**INSTITUTE FOR OPERATIONAL RESEARCH**

The First Four Years 1963-1967

***Institute for Operational Research***

*56/60 Hallam Street, London W1*

*and 42b New Union Street, Coventry, Warwickshire*

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The Institute for Operational Research was set up in May, 1963 on the joint initiative of the Operational Research Society and the Tavistock Institute of Human Relations. It is one of five research units within the framework of the Tavistock Institute, which is incorporated under the Companies' Acts as an association not for profit. Each unit is responsible, through its own sub-Council, to the Tavistock Council.

The Institute for Operational Research undertakes research on decision problems arising in the management of industrial organisations and public and social services. The Institute also provides advisory and training services related to its field of research.

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*More often than not it is the small things that one has done that bring the largest satisfactions. Such is the case relative to my role as a marriage broker in bringing Tavistock and the Operational Research Society together. I wish I could take credit for their offspring, the I.O.R.*

*In its few years I.O.R. has done a great deal to increase the professionalism of British O.R. It moved into a near vacuum created by the lack of development of academic O.R., a vacuum that fortunately has since been increasingly filled. I.O.R. has pioneered in the application of O.R. to new and important social problems and has displayed great courage and persistence in pressing back the frontiers of the unexplored. Its dedication to the extension of O.R.'s territory has benefited all who practise it. This benefit will become increasingly apparent as others move into the new territories opened by I.O.R. to settle there.*

*I.O.R. has proceeded with excessive modesty and inadequate publicity. Its work should be better known so that others, like me, can dip into it for encouragement and inspiration. My debt to the founders and operators of I.O.R. is very great. It is a great pleasure to have this opportunity to express it.*

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**Foreword**

Some five years ago a number of operational research scientists in this country were discussing an idea, then latent in the minds of many of us, that operational research, having proved its value in many fields, now needed the stimulus of new fields to conquer and the input of concepts from other disciplines, particularly those from the social sciences. These discussions eventually led to the setting up of the Institute for Operational Research. Professor Ackoff who was present in these discussions is, as you can see, very modest about his own part in the Institute's formation. His was a vital role, however. He was in a position to know that the Tavistock Institute of Human Relations was interested in operational research, having reached a stage in its own work and development where operational research seemed vital for the understanding of larger social systems. There were thus complementary needs. Discussions between leading members of the Operational Research Society and the Tavistock Institute led to the setting up of the Institute for Operational Research in May, 1963, as an autonomous research organisation with general responsibility to the Tavistock Council.

In the four succeeding years the I.O.R. has made remarkable progress in its task of widening the field of application of operational research, particularly in the public sector, and in the development of new ideas. It has also made a beginning in the assimilation of ideas from the social sciences, and has given a new perspective to a number of social scientists. The report that follows gives a good idea both of the range of work of the I.O.R. and of its outlook and philosophy.

As Chairman of its Sub-Council, I have been in a good position to watch the I.O.R.'s development and to help with its initial problems.

I believe that the I.O.R.'s work in the years to come will be influential in a number of ways, such as in the subject of operational research itself and in its relation with the behavioural sciences. As one of long connection with O.R., but more particularly as one now concerned with the practical tasks of management, I look forward to the diffusion of O.R. into the social sciences and into large scale problems, particularly those encountered in government, in the public and social services, and in the relations between government and industry.

I should like to conclude these remarks with a tribute to the Tavistock Institute of Human Relations. The tradition of this organisation is one of innovation. Without its initial financial support the I.O.R. would not have come into existence. It has enabled the I.O.R. to develop with a measure of help and protection in its early years but without constraint on matters of scientific direction, internal administration, and policy.

This is the outlook which encourages innovation and permits the Tavistock research units to develop distinctively and yet recognise their value to one another.

**SIR CHARLES GOODEVE**

Chairman,

I.O.R. Sub-Council

**The role of the ad hoc**

Some of the most urgent and intractable problems today concern the pressure of too many people on too few resources.

It is part of the human tragedy that the situation is made worse by a number of trends which, in themselves, are advantages to humanity. Examples of these trends include the decline in mortality as a result of widespread campaigns against disease, medically supported longevity, the growth of the ethic of social care and welfare, and economic interventions increasing the propensity to consume.

The economic, medical, educational, and other institutions which society has created to maintain these trends are creditable, stable, and effective. By contrast, the total problem seems too vast to comprehend as a subject for managerial or institutional action. There is a challenge here, facing any discipline applying itself to public problems, to develop the means for making simple sense out of great complexity.

Pressure on available land is one manifestation of the population-and-resources problem and underlies many public and private problems. It has given rise to the difficulties of urban planning legislation and practice. It appears again in problems of transportation, again in the problems of the disposal of waste products, and is probably responsible for many of the so-called `diseases of civilisation'. Allied to land shortage, lie the numerous and interdependent facets of the difficulty of putting roofs over the heads of an ever increasing population. Apart from land, there are the speed and cost of building; the capacity of the building industry; the problems of public and private finance; social measures aimed at reducing poverty; and there are the rules and practices of local authority housing departments. These and many other factors accentuate a fundamental conflict—the conflict between the economic need to have flexible use of the available housing stock and the overwhelming need of individuals to put down roots somewhere and there to remain.

