

**"OPERATIONAL RESEARCH CAN DO MORE
FOR MANAGERS THAN THEY THINK!"**

by

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Operational Research can do more for managers than they think!

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Abstract: Managing a company means decision-making in complicated, often confused, situations. Science, more in particular Operational Research (OR), has developed more tools than many a manager is aware of. A picture of Operational Research in practice.

Key words: Agriculture & food, Engineering, Manufacturing industries, Practice.

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1. Introduction

A multinational enterprise is selling a certain range of products in all 12 EEC countries. Demand per country is known. For historical reasons, there is a factory in ten of the countries (see Figure 1), serving mainly the national market. But European unification is proceeding -- the year 1993 is not far away. The attractiveness of delivery to the whole Common Market, from a small number of production centres, is increasing. The Board of Management of this enterprise is faced with the decision as to which of the ten factories have to be closed and which have to be expanded.

In this somewhat simplified scenario, the following circumstances hold:

- o in principle, each factory can be expanded so as to satisfy the total EEC need presently met by the 10 factories: there is space and the required staff can easily be hired;
- o the costs of expansion differ strongly per country, due to government subsidies, tax facilities, the level of wages and cost of living, and the size of the existing factory;
- o in Ireland, Spain and Portugal wages and costs of energy and water are relatively low and consequently so are the production costs;
- o production in these low-cost countries incurs high costs of transport, as the countries are situated far from the areas with the greatest demand (i.e. Germany and France).

This problem can be solved by using a *mixed-integer LP model*. 'LP' stands for linear programming, a model building-technique whereby scarce resources are assigned as well as possible to a number of competing activities. This is done by optimizing a linear target function (e.g. profit), taking into account a number of linear restrictions (e.g. capacity of a factory, or the amount of money available for investment). 'Mixed-integer' indicates that there are discrete and continuous variables. Finally, by using the word 'model' we simply state that the essence of the problem is expressed in a set of mathematical formulae.

The dimensions of such an LP model are determined by the number of countries that have to be served, the demand per country, the number of factories, the capacity of these production centres, the operating costs, the costs of expansion (terrain, buildings, personnel) and the costs of closing (dis-investments, arrangements for superfluous staff).

Basically, it is possible to apply the model manually, i.e. with the traditional pencil and paper. However, if the LP model has some realistic size, then this signifies a monk's task. So the OR worker turns to his computer and translates the model into a computer program. Standard LP packages are available. The calculating model after translation is often called 'computer model'.

For the fictitious cost structure of Figure 2 the LP model leads to the conclusion that production has to be concentrated in Ireland. This is mainly due to the low costs of expansion. If these costs were three times as high, then Germany, because of its central position and in spite of its high cost level, would become the most suitable place for concentrating the production. If in Italy costs of expansion would be zero, for instance because of an already existing overcapacity of sufficient size, then the model would indicate Italy as the supplier for Italy and Greece, while the rest of the EEC would be served by Ireland.

The model used is crude: the site of a factory in a country plays no part and each country can only be supplied from one factory. Simplifications of this type can, however, be removed easily. It also is possible to set up the program by means of which the foregoing results were obtained, in such a way that the user can 'play' with it, i.e. find answers of the *what if?* type. Here are some examples:

- o What would the solution look like if in country A the subsidies on investments disappear?
- o What happens if in country B demand increases or decreases substantially?
- o What would be the best decision if wages and costs were to be the same in all of Europe?
- o If cost ratios change, for instance because of a new oil crisis, where should production be concentrated?

2. How does the Operational Researcher work?

The OR worker called in to help a company, does not have the pretension to solve a problem. His purpose is far more modest: the manager and his staff should solve their problem; the OR worker assists them as well as he can. This can be achieved in many ways. Often, the manager and his staff do not understand precisely what their problem is. By means of a systematic and structured analysis, mainly based on interviews with local functionaries,

the OR worker is able to give them insight into the matter. From these interviews and by studying documentation from the client's organization, but also by questioning the purpose of the organization, its strategy, the available resources and the current procedures, gradually a picture emerges of the problem and its possible causes. A short report, soon after the investigation starts, shows the client what the OR worker is busy with and how he sees the problem area. In this way, any doubts still present about the OR worker's capabilities to really help solve the problem, quickly vanish. This is of the utmost importance to the gaining of confidence. In most cases the client has had to overcome some hesitation before asking an external consultant for help. Generally speaking, he is ready to believe that the consultant has a lot of theoretical knowledge. But will he be able to take practical circumstances into account, and local constraints?

Correct problem formulation and an indication of (possible) causes offer qualitative insight, first of all to the OR worker himself and then to the client and his staff. This leads almost automatically to an appreciation of the best approach. Solution methods come in sight. Only if at that moment quantitative details are required, will the 'tool kit' be opened that each OR worker has at his disposal. The client need not be more aware of that than he wishes. How the problem will be eliminated, with which tool, is mostly irrelevant to him. What counts is the solution, preferably at minimal cost and with (economic) advantages for his business. A quantitative analysis is not always needed: sometimes the qualitative insight gained is sufficient for designing an improvement plan.

3. Project approach

Successful application of OR almost always is done on a project basis. Client and consultant draw up an agreement describing as precisely as possible what the consultant is to do, at what cost, how much time he expects to need, and what assistance he desires from the client's organization. These are of necessity in the nature of estimates; adjustment occurs many times in the course of a project.

In practice, an approach in three phases has proven to be very useful (Figure 3):

Phase 1: preliminary analysis. Usually short, aiming at reconnaissance of the problem area and a problem description that the problem owner can agree

with. For him this phase has little risk. In his report, the OR worker indicates how he thinks the problem can be solved and what consequences this will have for the organization. As a matter of fact an estimate of throughput time and costs is indicated .

Phase 2: working out the proposed solution. Often this phase includes making a model of a piece of reality (e.g. the factory, the department, the group of machines) relevant to the problem. Regarding such a model, a statement by Geoffrion, one of the gurus of OR, is true: "The purpose of mathematical models is insight, not numbers". Experiments with the model do indeed lead to numerical results, but these provide insight into the interdependency of many parameters and reveal 'which dials the manager has to turn', and to what extent, in order to obtain the desired result. This project phase produces conclusions and recommendations. In the course of this phase, intermediate reports are produced at the customer's request or if the OR worker feels the need for it. Instructions for the implementation of the proposed solution often are a part of the final report.

Phase 3: implementation. Usually, this part of the project is executed by personnel of the client organization. In the ideal case, the OR worker is intensively involved in that activity, so that he turns into what EILON [1] calls a 'change agent'. In most cases, however, the client wishes the OR worker to remain in the shadow, so as not to hand over power to him.

