CHAPTER 6

The Model Builder's Outlook

Simulation modelling is carried out by people with a wide variety of backgrounds, working as individuals or in teams and in many kinds of institutions. Those whom we call 'modellers' have very different opinions as to the best approach to any given problem, and even fundamental differences in value systems and attitudes. It is probably true that few characteristics can be identified and no simple statement made that is universally true for the group. Nonetheless, it is possible to identify a few features which, taken separately, are much more likely to be true than not. Furthermore, these observations may, taken together, suggest explanations and solutions for some of the problems addressed later in this report, especially the fact that conclusions from modelling studies are often not accepted as enthusiastically as modellers might hope.

Modellers concerned with environmental problems work in a wide variety of institutional environments. In the developed countries, modellers are often to be found on the staffs of government ministries and research institutes. Many also work in universities or, less frequently, in private consulting firms. Most developing countries are, of course, characterized by a shortage of experienced personnel in modelling as in other specialized fields, and may need to rely largely on people from other countries, often brought in for particular projects.

This diversity makes it impossible to generalize about the modeller's institutional environment. However, it implies that modellers may find it difficult to maintain adequate communication with each other; in many cases this seems to lead to duplication of effort, and to inhibit dissemination of new techniques and developments within the modelling community*. Furthermore, the different reward systems under which modellers work increase the disparities among their individual conceptions of goals and purposes and, in some cases, may even discourage any involvement in cooperative modelling activities – particularly where inter-disciplinary cooperation is needed.

In addition to working in various types of institutions, modellers have a great variety of personal backgrounds – there is no accepted common pattern of training. Some may be primarily mathematicians, engineers or computer scientists, while

*There are, however, numerous ways in which modellers can and do remain in contact with other specialists in their profession. Technical journals such as the well-established *Journal of Environmental Management* and the newly-founded publications *Ecological Modelling* and *Applied Mathematical Modelling* provide a world-wide forum for discussion of precisely the issues discussed in this book. In addition, international programmes such as UNESCO's Man and the Biosphere (MAB) activity, and the United Nations Environment Programme (UNEP) have concerned themselves with improved communication in this area. Indeed, the present publication is one result of such a programme.

others have come in from one or the other of the disciplines relevant to the model.

If their models are to be used effectively by decision-makers, the modellers will need the approach of the applied scientist or engineer, rather than that of pure science. The attainment of a limited objective within a limited time and budget will be far more important than having the model represent fully the current state of scientific knowledge about the system. The criteria should be pragmatic rather than absolute.

On the other hand, the modellers will need to maintain good contact with their scientific colleagues, on whom they will rely for informed suggestions regarding model structure and for the data they need. In these contacts, the modellers may meet pressure to make the model scientifically more satisfying, where this will not contribute to the practical objective and may prolong the task unduly. The modellers will need to resist these pressures. They will have to try to convince the scientists that the goals at which they are aiming, although different from and perhaps more modest than those which the scientists might choose for themselves, are nevertheless sufficiently worthwhile to justify the best scientific input.

Interdisciplinary contact and integration can be greatly facilitated if the project includes some individuals who are able to communicate effectively with scientists in disciplines other than their own. Ideally, perhaps, the project leaders should be able to fill this role; in other cases a modeller may have the necessary talents. Otherwise, it may be worth seeking someone whose special abilities and responsibilities lie in this field of coordination and integration.

As already mentioned, it is regrettably common for modellers to find that the results of a modelling exercise are not, in fact, used by the decision-makers for whom it was undertaken. This may often arise because the modeller fails to recognize the constraints under which decision-making occurs. The decision-makers rarely have clear authority to take explicit action as a result of the conclusions of a modelling study. Moreover, decision-making is often performed by a group or committee unfamiliar with the modelling process and possibly lacking confidence in it, who may have had no direct contact with the modellers. They may even be under active pressure from those who feel that acceptance of model results may not be in their own best interests.

Not recognizing these constraints, the modeller may very well fail to devote adequate effort to identifying the true objectives of the decision-making body, and to involving members or representatives of that group, not only in the process of problem definition, but throughout the course of model development. Furthermore, the modeller often encounters difficulties because the process of decision-making is not well-defined, so that he does not know by whom or by what procedure his model will be evaluated and its conclusions accepted or rejected.

For whatever reason, modellers seem to have a specialized view of the purpose of simulation modelling. Whether because of isolation or perhaps because of their specialized disciplinary background, most modellers tend to concentrate on understanding the responses of the system (or perhaps the model), to the effective exclusion of other objectives, such as education or provision of a useful and acceptable tool for decision-makers (Mar, 1975).

At the technical level, modellers, like specialists everywhere, have preferences for particular techniques. For example, certain modellers may have special interests in linear programming, particular optimization methods, or specific simulation

languages, and may use them to address problems for which these techniques are not suited.

The organization of modelling projects is also a matter of concern. This has been widely discussed by specialists in management, as well as by modellers themselves. There is general consensus concerning the stages that such projects should go through, beginning with a clear definition of the problem and the objectives of the project, followed by identification of sub-systems and selection of research teams, through integration of results, validation, documentation and ultimate application. In practice, however, modellers pay less than adequate attention to the stages of problem definition and model application. Their main efforts are usually devoted to technical aspects of the task – in spite of the fact that techniques in these areas are already more sophisticated than in such areas as definition of objectives, validation, and user acceptance.

More attention, too, could usefully be devoted to the management of modelling activities themselves. Modelling projects are frequently coordinated by modelling specialists, who have no specific training in project management, and who are not given or do not take the opportunity to undergo training in this area.

The level at which interdisciplinary projects most often break down is that of final integration of sub-system results into a coherent and balanced framework. In the ideal case (rarely accomplished), this is facilitated by a clear definition of project objectives in advance, and the effort necessary for its accomplishment is available because integration is undertaken well before project resources have been exhausted. But the present organisation of science in separate disciplines encourages the treatment of sub-systems in isolation. As a consequence, the integrative step is often not given sufficient priority early in the planning of the project, and the carefully collected data and thoughtfully considered findings may remain fragmentary.

The communication of the final conceptual framework, as well as specific quantitative results, of a modelling study, is worth an exhaustive treatise in itself (e.g., Huysmans, 1971). Suffice it to say that modellers do not always regard it as their responsibility to use the variety of display and presentation techniques that may be necessary to achieve understanding, not only by decision-makers, but also by their technical and non-technical advisors, and even by interested parties who may be trying to influence their priorities. Workshop sessions, gaming-simulation exercises and carefully prepared visual displays, for example, may seem unnecessary to modellers, but can be extremely effective in presenting the results of their work to others.

These comments may seem to place a great burden on modellers themselves, although the team-work characteristic of modelling may ease the situation (Clymer, 1971; Benyon, 1972). In any event, it is rare for an individual modeller to be able to perform all aspects of the task without his own specialized modelling activity suffering from neglect. Two things at least should be emphasized: first, that each of the above points contributes to the likely success of a modelling project; and, second, that the modeller himself has the greatest stake in that success, and certainly stands to benefit from it. The solution may lie in the careful and explicit definition and allocation of responsibilities in the project. In any case, the attitude and approach of the modeller can certainly influence each of the points mentioned and can contribute markedly to the ultimate success of the undertaking.