Here again, nobody seems to have the equipment to comprehend the problem as a whole and must, it seems, tackle it in pieces with the attendant danger of missing the real problem altogether.

The instruments of government for taking a broad view of such complexities are the Royal Commission, and the Committee. Despite the eminence and thorough work of these bodies, however, the impression remains that, for instance, the television programme `Cathy Come Home', made a deeper impact on the public conscience than did the Milner-Holland report.

Cases such as Cathy's are handed on from agency to agency because the circumstances do not fit in with established rules. Only when the need is more than apparent can other organisations such as `Shelter' spring up ad hoc to cope with the job of finding ways through, across, or around the established institutions.

By its nature, an ad hoc arrangement is a sensitive indicator of a real need and hence serves a purpose even if the arrangement itself is inefficient. Nevertheless, why is it that the established institutions are, with all their advantages of power and locus, incapable of adapting themselves rapidly to changes in the needs which they were set up to serve? What are the barriers to innovation in them?

Firstly, there is the sort of tidy-mindedness which `cuts problems down to size'. Secondly, the means of communication between those who conceive policies and those who execute them simply cannot describe a sufficient variety of circumstances—the dialogue takes place in terms of explicit rules because that is the only language which both can understand. Thirdly, there is the barrier caused by the division of labour. Specialisation has produced economic progress and the advancement of knowledge. It has also served a psychological need to find satisfaction in one's work supported by the status given by membership of a profession or similar group. However, this often gives rise to a rigid approach which may well be `efficient' but inhibits real understanding of what is going on beyond the rigidly-defined boundaries.

All the tendencies then are for problems to be classified as `medical', `administrative', `chemical', `housing', `welfare', etc., but the really important problems refuse to respect the boundaries either of academic disciplines or of professional vanity. There is increasing need to look out for emerging problems and to foster minds and organisations which are flexible enough to handle them. What seems to be required is some way of setting up ad hoc organisations to tackle ad hoc problems.

Since such problems are not well enough understood for their solution to be approached with confidence, research is needed. What sort of research should this be? How should it be sponsored? Where can the initiative come from?

Since the task of research arises from uncertainty as to how to cope with problems, it must relate to the kinds of action likely to be feasible now and in the future. Research workers must not merely provide information. They must speculate, with their sponsors, on what kinds of action might be possible and set up experiments— which are a limited form of action—to probe the real world. Such a view of research is very different from one in which writing scientific papers is a main objective. To us, a report is a means to an end. It is merely an intervention in a developing process of realised need, sponsorship of research, decision-making, and innovation.

If a problem lies not in one field but in many, and interests a. number of organisations, each with its own perspective and values, research with a view to action is likely to be possible only if a sufficiently representative group of them agree that something needs to be done. Further, to be meaningful, the group must include those who can make a major contribution to any emergent action. So much is necessary, but how can it be brought about?

Research of this kind can be initiated in various ways—by professional bodies, by charitable and kindred organisations, by industrial or labour organisations, and by research organisations themselves—but it will be successful only if the initiators see that the problem is not simply their problem but that of others. We cannot expect this sort of awareness to be widespread, but a few instances of useful research of this kind would increase it markedly.

Government has a special role. It is increasingly aware of the importance of encouraging research outside the `purely scientific'. Government departments are becoming aware of the potential for effective change which they can realise by taking a hand in initiating research in fields that, at least in part, concern them. This does not mean that finance ought to come entirely from government sources.

It is unlikely that any participating organisation is sufficiently committed to give access to data and field opportunities if it is not also willing to pay according to its means.

Research under an `ad hoc' group of sponsors is an innovative act which can change circumstances, and may, in due course, give rise to establishment of separate research facilities on a permanent or semi-permanent basis. Over-centralisation of research funds and inability to form ad-hoc groups of sponsors for exploratory research on social problems would be serious barriers to their solution.

The task we have described is operational research, but operational research of a kind that has been little practiced so far. A capability to do it has to be developed from experience and a readiness to look at other disciplines and professions for the beginning of a new, and broader methodology.

What is the relevance of this to the I.O.R.? It is part of our purpose to provide a means by which new work on significant problems in society and industry can get started. But first we have to establish the competence to fulfil such a function. It is against this background that the work of these early years of the Institute should, we think, be judged.

**Completed research**

**Building industry**

***Pilot study on communications***

The building industry is one of the biggest and most complex industries in the country. It is complex not only because it consists of a large number of different types of organisation—builders, architects, suppliers, merchants, etc.—but also because of the nature of the building process itself.

The building process comprises the whole series of activities required between the point at which a client first experiences a need and the production of a building to fulfil that need. The people concerned in any one building process are the building team. They are drawn from parts of the separate and more-or-less permanent organisations that comprise the industry. They are brought together into a transient relationship for one definite purpose—the creation of a specific building. They may not have met before and, after the building has been completed, they may not meet again.

The building team is an example of a `multi-organisation', a term we have used to describe situations in which a number of different organisations are involved, each with different values and objectives. Different members of the building team—quantity surveyor, architect, building contractor, sub-contractor, suppliers—and the potential buyer, all have different factors to consider, which colour their points of view. This often gives rise to stubborn difficulties in communications between the various groups and elements that are concerned together in a building project.