4. Characteristics of the OR application

Although the OR worker has very advanced tools in his tool box, he will try to keep the proposed solution as simple as possible. This will increase the chance of acceptance by the organization. Often the available data are so unreliable or incomplete that the use of complex means would be as inappropriate as "peeling potatoes with a lancet". However, a comparison with a complex approach can be useful for the prediction of the effectiveness of simple solution methods.

Experience has shown that OR workers are less frequently involved in solving real-life problems in industrial organizations than is possible (given the available tools) and desirable (in view of the need to design, develop, produce, distribute, etc. products or services). This is due to managers not being aware of what OR has to offer. The fact that it is not always clear what can reasonably be expected of an OR consultant and what not, is of influence

here too. So it seems useful to list some of the more important characteristics of the OR consultant's role:

- o The OR worker does not pretend to produce an optimal solution, but one that is sound and executable and better than the existing method.
- o The OR worker does not take decisions. That task belongs to the manager or to the staff to whom he has delegated this authority.
- o The OR worker does not provide ready-made solutions that can be implemented without any effort on the part of the client and his staff. The client organization has to carry out such activities as data collection, modification of methods and procedures, and sometimes even a complete reorganisation.
- o The OR worker indicates feasible decision alternatives and calculates their (financial) consequences. The manager can thus make a choice based on firmer ground than intuition and *Fingerspitzengefühl*.
- o The OR worker determines what cost savings can be achieved after implementation of a developed solution. In general, such savings are not obtained immediately, because time is needed to eliminate existing problems such as excessive inventory levels.

5. Characteristics of the OR consultant

Especially during phase 1, when the *tool box* is still closed, the OR worker has to rely on talents and skills that can be obtained only from practical experience. During the exploration of the problem area, it is of primary importance to establish good contacts within the client organization, to obtain the collaboration of people who perhaps see no problem at all, and to create confidence in the eventual success of the project. The consultant needs to find an answer to questions like: Who are the key figures? What role do they play? How well (or badly) do they work together? Which (personal) interests are they pursuing? and What are they up to? He also needs to have eyes and ears (and possibly a sixth sense) for the possibility of people feeling threatened by his investigation and therefore sabotaging his work. Right from the start the consultant needs to make clear that his aim is to contribute to improvement of the local situation and not to point out the shortcomings of persons. In short, the OR worker needs to be "a sheep with five legs": a broadly oriented, experienced consultant with feeling for and insight into the processes of a client organization, a person speaking the language of the enterprise, with professional skills, and not a pure applier

of OR who sees OR models as the ultimate goal of his activities. He also needs to be able to listen very well. Only in that way can he collect the pieces of the jigsaw puzzle that may show him the way to a practical and feasible solution. Moreover, he is client-oriented: "The market does not ask for Operational Research, but wants assistance in problematic situations", Telgen rightly states in his inaugural speech [2].

So far we have assumed male OR workers in our comments. However, the probability that managers, themselves also no longer exclusively belonging to the 'strong' sex, will encounter female consultants, is growing fast.

6. Two more examples

1. Processing of fresh meat -- Newly butchered animals, for instance pigs, are converted by the meat processing industry into products that are offered for sale in retail outlets [4]. Like many other industries, this branch is strongly market-oriented; especially changing consumer behaviour (growing attention to quality and health aspects, critical attitude towards bio-industry, etc.) is carefully monitored.

The goods flow has the following characteristics:

- o each raw material needs to pass through a series of processing steps;
- o at each processing step, products appear in quantities with known, fixed ratios;
- o at each level of processing there can be shortages as well as surpluses;
- o for each raw material and sub-product there are various processing methods, each with its own costs and yields;
- o the "manpower" factor is responsible for a large part of the processing costs.

The question now is how consumer demand can best be met under the given circumstances and how a certain input of goods can be converted into products with maximum value. This is also a problem that can be solved via linear programming.

2. Selection of the best factory layout -- A factory is producing printed circuit boards (PCBs) in batches ranging from 5 to 250 pieces. (PCBs are plastic cards on which electronic components are mounted and connected via copper circuitry that is etched on one or both of the surfaces; they are used in virtually all modern electronic devices.) The factory produces 1000 types. Some years ago, management expected that customers would require ever smaller

batch sizes, with size 1 as a realistic possibility. With constant production volume, the manufacturing method would result in unacceptably long delivery times, as products would have to wait between the various processing steps [5].

An internal project group, with experts in the field of production methods, inventory management, organization & efficiency, logistics, planning and manufacturing systems, drew up an overview of possible solutions. After studying the advantages and disadvantages of each solution, three different production systems remained (Figure 4). Then the fundamental question was: Given a certain workload, which capacities in terms of personnel and equipment are required for each of these three cases, such that product throughput time and processing time are equal?

External consultants were called upon; they soon came to the conclusion that the proposed manufacturing processes and the interaction of products through the factory were so complicated that computer simulation was needed. Consequently, one of the most often applied OR instruments was taken from the "tool kit".

Briefly stated, simulation means the imitation of a piece of reality (the factory) in a model (mathematical formulas translated into a computer program). All relevant details of reality can be incorporated into such a simulation model, unlike the formerly applied analytical models. Via experiments with the simulation model, i.e. running the program under ever varying conditions as frequently as necessary, one can investigate the influence of changes without actually interfering with the actual processes. The factory continues to run undisturbed; real changes are implemented there only after simulations have revealed that they will have the required effect. The more a simulation model is an accurate image of reality, the more convincing will be its results.

Simulation of the three possible systems of Figure 4 showed that both the second and the third system would make the required throughput time possible. System B was chosen because the machine for production step 3 had been installed just before the investigation started. This layout has meanwhile been realized; it works to the full satisfaction of the company.

7. Application areas for OR

The analysis of processes and systems is by definition the most elementary OR technique. In addition to this, mathematical research has

produced a number of OR tools with a specialist character. Best known and most frequently used are mathematical programming, network analysis, game theory, combinatorial analysis, queuing theory, inventory theory and discrete simulation. In industry, their usefulness has been proven in the control of production processes (tuning of machines, determination of buffer sizes, scheduling of operations, choice of raw materials), in inventory control (optimal reorder levels, size of warehouses), and in the control of goods flows (control rules, reduction of throughput times, allocation of distribution points). This can be illustrated by means of an investigation into 188 OR projects executed between 1981 and 1988 at Philips (Ref. [6]) by the *Centre for Quantitative Methods*, an internal consultancy bureau. It reveals that, in the company, 'production' and 'design of production facilities' are important application areas for OR (see Figure 5). Of course, attention was also paid to the OR techniques applied. Discrete simulation turns out to be the most frequently used technique, closely followed by models in which probability theory plays a role (see Figure 6). The most common type of OR project is a simulation study for the design of a production line.

