

**OPERATIONS RESEARCH**

- A. What is the relationship of Operations Research to the actuarial profession?
- B. To what extent can traditional actuarial work be regarded as Operations Research? What are the essentially new features of Operations Research?
- C. What types of life insurance company problems appear to lend themselves particularly well to Operations Research study?
- D. What is the relationship of the electronic data processing field to Operations Research?

MR. G. D. SHELLARD, in discussing Section A, endorsed Mr. Anderson's Presidential address statement of the close connection between operations research and the actuarial profession.

During World War II, the Society helped provide men with actuarial training for Dr. P. M. Morse of M.I.T. when he was recruiting for his newly formed United States Navy operations research group. Five Fellows, two Associates and nine students became members of this group, including Mr. Shellard. Many members of operations research groups came to believe that the techniques employed were not limited solely to military applications.

Operations research is research into operations with the aim of providing management with a quantitative basis for making decisions. The actuary is to the insurance business much as the operations research worker is to business as a whole.

Actuaries can be producers of operations research. They may also, in their capacities as insurance businessmen, be consumers of operations research. Perhaps the most important contribution of operations research to the actuarial profession may lie in its redirecting the attention of actuaries to the possibility of studying scientifically various insurance problems outside the traditional actuarial field.

MR. C. M. STERNHELL, who also worked with the U.S. Navy operations research group during World War II, agreed with Mr. Shellard as to the close relationship between operations research and actuarial work. To illustrate the closeness of this relationship, he quoted from a book by P. M. Morse and G. E. Kimball entitled *Methods of Operations Research*:

1. Operations research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control.
2. The most important single mathematical tool of operations research is probability and statistical theory.

The basic concept underlying most applications of operations research in other industries is that of a mathematical model, such as a formula or table of numbers, which represents the major characteristics of the operation that is being analyzed. The actuarial profession also is based on a mathematical model developed over 200 years ago, namely, the mortality table. Only a few years ago, a former New York Life employee made a valuable contribution in the field of aircraft engine maintenance by introducing the very simple concept that the probability of aircraft engine failure depends on the elapsed number of flying hours since the last overhaul of the engine.

Mr. Sternhell pointed out examples of other actuarial techniques that fall within the fold of operations research and indicated that actuaries have been engaged in the practice of operations research even though they did not refer to it by that name.

While actuaries should attempt to become familiar with the new mathematical techniques involved in operations research, these techniques should be used only when needed. It is best to start by analyzing a particular operation, as many operations can be improved without using complicated mathematical techniques. For example, a significant improvement in a work activity became apparent once a flow chart depicting that activity was prepared.

Several of the more important basic concepts emphasized in operations research are:

- (1) establishment of quantitative criteria for determining an optimum objective,
- (2) specification of limitations or restrictions on variables subject to control,
- (3) exploration of effects of various alternative courses of action with respect to optimum objective,
- (4) attempt to find an optimum solution for as large a portion of the total organization as practical, and
- (5) use of team approach with team consisting of individuals with various professional backgrounds.

MR. N. F. JONES, in opening Section C, discussed possible techniques that can be used in solving operations research problems. Among these are "statistical quality control," "industrial psychology and engineering," "marketing research" and "integrated data processing."

Most literature on operations research discusses techniques such as "linear programming," "queueing theory," "game theory," "search theory," "information theory." Except for linear programming, all these techniques are still in early stages of theoretical development. Most of the instances in which large savings have been effected arose from utilizing

linear programming methods on transportation or inventory control problems. While such problems do exist in life insurance companies, the savings from this source are lower than elsewhere in industry.

Nevertheless, some of the techniques of operations research have potentially great value to life insurance companies. For example, "queueing theory," which deals with units arriving at a service point, may tell us what quantity of clerks or tabulators is needed to reduce the probability of "delayed cases" below any desired standard. "Information theory" may give us better ways to disseminate information from one place or person or file to another more rapidly, with minimum distortion or error.

