

Operations Research

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Operations Research (OR) is defined, according to the International Federation of Operational Research Societies, as *a scientific approach to the solution of problems in the management of complex systems*. Unlike the natural sciences, OR is a *science of the artificial* in that its object is not natural reality but rather man-made reality, the reality of complex *human-machine* systems. Furthermore OR involves not just theoretical study but also practical application. Its purpose is not only to understand the world as it is, but also to develop guidelines about how to change it in order to achieve certain aims or to solve certain problems. Ethical considerations are thus crucial to almost all aspects of OR, research and practice.

Operations Research, the origins

Although no science has ever been born in a specific day, or year, it is commonly acknowledged that Operations Research, as a specific scientific discipline, dates back to the years immediately preceding World War II. First in the United Kingdom and later in the United States, interdisciplinary groups were constituted with the objective to improve the military operations by means of a scientific approach. A typical example is the British Anti-Aircraft Command Research Group, better known as the *Blacketts circus*, which consisted of three physiologists, four physicists, two mathematicians, one army officer and one surveyor.

After the end of the war, the experience made in the military context found challenging applications in the context of industrial organisations. The development of ever increasingly complex, large and decentralized industrial organisation, together with the introduction of computers and the mechanisation of many functions, called for new and more scientific approaches to decision-making and management. That led to the establishing, not only

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in the industry but also in the academy, of the new discipline, called Operational Research in the U.K., and Operations Research or Management Science in the US (these two terms are often considered as synonyms).

The first national O.R. scientific society was the British one, founded in 1948. The American ones (ORSA, the Operations Research Society of America, and TIMS, the Institute of Management Science, today merged under the name of INFORMS) followed a few years later. In 1959 the International Federations of Operational Research Societies was established.

Among the methodologies developed within Operations Research, a major role has been played by *optimisation*: problems are formulated by means of a set of constraints (equalities or inequalities) and an objective function. The maximisation or minimisation of the objective function subject to the constraints provides the problem's solution.

Codes *vs.* principles

As with other applied sciences, ethics can be developed along two complementary lines. One is to have scientific or professional codes of ethics. These are typically sets of rules, sometimes well defined, sometimes generic. Useful as they are, ethics codes remain external rather than coming from within the individual, and may lead to double standards. Some evidence suggests that the ethical standards of individuals at work are often different and significantly lower than those they follow in their private lives. Although no major national OR society has a formal ethics code, the codes of related scientific disciplines may apply to OR.

A second is to develop a more personal ethical approach in which guidance is provided not by a set of rules that limit our freedom, but by principles and values that promote it.

According to Hans Jonas, the following principle can be chosen as the basis of an ethical discourse: we have a *responsibility* toward the *other*, be it humankind (past, present, and future generations) or nature. This general principle of responsibility can be complemented by another: that *knowledge, in all forms, must be shared and made available to everyone; cooperation rather than competition should be at the basis of research activity*. This has been called the *sharing and cooperation* principle (Gallo 2003). These principles might result fundamental in confronting two issues which are crucial to the very survival of our society: ever growing societal inequalities and sustainability.

Models and methods

Once the principle of responsibility has been accepted it must then be applied to the specific field of OR. Since model building is the fundamental activity in OR, we should start from models. The first question is whether ethics has anything to say about model construction. In his excellent book on ethics and models, William A. Wallace (1994) reports a large consensus in the OR research community to the effect that “one of the ethical responsibilities [of modellers] is that the goal of any model building process is objectivity with clear assumptions, reproducible results, and no advocacy” (p. 6), and on the “need for model builders to be honest, to represent reality as faithfully as possible in their models, to use accurate data, to represent the results of the models as clearly as possible, and to make clear to the model user what the model can do and what its limitations are” (p. 8).

But might responsibility arise also at an earlier stage, when choosing the methodology to be used? In other words, are methodologies (and hence models) “value neutral”? This is a controversial issue. It might be argued that behind the large role of *optimisation* in OR, and behind the parallel development of *optimality* as a fundamental principle in the analysis of economic activities and in decision-making related to such activities, there are assumptions with ethical implications: that self-interest is the only motivation for individual economic choices; that maximisation of the utility function is the best formal way to model individual behaviour; and that, by applying the proper rate of substitution, anything can be traded for anything else, with the consequence that everything can be assigned a monetary value.

These considerations have lead some (Brans 2002) to advocate the use of *multi-criteria* approaches in order to balance objective, subjective and ethical concerns in model building and problem solving. Here the different (often non-commensurable) criteria, among them those derived from ethical considerations, are not reduced, by weighting, to one single criterion, but maintain their individuality, leading to a solution that is considered *acceptable* to or *appropriate* for the parties, rather than *objectively optimal*.

Another issue is that optimisation-based models are often solution oriented: the final goal of the model is the solution, *i.e.* the recommendation of action to be made to the client. Some argue that more importance should be given to the *process* rather than to the solution: a learning process in which all the parties involved acquire a better understanding of the problem they face, of the system in which the problem arises, with its structure and its dynamics, and have a say in the final decision. These concerns, which call for a broader sense of responsibility, including not only the client but all stakeholders as well, have led to divisions in the OR community. The development of

alternative approaches such as *systems thinking* and *soft operational research* are one result.

Clients and society

Another important question concerns the kind of clients chosen. As pointed out by Jonathan Rosenhead (1994), OR practitioners “have worked almost exclusively for one type of client: the management of large, hierarchically structured work organisations in which employees are constrained to pursue interests external to their own” (p. 195). Yet these are not the only possible clients. Other types of organisations exist, operating by consensus rather than chain-of-command, and representing various interests in society (health, education, housing, employment, environment). But such organisations usually have only limited resources even though the problems they face are no less challenging for the OR profession.

This fact has a strong ethical relevance. Since the use of models constitutes a source of power, the OR profession runs the risk of aiding the powerful and neglecting the weak, thus contributing to the imbalance of power in society. A positive but rather isolated example is the experience of a *community operational research* in the United Kingdom. This is an initiative that has led many OR researchers and practitioners to work with community groups, such as associations, cooperatives and trades unions.

Another way OR may contribute to power imbalances at international level is the strict enforcement of patents and intellectual property rights. A wider dissemination of methodologies and software, according to the *sharing and cooperation* principle mentioned above, might reduce the technology divide between rich and poor countries.

Bibliography

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