The foregoing examples refer to applications with a logistical character in a technical environment. But outside the engineering world, application areas are easy to find: banks, insurance companies, agriculture, airlines, hospitals, education and government all use OR techniques to a large extent to run their 'operations' more efficiently and to support their decisions.

8. OR and the manager

When managers have to take decisions, OR can do more for them than many of them think. OR has developed powerful tools for comparing alternative scenarios quantitatively, for making the effects of decisions visible and hence open to discussion, and for reducing uncertainty in complex situations. However, the OR worker does not take decisions out of the manager's hands; but he does help him to improve the quality of his decisions and to shorten the time taken to reach them. This is done by revealing the consequences of possible decisions in as quantitative a way as possible. Intuition, experience and common sense remain indispensable to the manager for the last two steps: the choice of a solution and its implementation. Nevertheless, there is something strange about that intuition; sometimes reasonable (heuristic) solutions appear not to be best. Common sense and a heuristic approach often fail because they are arbitrary in the selection of a starting point, in the

sequence in which choices are made, in the selection of criteria to look at when characterizing a process, and in the amount of effort undertaken to prove that the eventual 'solution' really is the best one or almost so. Neat examples of this phenomenon can be found in [7]. They suffer from sub-optimization, because the mutual influences of step-by-step decisions are not taken into consideration.

Figure 7 summarizes the ways in which a manager can be supported by OR when he is taking decisions.

9. OR and the computer

Software for applying OR techniques is getting ever more powerful and user-friendly, whereas prices continue to fall. Problems for which an experienced programmer and a mainframe computer formerly needed many hours, can now be solved on a personal computer by a person with only an elementary knowledge of informatics. As a consequence of the interactive mode of operation, the user can have a look at the results much earlier than before; testing possibilities thus becomes an easy task. Just by 'playing' with the computer, he constructs a model of the system under scrutiny: at first, strongly simplified (the so-called *prototype*), but gradually growing into something with all the relevant characteristics of that system. Acceptance of a decision support system built in this fashion, by people in the vicinity can easily be obtained and the implementation is simple also. Modern software also opens the possibility of quickly investigating a simplified version of the problem on a PC and judging the strong and weak points of the solution method. After that, the real problem can be submitted to a large computer.

Of course, this coin has a less favourable side too. Since OR tools can be handled so easily, even by an 'outsider', the probability exists that a package is being used in the wrong way. The assumptions on which the OR techniques rest, are perhaps not satisfied. The output then becomes incomprehensible, misleading or does not tally with the expected results. Disappointment follows. In order to avoid this danger, good-quality OR courses are indispensable.

10. Concluding remarks

Generally stated, OR occupies itself with the analysis (research) of activities (operations). It creates order in situations that are problematic for decision-makers by collecting relevant facts and opinions and returning

these in a structured form to the client organization. In this way, a problem, at first vague and not quantifiable, becomes open to rational discussion. Causes and possible remedies come in sight. It then becomes clear which of the existing OR techniques can best be used or which new technique has to be developed to solve the problem in hand.

Modesty, however, is needed: OR is no panacea, and ready-made solutions do not exist. In all cases an effort is required to make the proposed solution applicable and effective. An OR model becomes active and helpful only after it is fed with reliable data. Often the collection of such data is a time-consuming and hence expensive affair. The OR worker should therefore not create too high expectations, but remain realistic and point out that the client's own efforts are indispensable.

In order to keep OR healthy, close interaction with practice is required: practice offers the OR worker the opportunity to test his theoretical discoveries for applicability and draws his attention to problems that urgently need solution. The mistake, formerly made by OR workers of preaching from their ivory towers, can thereby be avoided.

In industrial engineering circles, the merits of OR are not fully appreciated. It is believed there, that the OR worker can think only quantitatively and in terms of models, that his only aim is to use his *tool box* as soon as possible. This misunderstanding can also be found in many curricula for industrial engineering. Of course, a good OR worker does have a thorough knowledge of OR techniques, but his effort is aimed at the client organization and its problem areas. In a problematic situation he does not try to maintain the existing system at all costs, which would imply finding the best parameter setting for it. The OR worker devoted to his profession takes a fundamentally different stand: he finds out what system performance is required and he figures out what has to be done in order to achieve that performance, if necessary by means of a new system.

(Suggestion: The next section perhaps better in a separate box?)

Operational Research, now and in the past

Before World War II, Great Britain was developing radar in order to detect possible enemy aircraft before they became audible and visible. This *technical* research was successful in 1938, when it became possible to detect planes at great distances on the radar screen. However, the amount of time needed by the Royal Air Force to take countermeasures was far too long to

allow the destruction of these planes before they could become dangerous. Hence it was decided to do *operational* research to increase the RAF's speed of reaction to radar observations. Finding and eliminating bottlenecks in those processes ('operations') was of vital importance. Ever since, this type of multidisciplinary investigation has been denoted as *Operational Research*. Other names are Operations Research and Operational Analyses, as well as the abbreviation OR.

The Battle of Britain was won by the British, but it was a narrow escape. The British owed their victory in part to the pre-war OR teams in England. After the USA became involved in the war, in 1941, the German *U-Boote* formed a particularly serious threat. As a matter of fact, American OR was primarily aimed at anti-submarine warfare and other maritime problems. Both in the USA and in Great Britain, OR teams were actively engaged in the preparation of military operations. In all cases, they worked on very concrete and vital problems, and all the time their 'clients' belonged to top management, i.e. the military leaders. In almost all cases, their recommendations were implemented quickly and with success.

After the war there was a general expectation that OR could be helpful in the reconstruction of society also. OR workers were available and industrial activities such as production planning, inventory control and transport planning turned out to be very suitable for model-building and other forms of abstraction that lead, and still are leading, towards challenging mathematical problems. But solutions that really proved to be applicable in practice, were not as numerous as expected. This phenomenon had at least two causes. On the one hand, models used with the then available computers turned out to be such a simplified version of reality that practitioners no longer could recognize their problems in them. On the other hand, OR workers became more and more fascinated by the theoretical foundations of their profession. This produced great progress, particularly in the field of mathematical programming, combinatorial analysis and queuing theory. But the industrial problems of daily life received little attention. Gradually the disappointed managers lost interest in "mathematical decision theory": another name for OR. In this way a phenomenon appeared that is often called the gap between theory and practice: on the one hand, the manager with real, urgent problems for which simple and robust solutions are required; on the other hand, the scientist in his ivory tower, primarily interested in elegant solutions to abstract problems of his own invention.

This picture may have been correct in the past; now it is certainly no longer valid. An ever increasing number of OR workers are assuming a client-friendly attitude. The number of success stories is increasing too, as can be seen from the inventory by TILANUS (Ref. [3]).