The following insurance problems may be regarded as appropriate areas for operations research:

- (1) buy or lease decisions on I.B.M. equipment,
- (2) selection of integrated data processing equipment,
- (3) allocating funds for sales expansion for:
  - a) creation of new agencies,
  - b) hiring of new agents,
  - c) development of new products or lines of business,
  - d) sales promotion,
  - e) net cost reduction,
- (4) determining optimum hiring policy and salary scale,
- (5) selecting sales incentives best calculated to achieve company's goals, and
- (6) allocating funds among various investments.

While most of the literature is concerned with model-making, most of the hours are spent gathering data and analyzing. Every recommendation requires a criterion for decision. Sometimes criteria, not well-defined, might lead in the opposite direction from more obvious considerations. For example, it is possible, by applying inapplicable or incomplete criteria, to arrive at the erroneous conclusion that elimination of agents is needed in order to reduce the cost of insurance.

MR. D. H. HARRIS, in discussing Section D, stressed the similarity of problems encountered in designing an integrated data processing system as compared with those arising in operations research. In both, the "best" balance of elements from a broad over-all point of view is sought. Moreover, both fields require highly competent and imaginative personnel and access to all of the operating areas with which they are concerned.

Once the planning stage is over and the electronic equipment is put to use in data processing operations, the connection between the two fields will become weaker, except in so far as the electronic equipment may be used as a computing tool for operations research. The field of operations research encompasses much broader areas than those involved in elec-

tronic data processing as applied to life insurance administrative procedures.

CHAIRMAN ROOD, before yielding the floor to the next speaker, stated he understood that in operations research sometimes 30 or 40 simultaneous equations have to be solved, thereby making computers a very logical tool.

MR. J. T. BYRNE, in discussing Section C, mentioned that at the Metropolitan they have been applying the principles of statistical sampling to problems of quality control for many years. Those Divisions with outgoing quality sample audits calculate periodically error densities for each type of transaction and present the results graphically on an adaptation of the well-known percentage defective chart with control limits.

A second and more recent use of the sampling technique as a management tool has been in the Metropolitan work measurement program which, among other things, provides them with efficiency information. Under this program, work standards, expressed in minutes, are established for each type of transaction, and efficiency performance rates are calculated periodically by relating the standard minutes of work accomplished to the actual minutes spent in accomplishing it.

While still undeveloped, the operations research technique of "waiting-line" or "queueing" theory seems to offer considerable promise in solving certain life insurance problems. By using this theory, it is possible to estimate the effect on service of variations in work loads and work capacities.

MR. E. H. WELLS showed how, with slight paraphrasing, the definition of a typical actuarial study closely parallels a definition of operations research given by the National Industrial Conference Board.

Mr. Wells felt that in the asset share or model office approach, the actuaries have contributed a powerful technique of operations research which should be properly recognized along with the others. He cautioned against the temptation of employing outside consultants to solve essentially actuarial problems and warned that the solution of such problems might be much more costly if existing actuarial techniques are ignored. In closing, he stated that the traditional techniques of actuarial work are in no way subservient to operations research, or inferior in power.

MR. ARTHUR PEDOE stated he felt like M. Perrichon when he learned that he had been "speaking prose" all his life, for as an actuary he had been engaged in Operations Research for a lifetime without knowing it. An examination of recent issues of the proceedings of the two societies covering Operations Research, one in England and the other in the U.S.A., would indicate, Mr. Pedoe declared, that although the Operations

Research technician might learn much from actuarial methods, the reverse would hardly apply. He, personally, was concerned at the idea of extending the work of the actuary and the examinations of the Society even further. Is not the field of life, health and accident contingencies with its related legal, medical and investment problems enough, Mr. Pedoe inquired, without extending our field to time-motion studies, work measurement, guided missiles and theory of games? An actuarial training, he declared, should be of value in operations research but it would also be of value in other fields. Mr. Pedoe expressed the hope that being faced with attracting more men to our profession we would not allow a will-o'-the-wisp to distract us from our present-day problems; our examinations and requirements should be made more specific and the field of operations research seemed to him to be appallingly vague and ill-defined.