Communication problems within the building industry have been severely hampering its efficient working for some years. Although the industry itself was aware of this, it lacked any criteria for objective assessment which could lead to a solution. The National Joint Consultative Committee of: Architects, Quantity Surveyors and Builders (NJCC) therefore commissioned a pilot study with the main objective of defining terms of reference and the resources required for a major investigation.

The work was undertaken jointly by the Institute for Operational Research and the Human Resources Centre, both units within the Tavistock Institute. This was the first time that operational research and the social sciences had come together in a working relationship to examine the structure and problems of a whole industry.

Recommendations for future research with the aim of bringing about a general improvement in efficiency were presented to a Conference representative of the entire building industry, as a result of which a major study, the Building Industry Communications Research Project, was launched.

The research findings of the pilot study were eventually published in both hard-back and paper-back editions under the title 'Communications in the Buildings Industry'.[[1]](#footnote-1)

***Communications research project***

The Building Industry Communications Research Project was launched in January, 1964, following the recommendations of the pilot study. A Board of Trustees was set up to which a Communications Research Committee (CRC), charged with the responsibility for commissioning the work, reported back.

The CRC, under an independent chairman, Lord James of Rusholme, was representative of all sections of the building industry. The direct responsibility for the conduct of the project was delegated by the CRC to a small steering committee. As in the pilot study, the research team was drawn from two units of the Tavistock Institute—the Human Resources Centre and the Institute for Operational Research.

We realised from the start that we could not hope to encompass the whole building process in detail. But because of the emphasis on communications we did need to see the part played by all members of the building team. So we concentrated largely on the open and selective tendering systems, although various other contractual systems were also studied. We attended a number of public meetings and held private discussions with architects, surveyors, builders, merchants, suppliers and sub-contractors. We carried out a number of detailed case studies, on site, at various stages of the building process — briefing and design, construction planning, and construction control.

In selecting projects for study, we concentrated on those which seemed likely to go well. We saw no purpose in criticising projects which were obviously inefficient. We were assured that what we saw was normal, and that the contracts studied were regarded as 'good' by those concerned. Yet none of the projects studied seemed to live up to expectations. Our experience was an industry in which misunderstandings, delays, stoppages, and abortive work result from failures in communication.

These impressions did, however, provide a starting point for an analysis of the operational characteristics of the building process. Two major characteristics were interdependence and uncertainty.

Interdependence recognises that the basic operations of building must be looked at as parts of a highly connected whole and not as separate and independent phases. From a consideration of inter- dependence in the design process we developed a new approach to the management of complex situations involving choice. This approach has now come to be known as AIDA (Analysis of Interconnected Decision Areas) [[2]](#footnote-2)[[3]](#footnote-3)

Uncertainty arises from two sources in the building process. The first is `self-generated uncertainty', which arises from ignoring the interdependence of decisions and operations. The second is `external uncertainty' which arises from the environment of the project itself.

These two aspects—Interdependence and Uncertainty—were chosen by our sponsors to be the title of a precis booklet,[[4]](#footnote-4) published in November, 1966, which summarised the main points of a very full and detailed Realisation Report of our first year's work.

The full Realisation Report spelt out at some length a diagnosis of the industry. The report also considered the prospects for improvement. The main difficulty arises in defining improvement. Since there is a variety of participants in the building process, there is unlikely to be a single generally acceptable criterion for improvement.

Possibly the only set of objectives which stands any chance of tolerably wide acceptance is the set belonging to the client/user community complex.

More research is needed but this alone will not bring about the changes required: to go further requires a willingness among all sections of the building industry to consider more effective ways of working together.

***Supply of building materials***

One source of disruption to the building process which struck us time and again throughout the Communications Project was the lack of match between the demand for, and the supply of, building materials. Uncertainties and instabilities in supply appeared to be generated by the way in which information was being communicated.

It is well known, for instance, that news of an impending scarcity of some material can give rise to increased orders of a precautionary nature. Such orders help to create the shortage against which they were intended to afford protection. Retailers holding stocks can interpret an increase in demand (or orders) as a signal to increase stocks, thereby adding to the amounts they are buying to meet direct orders. These orders are amplified by the main distributor and passed on to the manufacturer who, in turn, further amplifies the demand. Eventually, after various delays in communicating information throughout the supply system, the factory production rate begins to respond. The gross exaggeration of what was originally a modest shortage gives way to over-production, followed by glut. The vicious circle of shortage alternating with excessive stocks is complete—induced by actions which seemed rational and reasonable to those who took them.

We suggested in our Realisation Report[[5]](#footnote-5) of the Communications Project that a better understanding of the supplying systems and their complex actions and interactions was a necessary first step towards the achievement of improvement. The Ministry of Public Buildings and Works, one of the principal contributors to the Communications Project, commissioned a pilot study to examine the feasibility of carrying out full-scale research on this subject. The pilot study concentrated on the mechanism of supply and distribution of metal windows, and also included case-studies of difficulties encountered by contractors and builders' merchants in connection with the supply of other building materials. The report[[6]](#footnote-6) of the pilot study, which is confidential to the Ministry of Public Buildings and Works, was completed in May, 1966.