*

Model-building plays an important part in modern OR projects, often in combination with discrete simulation. Models offer insight and the possibility to compare decision scenarios with each other, both in the qualitative and the quantitative sense. Almost always the computer is an indispensable tool in this. The driving force exerted by developments in informatics cannot easily be overestimated. A large part of the current arsenal of OR techniques can be used on the PC, thanks to software that is becoming more and more user-friendly and also cheaper. In recent years, the ease with which a problem area can be represented by a model that the problem owners consider sufficiently realistic, has grown enormously. Large quantities of data can easily be stored in databases that are simple to access. The opportunities for OR to really contribute to the reduction of uncertainty in complex industrial situations, are large. But there still are managers who are unaware of the help they can get from OR, like quickly calculating the consequences of decision variants, the preparation of decisions, and decision support. These managers are ignorant of the fact that with this help they can save considerable amounts of money. For OR workers who love their profession, here lies a vast area that urgently needs to be developed, in the interest of their science as well as of industry. (*End of suggested separate box*)

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Figure 1 -- Production centres in Europe, as described in this article.

FACTORY IN	COSTS OF EXPANSION	TRANSPORT AND PRODUCTION COSTS FOR:											
		B	DK	D	F	GR	GB	IRL	I	L	NL	P	E
<i>Belgium</i>	11200	475	860	1104	1211	615	1288	350	577	112	568	267	548
<i>Germany</i>	4000	577	823	1000	1400	597	1523	394	1246	114	623	286	486
<i>France</i>	6000	605	975	1350	950	624	1296	350	1253	124	691	243	405
<i>UK</i>	5000	594	894	1373	1196	665	850	262	1396	136	610	245	425
<i>Ireland</i>	1800	460	900	1569	1400	708	1061	120	1514	157	685	228	418
<i>Italy</i>	3800	1025	1195	1927	1988	395	2327	555	510	187	1087	276	450
<i>Luxemburg</i>	53100	535	843	1038	1192	574	1408	374	1149	90	612	264	438
<i>Netherlands</i>	10100	568	760	1196	1381	636	1319	344	1364	127	475	284	492
<i>Portugal</i>	24800	1212	1581	2562	2177	734	2300	475	1565	244	1296	70	242
<i>Spain</i>	16600	1044	1406	2181	1827	648	2027	448	1290	204	1129	126	150

Figure 2 -- Table of costs. The monetary unit is arbitrary; only the ratio between the numbers matters.

ACTIVITIES		DESCRIPTION
Phase 1	General survey	Discussions with client and staff. Interviews, study of documents. Global problem description. Generation of ideas for a possible approach
	Reporting	Outline of results to be expected. Proposal for Phase 2.
Phase 2	Model building	Systematic description of the problem area. In order not to make the model too complicated, only the most relevant factors are taken into account.
	Verification	Discussions with client and staff: Does the model correctly present the problem area, the organization, the methods, processes and procedures?
	Experiments	Translation of the model into a computer program. Calculations in various circumstances.
	Analysis	Investigation of results.
	Reporting	Presentation of the most important results, conclusions and recommendations. A proposal for Phase 3.
Phase 3	Implementation	Elaboration and implementation of recommendations. Teaching client and/or staff to work with the new method.

Figure 3 -- Summary of the steps in an OR project. In Phases 1 and 2 the consultant is heavily involved in the project. Usually, Phase 3 is carried out by the problem owner and/or his staff.

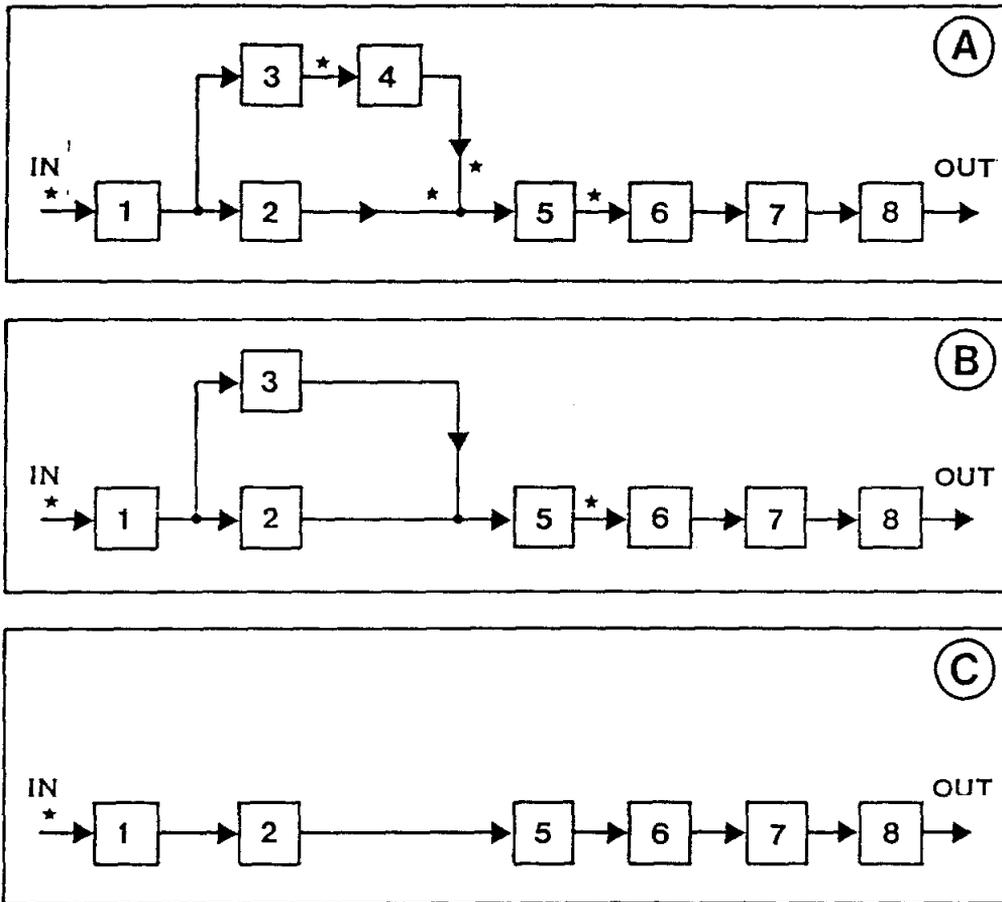


Figure 4 -- Three possible production systems. Each box represents a step in the production process for printed circuit boards. In System B, the activities of Step 4 have been added to those of Step 6. In System C, this applies to the activities of Step 3 also. In the positions denoted with an asterisk, a waiting queue can appear.

