PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

The Use of Operational Research and Systems Analysis in Decision Making in Unilever

K. H. Veldhuis

Phil. Trans. R. Soc. Lond. A 1977 **287**, 487-492
doi: 10.1098/rsta.1977.0155

Phil. Trans. R. Soc. Lond. A. **287**, 487–492 (1977) [487]
Printed in Great Britain

The use of operational research and systems analysis in decision making in Unilever

By K. H. Veldhuis
Unilever Limited, London EC4P 4BQ

An organization as big as Unilever (1975 sales were £7000 million) needs to consider the balance of interest between shareholders, employees, customers, government and the environment. Many routine decisions are computerized and no longer of scientific interest. The talk will be concerned with some more complex problems.

Decision trees are being used on investment and withdrawal problems. Systems analysis helps us to study the long-term effects of effluents on wild life in rivers. We have the world's largest private telecommunications network so that managers can have access to current information and we have computer based financial models to enable us to explore the effects of decisions on cash and profit flows.

1. Introduction

Unilever was formed nearly fifty years ago by the merger of the first Lord Leverhulme's soap and margarine interest with the Van den Bergh, Jurgens & Hartog interests in margarine and meat products. Leverhulme's search for raw materials had already lead him into the vast trading and plantation activities in Africa and elsewhere and it was the common interest in oils and fats, as raw materials, that lead to the merger. Two separate Unilever companies were formed – one in London and one in Rotterdam – but they share a common Board of Directors and publish consolidated accounts. For all practical purposes (including dividends) they operate as a single company whose head office happens to be split between London and Rotterdam.

In 1975 Unilever made and sold nearly £7000 million of goods to third parties in over 75 countries. Its principal products are used by housewives directly and include soaps and detergents; foods (margarine, ice cream, other frozen goods, meat, fish and vegetables processed in various ways); drinks, toilet preparations. In addition there are interests in retail outlets, fishing fleets, chemicals, paper, plastics, land and sea transportation and animal feeds. Of particular interest to our discussions today are the computer subsidiaries and those engaged in collecting and analysing market research data.

Such a vast and complex organization has an enormous need for skilled management and we utilize all the analytical tools which are available. Before describing some examples of how we use systems analysis and O.R. I should like to make some general observations.

When the Royal Society was founded some 300 years ago, it provided a forum where all who were interested could meet. Today it is an august body of eminent scientists whose primary focus is quite appropriately on science itself. I welcome this seminar as evidence of a wider interest, and an awareness of the problems which lie beyond the conventional bounds of science.

Too many of our brighter students are led to believe that business, by which I mean the creation and distribution of wealth, is not an activity which can provide the intellectual challenge they seek. Worse still, many of them do not even see the need for vast business enterprises.

Large organizations who own and operate large amounts of capital are seen as impersonal bodies who will somehow survive and make profits without assistance from our idealistic young intellectuals. This simply is not so. We will see in a moment how Unilever's decisions are no longer concerned only with the balance between the short- and long-term gains accruing to shareholders. In addition we are concerned with the impact we have on our customers, our suppliers, the governments and the communities in which and with which we work. There are the interests of our employees and their families. Today we consider what happens to the flora and fauna in the environs of our factories.

Of course, we are a large organization. How else could we produce goods in the quantities demanded by today's customer? In this country we have seen enough examples of how the Government has to intervene to prevent the demise of large manufacturing organizations, not to believe that it is in everyone's interest to see that industry gets its share of the available talent to ensure its survival. Only if our brighter students are encouraged to help in the creation of wealth will our grandchildren enjoy an inheritance similar to our own.

In an organization of this size it is essential to employ managers with entrepreneurial skills and decision-taking abilities, but this is not in itself enough. Where we can compute the likely consequences of decisions we can use the computations to pick the actions we most prefer. When, as is more common, we can only compute the partial effects, we can nevertheless use the computations to assist our judgement. The human brain has a talent for judgement and synthesis against which our largest computers are mere babes in arms. On the other hand our computers can process and digest data and ascertain the logical consequences on a scale which is difficult to comprehend. The proper matching of these two is one of the great intellectual challenges of our time.

2. Large-scale data processing

A good example of processing vast amounts of data is a calculation which is now so commonplace in our business that few of those who receive the output realize how much is involved. Recently a tax on vegetable oils has been proposed as a method of reducing Europe's butter mountain. How successful is this likely to be? In the major countries in which we operate there are panels of up to five thousand housewives who keep records of their purchases. Over a year vast amounts of data are processed. A single product field in one country can result in 150–250 000 purchase records. From these data we can distil quite simple summaries, from which we obtain graphs showing relations between volumes and price, either for the product group as a whole, or for particular brands. We have a great deal of information on how butter volume changes as margarine becomes more or less expensive. In most western countries consumption of yellow fats is falling; in the U.K., where historically butter has been cheap, butter volume is quite sensitive to price relative to margarine. This is less true in other countries. The effects of price change on particular brands is more complicated, but we are beginning to understand it.