**Health**

Adaptation to change by hospital management

In the twenty years of its existence, the National Health Service has become an essential element in the social welfare of the community. Implicit in this is the need to be constantly aware that the service must adapt to the needs of the modern world. There has always been an awareness within the Ministry of Health, that as resources provided for and used in the hospital service increase so too do the problems of organisation and management. There has been a growing debate on whether some changes in organisation and structure might result in more efficient use of these resources and the Ministry have sponsored research projects to probe these problems. The Permanent Secretary in 1965 said:

*"We want to discover firstly, those features of the present organisation which help and those which hinder efficient management; secondly, whether experiments in management might be made and the form they might take; thirdly, what the respective roles and tasks of the many hospital managers really are so that the management training of administrative and non-administrative staff can be related to them; and lastly, what the management problems of the large district general hospital of the future are likely to be and how we can overcome them."*

In 1964 the Ministry invited the Institute to take part in this research. The initial project, which we undertook, was completed in September, 1966.

The hospital service must be freely adaptable, adapting to the changing requirements of the community which it serves as well as adapting to internal organisational changes. Changes in the health pattern of the community require changes in medical care. This in turn depends to some extent on the availability of resources such as staff, equipment and buildings and the ability to incorporate these into the existing system.

We were interested, therefore, to discover how this adaptation was in fact being managed, and decided that this could only be done by close observation and involvement in imminent changes. The following four case studies were undertaken:

(i) the building and commissioning of an outpatient department and day hospital;

(ii) the design and incorporation of an intensive care unit into a hospital;

(iii) the development of a Regional nurse staffing policy;

(iv) the allocation of minor capital.

The first three were HMC Group problems, the fourth within a teaching hospital.

It was agreed at the outset that the results should be confided to and approved by the respective Boards before they were passed on to the Ministry. The findings were communicated in a report consisting of two parts.[[7]](#footnote-7)

Part two gives detailed accounts of the four case studies. It contains practical examples of situations which arise in problems of adaptation. It also outlines new methods of solving or delineating these problems, which have both particular and general applications.

A hypothesis was drawn up[[8]](#footnote-8) that quality could be measured for each operation. The proposed method of doing this was that a team experienced in catering should give a score to the activities within each operation.

***Hospital catering: Trial measurements***

The Institute was asked to test the foregoing hypothesis. Work began in October, 1966, and finished in January, 1967.

For the purpose of this exercise only two catering systems were considered. Three hospitals were visited which used the old Bulk Delivery system, and three which used a Central Plating system. The team of observers consisted of three catering advisers, two from the Ministry and one from the Scottish Home and Health Department. They observed plating and distribution operations for four meals at each hospital.

Statistical analysis of the results substantiated the hypotheses.[[9]](#footnote-9) As the sample size was small the results were not quite sensitive enough to demonstrate the superiority of one system over the other. However, the analysis did highlight and explain the noticeable differences in performance between one hospital and another. These differences were due more to the standard of management than to the type of catering system.

**Education**

***O.R. in national educational planning***

This project originated from an initiative by the Organisation for Economic Co-operation and Development (O.E.C.D.). The O.E.C.D. was set up in 1960 (as the successor to the Organisation for European Economic Co-operation) to promote policies designed to contribute to economic expansion. In 1965 it became concerned with developing in member countries an awareness of the benefits that operational research can bring when applied to educational planning. As one of three studies launched by the O.E.C.D., a survey of the potential for operational research in planning for education at the national level was undertaken by the I.O.R.

This survey was carried out in collaboration with the Department of Education and Science who provided opportunities to study the educational system in the United Kingdom.

Our first task was to map out a review of areas in which we felt O.R. could make the best initial impact. This led us to select one problem area, further education, for deeper analysis. Further education describes the third stage of the educational system which, unlike primary and secondary education, is not compulsory. Our study was concerned with the provision of the continued education, both full-time and part-time, of those who are older than school-leaving age and who are not at a school, university, or college of education.

We began our field work within the Department itself by interviewing those concerned with the mechanism of the further education system. We followed this up by visiting technical colleges, examining bodies, local education authorities, employers, training boards, and research associations.

Perhaps the most striking impression we gained from all this was that the decision-making process in education is far more intricate than any management system we have encountered in industry. No one decision-maker is in a position to alter substantially the further education system; rather it is the combined effect of many decision-makers, often working independently, that brings about change. In many cases influence may lie with individuals who are not explicitly recognised as educational decision-makers. A case in point was where a marketing director from private industry contacted an examining body about the availability of courses in marketing. This led to the setting up of an exploratory committee to examine the potential for such courses, and as a result, a number of technical colleges began to include marketing courses, some with qualifying examinations, in their already extensive prospectuses.

In an attempt to describe more objectively what we had seen in our field work we introduced the concept t of an `influence vector'. This was a way of representing, by analogy with the well-known theorem on the resolution of forces in applied mechanics, how the decisions of separate individuals and of groups at various levels, locally, regionally, and nationally, interact.

The point here is not that different decision-makers may have conflicting objectives but that they may not know, in sufficient detail, what each others' objectives are.

For a decision-maker to achieve his objectives effectively, he must be provided with information about the objectives of all the other decision-makers whose actions may have a bearing on his own. He must have not only models of the education system and its environment but also a model of the decision-making process itself.