Number of applications

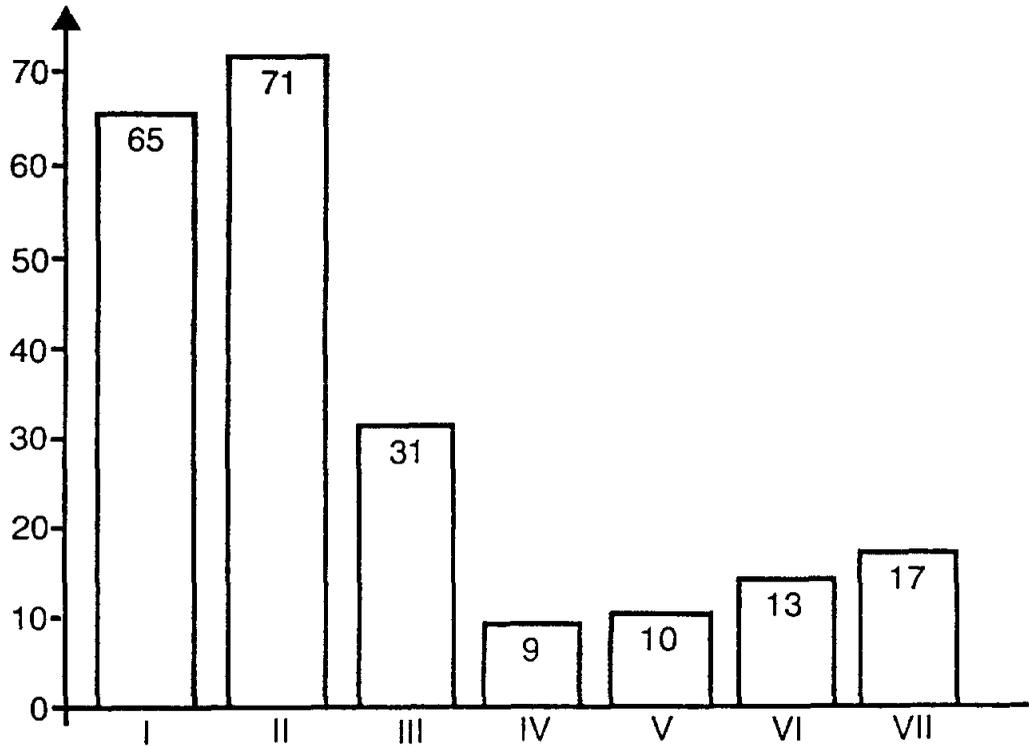


Figure 5 -- Application areas for OR inside Philips, taken from Ref. [6], in which 188 projects have been analysed. Legend: I = Production; II = Design of production systems; III = Transport and storage; IV = Design of systems for transport and storage; V = Performance of systems; VI = Training and courses; VII = Miscellaneous, i.e. among others: portfolio analysis, measuring the quality of information systems, and performance indicators.

Number of applications

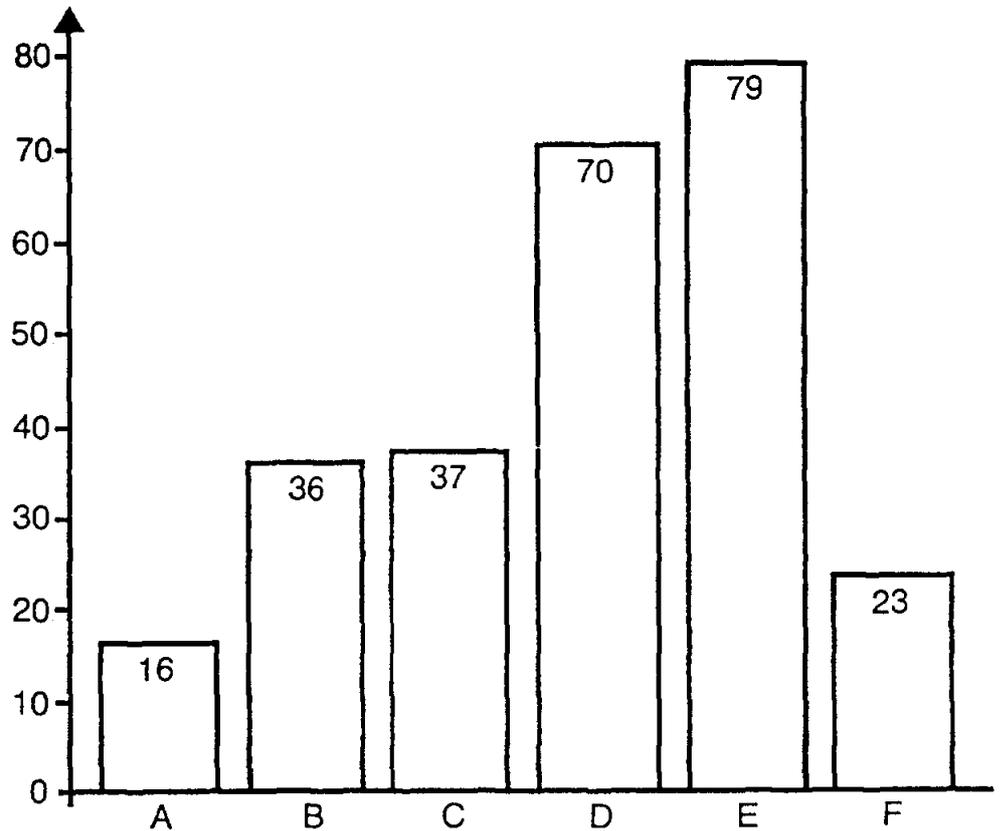


Figure 6 -- OR techniques applied inside Philips, taken from Ref. [6], in which 188 CQM projects are analysed. Legend: A = Mathematical programming; B = Combinatorial analysis; C = Inventory models; D = Waiting theory models; E = Discrete simulation; F = Miscellaneous. Category A contains many LP models. Category F comprises, among other things, the categorization of facts and figures. Many projects start with this elementary type of OR; sometimes it is all the client wants.

-
- CONSISTENCY
 - all considerations become visible to all personnel involved
 - no yes/no discussions

 - MORE THAN ONE COMPARISON AT THE SAME TIME

 - WHAT-IF QUESTIONS AND SENSITIVITY ANALYSES BECOME POSSIBLE

 - INSIGHT INTO BOTTLENECKS

 - ALL RELEVANT FACTORS CAN BE QUANTIFIED

 - MORE DISCIPLINE, DUE TO FIXED PROCEDURES

 - IF THERE ARE NO LONGER FIRES TO BE EXTINGUISHED, ONE CAN TACKLE THE REAL PROBLEMS
-

Figure 7 -- The significance of OR models for medium-term planning.