A second example of processing on a large scale is the (now) routine use of linear programming in allocation problems. I understand the generic form of the problem is now taught in elementary school maths and it is perhaps no accident that such a basic and powerful tool is conceptually simple enough for a school algebra lesson. Of course, there are practical problems of sheer size, but these pale beside the elegance and simplicity of the concept. We started using linear programming on mix problems for animal feeds.

With constantly changing commodity prices and availability it is necessary to vary detailed formulations so as to maintain nutritional values and specifications and to do so at a price our customers are willing to pay.

Not only in the U.K. but throughout the world there is a growing market for additives for customers who wish to compound their own materials to make feed. We not only supply the additives, but with the aid of linear programming we can advise on the best combinations of ingredients to be added to those specified by the customer. This service entails a central data bank, which holds on a world-wide basis information on animal nutrition requirements, prices and availability of raw materials. An up-to-date telecommunications network makes all this available to our salesmen who even carry portable computer terminals in the boot of their cars. It is of interest to note that selling such a service is only possible if confidentiality is ensured. No farmer wants the details of his stocks, additives and product specifications made public, and for that matter we cannot afford to publish details of our own trade secrets.

3. Environmental problems

Environmental problems are of two types. We must exercise proper control over the effluents discharged from our own plants, but we are also concerned with the effects of effluents discharged by consumers as a direct result of using our products. To set product standards requires us to forecast the consequences, particularly the long-term consequences of sewage flows into rivers. Of course, Unilever uses all the standard forecasting techniques for a variety of purposes, but recently we completed a study on the pollution effects of effluents on river ecology, using what we believe to be some novel techniques, at least in their application to this particular area. We are concerned with the chronic effects of sub-lethal dosages. It is not sufficient to assume that provided we keep pollution just below acute toxicity levels, there will be no long-term effects. But it may be an unnecessary use of resources to keep it far below such levels.

We investigated a simple aquatic community consisting of brown trout, aquatic flies and gammarus, algae and detritus, at three distinct feeding levels. A systems model of the population dynamics was developed to take into account life cycles and feeding habits. The perturbing effects of pollutants could be considered. The benefits of such models are twofold; they give direct insight into the behaviour of river systems and they help structure a complementary experimental programme. It is so much easier to experiment when we have some idea of what we are looking for. Ultimately we hope all this will lead to better standards of emission control.

4. Unilever experience with decision trees

So far I have described some Unilever uses of systems analysis and operations research without touching on areas which outsiders most readily associate with the word 'business'. Of course, many of our managers spends much of their time on such problems, but I now turn to the questions which you may consider to be more traditional management.

You may consider that management involves taking decisions about appropriate courses of action and then seeing they are carried out.

For a single decision, the best choice is theoretically simple. Choose whichever action leads to the greatest return. If the outcomes are not certain, then consider expected or average returns. I would assert that no business decision arises on its own. Depending on the consequences a second, third and subsequent opportunity arises for consideration. It is necessary to have a method for handling a sequence of decisions in the presence of uncertainty. Such a method, which in principle can handle almost all problems, is called 'decision tree analysis'. It is named after the branching diagram used. Each branch represents a sequence of possible events, characterized by a pay-off at a point in time, and a cost of traversing each section. Where branching decisions are up to 'nature' there is also a probability associated with her choice. Where the choice is up to us, systematic evaluations of the discounted cash flows enable us to choose the most profitable path.

One of the great advantages in this approach arises when a problem involves many specialist aspects such as technical/production alternatives, foreign currency forecasts, legal/taxation considerations. Unilever usually tackles such problems with a committee of the different specialists and often there are difficulties in synthesizing their views into joint recommendations. The decision tree provides a valuable method of reconciling the various positions.

When decision trees are mentioned at Unilever, one or two examples of important problems which were resolved with their aid spring to mind, but despite the wide theoretical range of application, decision trees have not been greatly used and our experience on the whole has been disappointing. Part of the reason may be the considerable difficulties in assessing subjective probabilities, but it may be that their apparent precision in itself mitigates against their acceptability. It may be that the preciseness of those aspects which are quantified diverts effort from thinking about other possibilities.

Decision taking is a complex organization process. Decisions are rarely taken by one person at a single point in time. There is much to be said for collective responsibility, enthusiasm and commitment and these together can make a success of a decision which on theoretical grounds was a non-starter. Future research in this area must be in the organizational and personnel aspects of decision making. The existing technology, while serving as an excellent means of communication, seems to underestimate the importance of the aspects not considered.

5. Simulation

On a somewhat different scale are the simulations used to influence design of process plant, particularly in respect of optimization of size (i.e. cost) in relation to throughput, energy consumption and controllability. Such simulations are of dynamic situations where the relations between processing conditions and time are of importance to the final product quality. As an example we have the design of a bean edible oil extraction plant. Here, a mathematical model of each possible configuration was constructed and its performance under various control systems evaluated with the use of a small computing system. Besides establishing the optimum layouts and capacities for given throughputs, a good assessment of manning levels could be made and the choice between either a centralized or a distributed plant control system settled.