A major recommendation of our report[[10]](#footnote-10) is related to providing for the demand for further education. We recommend that a study in depth of technical colleges and the areas they serve should be undertaken with the aim of identifying and, where possible, quantifying the pressures, incentives, and restraints under which college principals and others act in making decisions about courses. This further study of decision-making at the "grass-roots" of the further education system would be the necessary first step towards understanding the effects of higher influences and how, through selective intervention, national educational planning can contribute most effectively to meeting the demand for further education.

***Resources for Learning***

The Nuffield Foundation is sponsoring a research and development project under the general title of Resources for Learning. The aims of this project are to study ways of organising work in schools so as to make the best use of teachers' skills and of new developments in method and equipment. The I.O.R. has been involved in the preliminary stages of setting up the project and is represented by the Deputy Director on the consultative committee which will guide the Nuffield Research team.

Initially Nuffield commissioned a number of reviews of existing and potential research and development in relevant areas.

The idea behind these reviews was to give the Nuffield research team a basis from which to start the project. The I.O.R. was commissioned to undertake one such review, the application of operational research to education.

The main emphasis of our review was on a survey of the literature relating to research in education. Writings on educational research were found to fall into two distinct categories: `educational methods' in which the approach ignores considerations of consumption of resources; and `functional problems' in which consideration of benefit to pupils is specifically excluded. The preparation of the school timetable, to which much mathematical effort has been devoted, is a typical `functional problem'.

What appears to be absent is any tradition of research around the problems of reconciliation between educational goals and the resources used up in achieving them. This led us to consider applying to education those methods of O.R. which have been successful in other fields. In the main, there are difficulties of identifying objectives, of relating crucial decisions to the effects they produce, and of securing adequate data. Our review[[11]](#footnote-11) also examined what adaptations of the `traditional' operational research approach should be made to improve its applicability to education.

**Management information**

***Management reporting using a predictive system***

Planning the programmes of construction and plant overhaul for the Central Electricity Generating Board is a complex task, and departures from the programme have far-reaching effects on the ability of the Board to meet its demands.

Critical path techniques are used for individual plant items but cannot provide an overall assessment since there is no single endpoint to the programme. The plant available for service must be adequate to meet demand at every point in time through the year.

The Midlands Region therefore sought our help in February, 1966, in developing an information system to give early warning of the risk that difficulties might arise.

A working group, comprising I.O.R. and Regional staff, was set up and the group reported[[12]](#footnote-12) on their findings after one month's intensive study of the problem.

An important component of the new information system is the Regional Information Centre[[13]](#footnote-13). Its function is to make bias-free information of a predictive nature readily available to all levels of management, using the following broad principles:

Statements about the future are expressed in terms of subjective probabilities.

Information in the system is treated as a neutral commodity available to all.

The system is clearly distinguished from the established hierarchical system of management reporting and control.

It is hoped in this way to avoid such biases as:

Necessary information being filtered out at intermediate levels at which interaction with other events is not seen or understood.

Time-lags in the passage of information channelled through people whose primary concern is with the activities under their own control.

A tendency to preserve the appearance that the situation is under control even though resources are being strained to keep it so.

Regular subjective assessments of the probabilities of meeting agreed target dates for overhaul and construction programmes are agreed over the telephone between an information centre and each of the power stations, transmission districts, etc. In order to assess the seriousness of the situation in each future week these judgements are combined statistically in accordance with the function of each plant item in the total supply network.

Although the system was created at very short notice, particular attention was given to implementation. A high degree of self-discipline at all levels of management is needed and the implementation strategy was aimed at instilling an understanding of this. The system was designed to be able to adapt to the fresh problems that would occur during its operation. Its objectives were clear at the start; its methods had to evolve.

**Research in progress**

**Local government**

***Policy research project***

This research arose from a recognition of the complex technical and procedural task of local government in formulating long-term plans. Local government's field of concern is comparable with that of central government itself. It is beset with not only the uncertainties which are inherent in any work which concerns social systems, but also those which arise from the involvement of other policy-making bodies such as neighbouring local authorities, industrial management, public boards, and ministries. The technical processes themselves are highly formidable, so too are their counterpart problems of communication and understanding.

The project `Policy research for local government' is sponsored by the Nuffield Foundation and concerns, in particular, the Coventry Corporation who have kindly given access to all aspects of their ongoing work. The research, now in its third year, is due to end in December, 1967.

The objectives of the research are to obtain an understanding in depth of the processes by which policy is formed. This has involved identifying approaches which would help clarify the underlying problems, considered from the point of view of both the officials and the elected representatives in local government.

We have been fortunate during our period of research to see many aspects of a Development Plan Review. This experience has helped in the formulation of models of the planning process. This city has been regarded as a system in which there is a constantly changing interaction, both between its constituent parts and with its environment. At one level, this view concerns what the planners plan about—the present and future communities and their related implicit and explicit values. At another level, it concerns the way phases of policy-formation and plan-development interleave and interact with one another.

All through the research there has been every opportunity to discuss ideas and impressions with many individuals and groups representing different shades of political opinion and different specialists' interests. It is hoped that much of the report which is being written will be published.