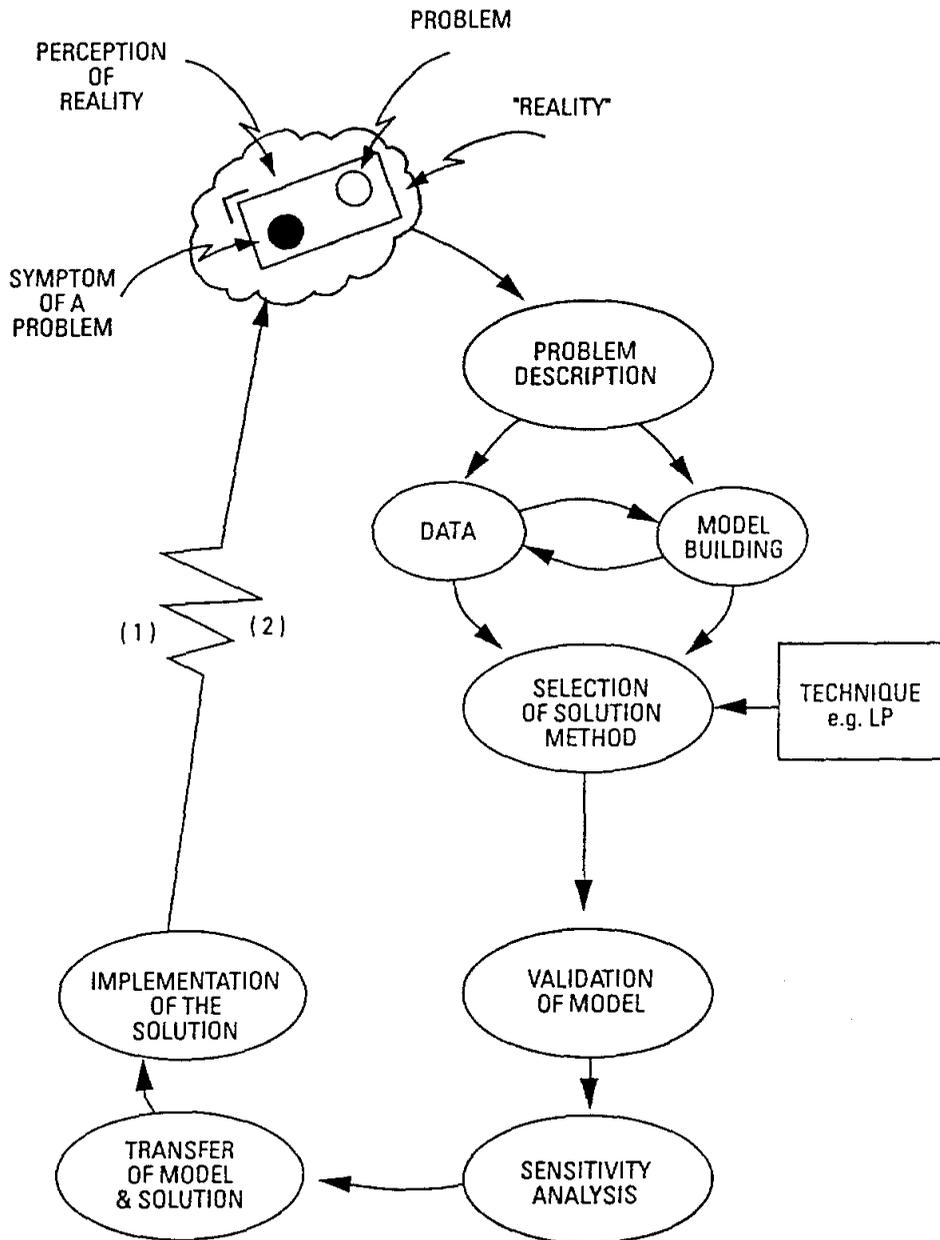


Figure 8 -- Schematic overview of the steps in an OR study and their interrelationship. Each step takes time. Most steps require time to make simplifications and assumptions about "reality". Therefore, a moment crucial to the OR worker follows after the last step: all he can do is hope that (1) the problem has been solved correctly, and (2) the problem has not changed in the meantime.

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88/04	Susan SCHNEIDER	"National vs. corporate culture: implications for human resource management", January 1988.	88/16	Gabriel HAWAWINI	"Market efficiency and equity pricing: international evidence and implications for global investing", March 1988.
88/05	Charles WYPLOSZ	"The swinging dollar: is Europe out of step?", January 1988.	88/17	Michael BURDA	"Monopolistic competition, costs of adjustment and the behavior of European employment", September 1987.
88/06	Reinhard ANGELMAR	"Les conflits dans les canaux de distribution", January 1988.	88/18	Michael BURDA	"Reflections on "Wait Unemployment" in Europe", November 1987, revised February 1988.
88/07	Ingemar DIERICKX and Karel COOL	"Competitive advantage: a resource based perspective", January 1988.	88/19	M.J. LAWRENCE and Spyros MAKRIDAKIS	"Individual bias in judgements of confidence", March 1988.
88/08	Reinhard ANGELMAR and Susan SCHNEIDER	"Issues in the study of organizational cognition", February 1988.	88/20	Jean DERMINE, Damien NEVEN and J.F. THISSE	"Portfolio selection by mutual funds, an equilibrium model", March 1988.
88/09	Bernard SINCLAIR-DESGAGNÉ	"Price formation and product design through bidding", February 1988.	88/21	James TEBOUL	"De-industrialize service for quality", March 1988 (88/03 Revised).
88/10	Bernard SINCLAIR-DESGAGNÉ	"The robustness of some standard auction game forms", February 1988.	88/22	Lars-Hendrik RÖLLER	"Proper Quadratic Functions with an Application to AT&T", May 1987 (Revised March 1988).
88/11	Bernard SINCLAIR-DESGAGNÉ	"When stationary strategies are equilibrium bidding strategy: The single-crossing property", February 1988.			

