCATION AND THE FUTURE OF APPLIED OPERATIONS RESEARCH*

I was asked to speak today about "Recent Advances and Future Prospects for Research in Lanchester Prize Award Winning Areas." I won the Lanchester Prize in 1974 for a paper I coauthored with Peter Kolesar that described an algorithm for dynamically repositioning available fire companies in response to changing patterns of availabilities (Kolesar and Walker, 1974). The life story of that algorithm motivates my vision for the future of the applied side of our profession.

History of the Relocation Algorithm

The relocation algorithm is a simple, but sophisticated, four-step procedure, which includes the sequential solution of three integer programs (only one of which is solved using an optimization algorithm). It was carefully tested, validated, and documented in the early 1970s. The FORTRAN program itself was documented in a RAND Report (Shanesy, 1975). The algorithm was implemented in Brooklyn as part of New York City's computerized Management Information and Control System in 1977. By 1980 the system (including the relocation algorithm) was implemented citywide.

That is where the algorithm's use stood until 1986. In March of that year I received a letter from a fire protection engineer working for the Port Authority of New York and New Jersey. As an extra-curricular activity, he was developing microcomputer-based software for the fire service. He had discovered the documentation for the emergency service deployment models developed at The New York City-RAND Institute lying on a shelf, and asked if he could adapt the programs for use on microcomputers. He felt that the models were "innovative and ahead of their time."

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RAND gave its approval (the programs were in the public domain). The models were reprogrammed; menus, color graphics, and geographic displays were added. The new programs will be introduced at the National Fire Protection Association's National Convention in May 1988.

The reissuance of the updated relocation algorithm holds a lesson for the applications branch of the operations research (O.R.) tree. That lesson is found in Papert's Principle (see Shubik, 1987), which was originally applied to the mental growth of a child:

> Some of the most crucial steps in mental growth are based not simply on acquiring new skills, but on acquiring new...ways to use what one already knows.

Just as human beings grow and change, a professional area as closely connected to the world as O.R. must grow and change or it will become sterile and irrelevant.

O.R. Applications

The O.R. tree is nourished by a spectrum of modeling tools: queueing theory, linear programming, simulation, and others. Some O.R. professionals prefer to remain on the theoretical branches, expanding theory and developing new methodology. Other branches include practitioners whom Hugh Miser (1987) and Jack Borsting (1987) quoting Schön have recently criticized as staying on the high, hard ground, where problems have great technical interest and may be solvable using analytical models, but where the solutions are "often relatively unimportant to clients or to the larger society."

I have chosen to pursue an applications branch that seeks to use these tools in what Schön has called "the swampy lowland of messy, confusing problems of great human concern, in which neat mathematical models cannot be developed and applied to obtain 'THE SOLUTION.'" Although not much new has occurred in the domain of fire department deployment analysis along this branch in the last 15 years, a great deal has happened in other domains--for example, water management and transportation planning.

Obviously I find this an exciting and satisfying branch. One that will be important for O.R. professionals in the next few years *if they climb on board*. One that could change Ackoff's (1987) foreboding about "the imminent death" of operations research.

Development of Operations Research

Shubik (1987) said in his Plenary address at last year's TIMS/ORSA meeting in New Orleans, "The development of a management science is part of an ongoing process."

The tools of operations research were developed to solve certain specific real-world operational problems. O.R. theory developed to support practitioners' needs. In the public sector, the tools were originally used primarily in the context of defense decisionmaking. These studies were often called systems analyses. Secretary of Defense Robert McNamara relied heavily on systems analyses. The tools were often successful in solving certain types of narrowly defined problems. This led to great expectations. In fact, when John Lindsay brought RAND to New York City in 1968, he stated, "The people who put men on the moon should be able to solve the problems of the city."

This was not necessarily true. The urban environment was very different from the military environment. The original RAND analysts in New York had trouble dealing with the complexities, uncertainties, and multiple variables in the urban policymaking environment. Military models rarely included human beings or reflected human behavior; urban models had to do so.

RAND quickly realized that different types of researchers were needed. It hired young operations research analysts fresh out of graduate school who had no military experience--people like Ed Ignall, Jan Chaiken, Art Swersey, Peter Kolesar, and me. It also hired sociologists, regional planners, lawyers, political scientists, and psychologists.

So, in the 1970's and 1980's, systems analysis evolved into the multidisciplinary art of policy analysis. The boundaries of the problem space expanded. Contexts became broader and richer. What was

previously taken as "given" (exogenous to the analysis) became a variable (endogenous to the analysis) later. Modeling became a small part of the entire process. Performance measures used to evaluate economic costs and benefits were expanded to consider other elements, such as political, sociological, psychological, organizational, and distributional effects. And, the policymaker is now more an integral part of the process.

Decision Support Systems

The "swampy lowlands" branch of operations research applications has come a long way since the 1960's. It has grown rapidly over the last few years, primarily as a result of the increasing availability of a new tool. This tool is not a new methodological development. It is a technological development--the microcomputer. With the microcomputer revolution has come an increasing interest in decision support systems (DSS's). I believe that DSS's offer great opportunities to O.R. analysts and the O.R. profession. They enable us to get models directly into the hands of those who can use them--the policymakers and their staffs.

At the present time, many decision support systems are being developed by those having no contact with O.R. These systems are empty at their cores. Lacking good models, they are little more than fancy accounting systems. O.R. analysts can seize this opportunity. There are good, useful, and important models that have been developed over the last 25 years. Many of these are lying on shelves or in punched card drawers. In light of the microcomputer "explosion" we should re-examine those models for current and future use. More important, we should develop new models that take advantage of the graphic capabilities, flexibility, and interactivity of microcomputers.

What happened with our fire models can happen elsewhere in our profession. It is one way to avoid the fate Ackoff (1987) has predicted for operations research.

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