A member of the research team has been seconded to the staff of the Royal Commission on Local Government in England and Wales recently set up by the Government.

**Health**

***Implementation of operational research in hospitals***

One of the hypotheses of the Adaptation to Change report (see ref. 7) was that hospital managements tended to consider their particular problems as if they were unique. The manager, faced with pressing problems, seemed either unaware of relevant research, or unable to interpret and apply the results owing to the shortcomings of the way in which they were reported. Both of these factors severely hamper effective adaptation in the hospital service.

The Ministry asked whether there was any problem, arising from the Adaptation to Change report, which could be tackled while the report was being assessed. We suggested an experiment in implementation of research on work loads in outpatient and service departments. This was agreed and work began in June, 1966. This is initially a 12-month project with provision for an additional three-month review in 1968.

The basis of the method is first to write a working handbook which is intended to help hospital managers to formulate their particular problems. The handbook then helps them to define alternative solutions. The problem, in this instance, is that of fluctuating work-loads. The solutions are concerned with eliminating the peaks and troughs, by regulating the flow of work arising from different sources. A computer programme has been written which will be made readily available for processing data provided by the various hospitals concerned.

About 16 Hospital Management Committees will have participated by the end of the project. The experiment is to test the extent to which adaptation is influenced in this particular instance by:

(i) the working handbook on its own, and

(ii) the working handbook together with differing degrees of assistance by the Institute.

***Operational policies for a new hospital***

Most Regional Hospital Boards are in the process of planning or building new hospitals. Because these new hospitals are conceived on fundamentally new principles, there is a problem of optimising their contribution within the existing hospital system. There is a transition from each Board's own control in the planning stage, to control by the Hospital Management Committee in commissioning and final occupancy, and each Board tends to approach the transition in different ways.

The Birmingham Regional Hospital Board invited the I.O.R. to participate in the development of operational policies for the new hospital at Walsgrave, Coventry. This involves considering not only the resources of the new hospital, but of the Group as a whole. Work is being concentrated initially on the intensive care beds on each ward floor, the operating theatre suites and some service departments. It would not be possible to do this work effectively without considering in parallel the complex task of commissioning such a large hospital. Work began in 1966 and is expected to last for three years.

A Steering Committee, consisting of members of the I.O.R. and representatives of the Board and the Hospital Management Committee, acts as a co-ordinating body. There is also close contact with and ready availability of the staff of the hospitals, the Group organisation, and the Board at all levels. Mathematical models are being built to examine the effects of generating different work loads. These are designed to predict the effects on resources of different policies and, hence, choose the most efficient.

The hospital secretary is deeply involved in commissioning. He and his staff, together with the staff of all departments, have collaborated with us in drawing up critical path networks which show the inter-relationship of all the activities forming part of the intricate commissioning phase. A routine monthly reporting procedure has been set up which draws the timing of key activities to the attention of the persons responsible. It is hoped by this means to ensure that commissioning is sequenced so that no activity is delayed which jeopardises the target opening date.

It is expected that many of the methods for resource allocation and commissioning will later prove to be of valuable general application.

***Management of a ward floor of a new hospital***

Wessex Regional Hospital Board invited us to explore the problems of managing a large (240-bedded) ward floor. This research is aimed at developing practical methods for new district general hospitals planned for the Region. The first phase began in October, 1966, and is expected to last nine months.

In this instance involvement with personnel is not as close as in the case of the new Walsgrave Hospital. On the other hand, the time span coupled with the narrower scope of the project will enable more fundamental research to be undertaken. There is fruitful cross-fertilisation between these two projects.

The approach in this case is in terms of simulation by means of a `game'. This will be played in order to determine which are the most favourable policies and decision rules for efficient management of the available resources. Data for this simulation is provided by the Regional Board from a comprehensive analysis of the activities within a hospital and from a survey of patient dependency. It is later hoped to inject greater reality into the `game' by using actual hospital staff. Eventually the simulation with all its developed rules will become reality when the staff run the ward floor.

***Computer applications in hospital management***

Regional Hospital Boards and Teaching Hospitals have been using computers to process their statistics for some time now. It is a natural progression to consider their application at the Hospital Management level. The Ministry have set up a Computer Policy Department to consider this application of computers.

The Birmingham Regional Hospital Board are experimenting in the use of an English Electric-Leo-Marconi Computer in one of their hospital areas. We have been asked to act in an advisory capacity.

Much of our work has already led us to develop computer programmes which have application at Hospital Management Committee level. We are increasingly aware of the potential importance of computers at this level and the scope of their application.

**Design**

***Decision-making aids in engineering design***

The I.O.R. first became involved with the design process during the Building Industry Communications Research Project (see ref. 5). This experience encouraged us to extend the AIDA approach to design problems in other fields and particularly in engineering.

A research project funded by a grant from the Science Research Council is proceeding by means of field studies of the live design process in a number of co-operating firms. This work started in April, 1965, and is due to finish in April, 1968.

Our concern is not with the engineering technology: that is the designer's province. What we are interested in is the pattern of constraints which orders the designer's work. There is usually a dependency between different aspects of design which essentially limits the scope available to the designer. In our field studies we have examined a number of these constraints and have attempted to develop logical aids to assist the designer in resolving them.