88/23	Sjur Didrik FLAM and Georges ZACCOUR	"Equilibres de Nash-Cournot dans le marché européen du gaz: un cas où les solutions en boucle ouverte et en feedback coïncident", Mars 1988.	88/34	Mihkel M. TOMBAK	"Flexibility: an important dimension in manufacturing", June 1988.
88/24	B. Espen ECKBO and Herwig LANGOHR	"Information disclosure, means of payment, and takeover premia. Public and Private tender offers in France", July 1985, Sixth revision, April 1988.	88/35	Mihkel M. TOMBAK	"A strategic analysis of investment in flexible manufacturing systems", July 1988.
88/25	Everette S. GARDNER and Spyros MAKRIDAKIS	"The future of forecasting", April 1988.	88/36	Vikas TIBREWALA and Bruce BUCHANAN	"A Predictive Test of the NBD Model that Controls for Non-stationarity", June 1988.
88/26	Sjur Didrik FLAM and Georges ZACCOUR	"Semi-competitive Cournot equilibrium in multistage oligopolies", April 1988.	88/37	Murugappa KRISHNAN Lars-Hendrik RÖLLER	"Regulating Price-Liability Competition To Improve Welfare", July 1988.
88/27	Murugappa KRISHNAN Lars-Hendrik RÖLLER	"Entry game with resalable capacity", April 1988.	88/38	Manfred KETS DE VRIES	"The Motivating Role of Envy : A Forgotten Factor in Management", April 88.
88/28	Sumantra GHOSHAL and C. A. BARTLETT	"The multinational corporation as a network: perspectives from interorganizational theory", May 1988.	88/39	Manfred KETS DE VRIES	"The Leader as Mirror : Clinical Reflections", July 1988.
88/29	Naresh K. MALHOTRA, Christian PINSON and Arun K. JAIN	"Consumer cognitive complexity and the dimensionality of multidimensional scaling configurations", May 1988.	88/40	Josef LAKONISHOK and Theo VERMAELEN	"Anomalous price behavior around repurchase tender offers", August 1988.
88/30	Catherine C. ECKEL and Theo VERMAELEN	"The financial fallout from Chernobyl: risk perceptions and regulatory response", May 1988.	88/41	Charles WYPLOSZ	"Assymetry in the EMS: intentional or systemic?", August 1988.
88/31	Sumantra GHOSHAL and Christopher BARTLETT	"Creation, adoption, and diffusion of innovations by subsidiaries of multinational corporations", June 1988.	88/42	Paul EVANS	"Organizational development in the transnational enterprise", June 1988.
88/32	Kasra FERDOWS and David SACKRIDER	"International manufacturing: positioning plants for success", June 1988.	88/43	B. SINCLAIR-DESGAGNÉ	"Group decision support systems implement Bayesian rationality", September 1988.
88/33	Mihkel M. TOMBAK	"The importance of flexibility in manufacturing", June 1988.	88/44	Essam MAHMOUD and Spyros MAKRIDAKIS	"The state of the art and future directions in combining forecasts", September 1988.
			88/45	Robert KORAJCZYK and Claude VIALLET	"An empirical investigation of international asset pricing", November 1986, revised August 1988.
			88/46	Yves DOZ and Amy SHUEN	"From intent to outcome: a process framework for partnerships", August 1988.
			88/47	Alain BULTEZ, Els GUSBRECHTS,	"Asymmetric cannibalism between substitute items listed by retailers", September 1988.

	Philippe NAERT and Piet VANDEN ABEELE		88/59	Martin KILDUFF	"The interpersonal structure of decision making: a social comparison approach to organizational choice", November 1988.
88/48	Michael BURDA	"Reflections on 'Wait unemployment' in Europe, II", April 1988 revised September 1988.	88/60	Michael BURDA	"Is mismatch really the problem? Some estimates of the Chelwood Gate II model with US data", September 1988.
88/49	Nathalie DIERKENS	"Information asymmetry and equity issues", September 1988.	88/61	Lars-Hendrik RÖLLER	"Modelling cost structure: the Bell System revisited", November 1988.
88/50	Rob WEITZ and Arnoud DE MEYER	"Managing expert systems: from inception through updating", October 1987.	88/62	Cynthia VAN HULLE, Theo VERMAELEN and Paul DE WOUTERS	"Regulation, taxes and the market for corporate control in Belgium", September 1988.
88/51	Rob WEITZ	"Technology, work, and the organization: the impact of expert systems", July 1988.	88/63	Fernando NASCIMENTO and Wilfried R. VANHONACKER	"Strategic pricing of differentiated consumer durables in a dynamic duopoly: a numerical analysis", October 1988.
88/52	Susan SCHNEIDER and Reinhard ANGELMAR	"Cognition and organizational analysis: who's minding the store?", September 1988.	88/64	Kasra FERDOWS	"Charting strategic roles for international factories", December 1988.
88/53	Manfred KETS DE VRIES	"Whatever happened to the philosopher-king: the leader's addiction to power, September 1988.	88/65	Arnoud DE MEYER and Kasra FERDOWS	"Quality up, technology down", October 1988
88/54	Lars-Hendrik RÖLLER and Mihkel M. TOMBAK	"Strategic choice of flexible production technologies and welfare implications", October 1988	88/66	Nathalie DIERKENS	"A discussion of exact measures of information asymmetry: the example of Myers and Majluf model or the importance of the asset structure of the firm", December 1988.
88/55	Peter BOSSAERTS and Pierre HILLION	"Method of moments tests of contingent claims asset pricing models", October 1988.	88/67	Paul S. ADLER and Kasra FERDOWS	"The chief technology officer", December 1988.
88/56	Pierre HILLION	"Size-sorted portfolios and the violation of the random walk hypothesis: Additional empirical evidence and implication for tests of asset pricing models", June 1988.	<u>1989</u>		
88/57	Wilfried VANHONACKER and Lydia PRICE	"Data transferability: estimating the response effect of future events based on historical analogy", October 1988.	89/01	Joyce K. BYRER and Tawfik JELASSI	"The impact of language theories on DSS dialog", January 1989.
88/58	B. SINCLAIR-DESGAGNÉ and Mihkel M. TOMBAK	"Assessing economic inequality", November 1988.	89/02	Louis A. LE BLANC and Tawfik JELASSI	"DSS software selection: a multiple criteria decision methodology", January 1989.