I have already referred to studies on the long-term effects of effluents, but more immediate problems arise in designing control systems for our factories. It is necessary to know the requirements such as heat output over a range of ambient temperatures and humidities, before we can select the most effective combination of treatment plants and holding tanks. Computer based techniques enable us to simulate the design, testing and operation of plants so that we can select the most effective. We have just commissioned the world's largest ice-cream plant and it is economical to install digital computers to control it centrally, thus permitting a higher operating rate than is possible with manual control.

Simulations require a considerable amount of skill because they are built up from detailed knowledge of the characteristics of individualunits, together with their interactions. It is always necessary to balance the degree of detail used against the costs involved and the accuracy of the computed results.

Few people realize how closely the work of design engineers becomes involved in process management and in company management as a whole. For a given design objective there may be many possibilities with widely varying capital and running costs. It is necessary to consider how objectives may vary over the economic life of the plant and we need to forecast the mode and level of operations together with any externally imposed conditions brought about by social or legal changes. We have found simulation to be useful aid in considering the range of possible designs.

6. Financial models

The last example I would like to cite is again a case where the conceptual problems are simple, but the sheer mechanics of producing the right analysis at the appropriate time have meant that only recently have we been able to offer managers worthwhile assistance. I refer to so-called financial models. These are annual profit and loss statements together with balance sheets. Accountants have long produced such analysis for the past, but in order to understand the effects of decisions it is necessary to project into the future. Although the basic variable is money, it is necessary to consider the implications on men, materials, machines, markets and marketable products.

Until recently such analyses were done by hand; the volume of arithmetic in aggregating to, say, the level of an operating company, was such that in general, details could only be completed for a single set of assumptions. Thus the assumptions became critical and much time of senior management was taken up in their determination. Even so the effects of many key factors, outside company control could not be considered, other than in some average sense. What happens if price legislation is altered? What about raw material prices, competitive reaction, consumer behaviour? How about changing standards of effluent control?

Today we produce financial planning models with a computer. They are the same models as have always been used, but they can now be produced at high speed and low cost. This means that variations in key assumptions can be made easily and management can concentrate on those which are most important – those where small variations have the largest effects. Thus such models are not only useful for planning, they also aid in control. We consider them to be one of the most successful parts of our O.R. effort.

There are two reasons for this success. The models are 'modular'. They can represent all or some selective parts of the company at will. Apart from the possibility of studying more troublesome areas in greater detail, this means that as we understand part of the system better we can improve that section of the model without major changes in other aspects. For example, we may start with subjective estimates of volume at various prices. Later we may have data which enable us to compute volume at any given price.

The second reason for success is that because of their simplicity they can be used by managers without intervention from the O.R. scientist. His rôle is to provide the necessary simplicity so the model can be used without his active participation. In our experience the virtuoso model beloved of the O.R. literature and understood only by the O.R. expert is seldom of practical value. By and large people fear and distrust that which they do not understand.

The first applications of these models were to do the decisions about the direction of the company; largely future investment and pricing problems. Investment in the right areas in the right quantities has a major influence on the enterprise for many years to come. The typical model is based on individual consumer brands. The money based models break down brand revenue into various cost allocations. The brands are then aggregated into groups, into divisions of the company, into factories, into companies and finally groups of companies and Unilever as a whole. It is very much a broad brush approach.

Apart from investment and planning, these models are also used as a basis for day-to-day control. The models are still financial but the time horizon is now a year, rather than five years commonly used for planning purposes. They enable us to delineate those parts of the company most in need of managerial attention.

In addition to the very wide usage for planning and control a number of *ad hoc* studies have also used this type of model. For example we have considered plant location problems and automatic warehouses with their help.

Many of our operating companies possess these models, and our central management groups also have financial models. The two sets are not linked one to the other. This may seem surprising, especially as the company models are often devised by Head Office Service Departments. However, the degree of detail required is quite different. Unilever delegates many decisions to its operating companies and it would not be appropriate for Head Office to raise issues of detail that are better understood by the local company within whose province they lie.

Conclusions

Unilever is using O.R. and systems analysis in a variety of areas; some we consider to be new developments, or at least applications in new areas. Others have been described in the literature for twenty years or more. We find that there is no such thing as a routine application of a proven technique. Every problem presents features which are new and thus offers a challenge both to the manager charged with its resolution and to the professional analyst who must assist. It is because there are always these two parties that the simplest models work best, if by work best we mean they lead to action. No manager of ability is going to delegate his responsibility to a mathematical formula which he does not fully comprehend. Our managers' numeracy has progressed considerably in the last few years, but they are not mathematicians. Thus mechanization and elaboration of well known arithmetic operations are most readily understood and accepted. This happened to our financial models. Marketing models, whose underlying concepts can be presented graphically, are much better received than those which produce forecasts by elaborate simulations whose details defy all but their designers. The challenge to O.R. scientists working in industry is to produce models, adequate for the task in hand, models which run on reasonable amounts of what is often expensive data and overwhelmingly models which are understandable enough to be used. I have tried to show you some of these at Unilever.