Enough work has now been done in this field to establish that these approaches can be relevant. Mathematical models have been built which, in the simpler stages, can be handled manually[[14]](#footnote-14). A computer programme is being developed which will handle the complex problems. The present phase of the research seeks to introduce these ideas to designers and to test them through use in practical situations.

**Basic research**

**Industrial Basic Research Fund**

The Fund was launched in the summer of 1964 on the initiative of Sir Charles Goodeve. He wrote to leading companies asking for their support to provide a basis on which the I.O.R. might conduct exploratory research directed at the development of ideas arising from project work. The idea was explained as a form of co-operative research in which contributing companies might provide not only a forum for discussion but also a means of testing out ideas in practice in an industrial setting.

The Industrial Panel consists of representatives of seven contributing firms. The I.O.R. and the Panel have agreed upon a programme which has two focal topics: capital investment and manpower studies.

In consultation with the Industrial Panel we have identified certain other broad areas of interest, such as communication, organisation, and control in management systems. More specialised topics for further development include `programmed exploration' of company problem-areas, and the use of AIDA-type networks in policy `design'. In each of these areas, as in capital investment and manpower studies, we are particularly concerned with the `implementability' of research.

***Capital investment policies***

The Industrial Panel and the I.O.R. had two basic aims in mind when they chose this topic. According to a number of surveys considerable research on capital investment has not been implemented. The first aim was therefore to discover why there was so little use of operational research methods and economic advice. The second aim was to extend models of individual investment opportunities to cover the complete management system.

We explored the capital investment systems of two firms which are represented on the Industrial Panel. This disclosed considerable differences, which were not entirely explained by the different manufacturing processes. Considerations of innovation and interdependence very often took precedence so that there was little scope for standard replacement theory.

We decided that the preliminary study was fruitful enough to continue on the following lines of research:

(i) to develop a method of classifying the management of investment according to eighteen factors, and to apply it to other firms;

(ii) to explore the ways in which investment proposals arise in firms and how they can be affected ('opportunity generation' studies);

(iii) to build a mathematical model of the firm. The model would allow for differences in manufacturing processes, in opportunity generation processes, and in appraisal processes.

The object is to be able to recommend complete appraisal processes for any given firm.

***Manpower studies***

Our first study under this heading was a survey of the literature of manpower planning, with special reference to mathematical models of labour turnover. This work was presented as a paper[[15]](#footnote-15) at a symposium on planning for recruitment and employment, held at Imperial College in April, 1965.

More recent work has been largely in the nature of a review of existing manpower planning practices within three firms represented on the Industrial Panel.

In parallel with this, a certain amount of theoretical work is being carried out. This is concerned with examining the robustness of various models of wastage, with a view to developing better representations of real-life situations.

Some research directions for future work include an examination of costs and benefits of manpower policies. The relation between organisation structure and size, and the wider aspects of effective use of manpower within organisations are other important topics for further research.

Implementation studies

Both in the capital investment and manpower planning fields there is a wealth of literature, but as yet little evidence of widespread practical application of these techniques. This has led us to consider setting up under the Basic Research Fund a series of studies with the general theme of implementation. It is this theme which links together not only our basic research work but much of our project work as well.

Many of the problems we have been concerned with have been loosely structured. This often arises from the nature of the decision-making process, and not just from the technical nature of the problem itself. We have already used the term `multi-organisation' to describe this type of decision-making situation: the building industry is a typical example. Within other industries, multi-organisational relationships exist in functions such as design and marketing, which require inter-departmental and inter-professional collaboration. Examples in the public sector include town planning, education, and health.

We have begun to examine aspects of methodology which need to be developed if O.R. is to make a useful contribution to the implementation problems of multi-organisations. A paper"[[16]](#footnote-16), which sets out some practical questions on which useful work could be done, has been presented to recent conferences and is shortly to be published.

Other work on the theme of implementation has been concerned with the spread of new ideas[[17]](#footnote-17), and we are beginning to develop experiments to test models of dissemination.

**Other activities**

**Consultancy**

From the outset, we have regarded a proportion of consultancy work in our overall activity as essential. It helps us to keep in contact with a wide range of applications of operational research. It also enables us to maintain a capacity to deal with `here and now', and often urgent, situations.

We have found that contact with and exposure to these problems can lead to unexpected advances in theoretical formulation. For instance, the development of basic research on manpower studies originally stemmed from an ad hoc enquiry from an organisation faced with staffing difficulties. Another example was the design of a management information system which dealt with events that could be expressed only in terms of probabilities. The technical basis of this system and the human organisation set up to maintain it gave useful insight into problems of co-ordination in decentralised organisations.

A great deal of our consulting experience has been in providing assistance required by firms in the setting up and maintenance of their own O.R. units. This assistance has taken the following forms:

(i) appraising the opportunities for O.R. and definition of problems;

(ii) giving advice on the initial formation and structure of an O.R. unit;

(iii) providing assistance with the recruitment and selection of O.R. personnel;

(iv) broadening the experience of an organisation's own staff.

Other consulting work has been concerned with management and co-ordination problems. These have included liaison between production and marketing functions in the consumer field, and the organisation of maintenance work.

Consulting work arises directly from the needs of client organisations who feel that we can help. Since such work is done under normal commercial conditions of confidentiality, results are not available for general publication.

**Other activities: Lectures and courses**

***Lectures and courses***

We have taken on an increasing lecturing commitment over the four years and, although this can cause financial difficulties to an organisation whose income is tied to specific research projects, we regard it as an essential task if ideas and results are to be effectively and widely implemented. Lecturing has been broadly of four kinds:

(i) lectures and papers to professional bodies, such as the Royal Statistical Society and the Operational Research Society, to report on work done. This includes participation in conferences, both at home and abroad. We expect this type of lecturing commitment to increase as more research work reaches fruition.

(ii) lectures to those working in a field in which we have done applied research. Our aim is to stimulate them to look again at their own local situation. We consider this type of lecturing to be very important, especially in the hospital service, as a means of bringing about change. The lectures we are giving to the Hospital Administrators' National Training Scheme are one example. Another example is the conference we held for engineers on Design Methods which proved to be a fruitful forum both for the participants and for ourselves.

(iii) courses of lectures arranged for specific bodies to introduce operational research. Such a course was given, for example, to senior managers of the Milk Marketing Board.

(iv) lectures to university students based on current practice and ongoing research projects. Such lectures have been given as part of courses in statistics, architecture, operational research, and management at Birkbeck College, University College London, Birmingham University, and the University of Aston in Birmingham.

**Future developments**

It is appropriate at this point to outline the direction in which we can see our work developing from the experience of these first four years.

Some of our current work, especially that on hospitals, is moving toward the stage where dissemination and widespread implementation of results can be seen as possible. In other fields, for example local government, the picture is less clear. However, in all the fields in which we work it is our aim to find ways of continuing up to the point where there is a practical realisation of emergent concepts.

Our first work in the hospital field was for the Ministry of Health, but we regard as entirely healthy the tendency of hospital authorities to commission, and pay for, research apposite to their own current problems. We hope that this aspect of our work will continue to flourish but, in addition, we can see great merit in being continuously attached to a particular Group of hospitals. We are currently discussing this possibility and expect shortly to come to such an arrangement with a teaching hospital group. In order to make the best use of these opportunities we have applied to the Ministry of Health for a continuing grant to cover work under the following headings:

(i) publication of work, in a manner useful to the Hospital Service;

(ii) systematic development of techniques which have been used in particular situations;

(iii) exploration of new ideas and techniques, and of situations in which they can be tested;

(iv) training of hospital service personnel.

The last we consider most important if operational research is to become an integral part of hospital activity and would be of two kinds. An appreciation course in operational research would be based on our hospital service experience and last about two weeks. A scheme for longer apprenticeships to train hospital service personnel in the use of O.R. would enable them to achieve varying degrees of proficiency in recognising potential O.R. problems and taking part in their solution.

In education we anticipate a growing recognition of the contribution that operational research can make at both tactical and strategic levels. An interesting development, arising from our O.E.C.D. study, has been an invitation from the Department of Education and Science to submit proposals for an intensive study of further education in a local area. Specific terms of reference and details of the timing of the study are under discussion. In broad terms, however, the study would be concerned with the impact of the Industrial Training Act and with those factors which may be affected by the college itself and by the local education authority. We envisage that one important purpose of the study will be to discover whether there are ways in which the effectiveness of local and national planning of courses and facilities can be improved.

We expect that our work on engineering design methods, and on manpower planning and capital investment for the Basic Research Fund, will continue along lines already developing. In the engineering design project, however, we expect to extend our existing computer programmes to allow a closer dialogue between designer and computer output.

Much of our work has been in loosely structured organisations such as are found in hospitals, educational planning, local government, and the building process. These organisations bring together many people each belonging to their own separate professional organisations and, whilst they have some of their aims in common, other aims are divergent. The difficulties of planning for such multi-organisations have features which are not covered by textbook O.R. Our present variety of work has given us opportunities to explore these added complications. One of our hopes is that this report will stimulate recognition of other situations of this kind. In the social field the problems of housing, law and order, transport, and environmental design would appear to fall into this category. In industry and commerce there are problems which involve whole sectors rather than individual firms. We are always ready to consider work on such problems, however diffuse and ill-defined they may initially seem to be. An application has been made to the Social Science Research Council for a grant to support a continuing programme of In education we anticipate a growing recognition of the contribution that operational research can make at both tactical and strategic levels. An interesting development, arising from our O.E.C.D. study, has been an invitation from the Department of Education and Science to submit proposals for an intensive study of further education in a local area. Specific terms of reference and details of the timing of the study are under discussion. In broad terms, however, the study would be concerned with the impact of the Industrial Training Act and with those factors which may be affected by the college itself and by the local education authority. We envisage that one important purpose of the study will be to discover whether there are ways in which the effectiveness of local and national planning of courses and facilities can be improved.

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The proportion of our effort devoted to advice and service on a direct consultancy basis is valuable to us because it heightens research effort for short spells and provides stimulus to research workers. As our experience grows we would expect to be called upon to a greater extent.

We are now in a position to offer training facilities for O.R. scientists and for other persons wanting an appreciation of O.R. methods applicable to their problems. We have already mentioned our plans for training hospital personnel, and are currently exploring similar possibilities for university students.

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