89/03	Beth H. JONES and Tawfik JELASSI	"Negotiation support: the effects of computer intervention and conflict level on bargaining outcome", January 1989.	89/13	Manfred KETS DE VRIES	"The impostor syndrome: a disquieting phenomenon in organizational life", February 1989.
89/04	Kasra FERDOWS and Arnoud DE MEYER	"Lasting improvement in manufacturing performance: In search of a new theory", January 1989.	89/14	Reinhard ANGELMAR	"Product innovation: a tool for competitive advantage", March 1989.
89/05	Martin KILDUFF and Reinhard ANGELMAR	"Shared history or shared culture? The effects of time, culture, and performance on institutionalization in simulated organizations", January 1989.	89/15	Reinhard ANGELMAR	"Evaluating a firm's product innovation performance", March 1989.
89/06	Mihkel M. TOMBAK and B. SINCLAIR-DESGAGNÉ	"Coordinating manufacturing and business strategies: I", February 1989.	89/16	Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN	"Combining related and sparse data in linear regression models", February 1989.
89/07	Damien J. NEVEN	"Structural adjustment in European retail banking. Some view from industrial organisation", January 1989.	89/17	Gilles AMADO, Claude FAUCHEUX and André LAURENT	"Changement organisationnel et réalités culturelles: contrastes franco-américains", March 1989.
89/08	Arnoud DE MEYER and Hellmut SCHÜTTE	"Trends in the development of technology and their effects on the production structure in the European Community", January 1989.	89/18	Srinivasan BALAK- RISHNAN and Mitchell KOZA	"Information asymmetry, market failure and joint-ventures: theory and evidence", March 1989.
89/09	Damien NEVEN, Carmen MATUTES and Marcel CORSTJENS	"Brand proliferation and entry deterrence", February 1989.	89/19	Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN	"Combining related and sparse data in linear regression models", Revised March 1989.
89/10	Nathalie DIERKENS, Bruno GERARD and Pierre HILLION	"A market based approach to the valuation of the assets in place and the growth opportunities of the firm", December 1988.	89/20	Wilfried VANHONACKER and Russell WINER	"A rational random behavior model of choice", Revised March 1989.
89/11	Manfred KETS DE VRIES and Alain NOEL	"Understanding the leader-strategy interface: application of the strategic relationship interview method", February 1989.	89/21	Arnoud de MEYER and Kasra FERDOWS	"Influence of manufacturing improvement programmes on performance", April 1989.
89/12	Wilfried VANHONACKER	"Estimating dynamic response models when the data are subject to different temporal aggregation", January 1989.	89/22	Manfred KETS DE VRIES and Sydney PERZOW	"What is the role of character in psychoanalysis?" April 1989.
			89/23	Robert KORAJCZYK and Claude VIALLET	"Equity risk premia and the pricing of foreign exchange risk" April 1989.
			89/24	Martin KILDUFF and Mitchel ABOLAFIA	"The social destruction of reality: Organisational conflict as social drama" zApril 1989.

89/25	Roger BETANCOURT and David GAUTSCHI	"Two essential characteristics of retail markets and their economic consequences" March 1989.	89/36	Martin KILDUFF	"A dispositional approach to social networks: the case of organizational choice", May 1989.
89/26	Charles BEAN, Edmond MALINVAUD, Peter BERNHOLZ, Francesco GIAVAZZI and Charles WYPLOSZ	"Macroeconomic policies for 1992: the transition and after", April 1989.	89/37	Manfred KETS DE VRIES	"The organisational fool: balancing a leader's hubris", May 1989.
89/27	David KRACKHARDT and Martin KILDUFF	"Friendship patterns and cultural attributions: the control of organizational diversity", April 1989.	89/38	Manfred KETS DE VRIES	"The CEO blues", June 1989.
89/28	Martin KILDUFF	"The interpersonal structure of decision making: a social comparison approach to organizational choice", Revised April 1989.	89/39	Robert KORAJCZYK and Claude VIALLET	"An empirical investigation of international asset pricing", (Revised June 1989).
89/29	Robert GOGEL and Jean-Claude LARRECHE	"The battlefield for 1992: product strength and geographic coverage", May 1989.	89/40	Balaji CHAKRAVARTHY	"Management systems for innovation and productivity", June 1989.
89/30	Lars-Hendrik ROLLER and Mihkel M. TOMBAK	"Competition and Investment in Flexible Technologies", May 1989.	89/41	B. SINCLAIR-DESGAGNE and Nathalie DIERKENS	"The strategic supply of precisions", June 1989.
89/31	Michael C. BURDA and Stefan GERLACH	"Intertemporal prices and the US trade balance in durable goods", July 1989.	89/42	Robert ANSON and Tawfik JELASSI	"A development framework for computer-supported conflict resolution", July 1989.
89/32	Peter HAUG and Tawfik JELASSI	"Application and evaluation of a multi-criteria decision support system for the dynamic selection of U.S. manufacturing locations", May 1989.	89/43	Michael BURDA	"A note on firing costs and severance benefits in equilibrium unemployment", June 1989.
89/33	Bernard SINCLAIR-DESGAGNÉ	"Design flexibility in monopsonistic industries", May 1989.	89/44	Balaji CHAKRAVARTHY and Peter LORANGE	"Strategic adaptation in multi-business firms", June 1989.
89/34	Sumantra GHOSHAL and Nittin NOHRIA	"Requisite variety versus shared values: managing corporate-division relationships in the M-Form organisation", May 1989.	89/45	Rob WEITZ and Arnoud DE MEYER	"Managing expert systems: a framework and case study", June 1989.
89/35	Jean DERMINE and Pierre HILLION	"Deposit rate ceilings and the market value of banks: The case of France 1971-1981", May 1989.	89/46	Marcel CORSTJENS, Carmen MATUTES and Damien NEVEN	"Entry Encouragement", July 1989.
			89/47	Manfred KETS DE VRIES and Christine MEAD	"The global dimension in leadership and organization: issues and controversies", April 1989.
			89/48	Damien NEVEN and Lars-Hendrik RÖLLER	"European integration and trade flows", August 1989.

89/49	Jean DERMINE	"Home country control and mutual recognition", July 1989.	89/62 (TM)	Arnoud DE MEYER	"Technology strategy and international R&D operations", October 1989.
89/50	Jean DERMINE	"The specialization of financial institutions, the EEC model", August 1989.	89/63 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Equivalence of simulations: A graph approach", November 1989.
89/51	Spyros MAKRIDAKIS	"Sliding simulation: a new approach to time series forecasting", July 1989.	89/64 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Complexity of simulation models: A graph theoretic approach", November 1989.
89/52	Arnoud DE MEYER	"Shortening development cycle times: a manufacturer's perspective", August 1989.	89/65 (TM, AC, FIN)	Soumitra DUTTA and Piero BONISSONE	"MARS: A mergers and acquisitions reasoning system", November 1989.
89/53	Spyros MAKRIDAKIS	"Why combining works?", July 1989.	89/66 (TM,EP)	B. SINCLAIR-DESGAGNÉ	"On the regulation of procurement bids", November 1989.
89/54	S. BALAKRISHNAN and Mitchell KOZA	"Organisation costs and a theory of joint ventures", September 1989.	89/67 (FIN)	Peter BOSSAERTS and Pierre HILLION	"Market microstructure effects of government intervention in the foreign exchange market", December 1989.
89/55	H. SCHUTTE	"Euro-Japanese cooperation in information technology", September 1989.			
89/56	Wilfried VANHONACKER and Lydia PRICE	"On the practical usefulness of meta-analysis results", September 1989.			
			<u>1990</u>		
89/57	TaeKwon KIM, Lara-Hendrik RÖLLER and Mihkel TOMBAK	"Market growth and the diffusion of multiproduct technologies", September 1989.	90/01 TM/EP/AC	B. SINCLAIR-DESGAGNÉ	"Unavoidable Mechanisms", January 1990.
89/58 (EP,TM)	Lara-Hendrik RÖLLER and Mihkel TOMBAK	"Strategic aspects of flexible production technologies", October 1989.	90/02 EP	Michael BURDA	"Monopolistic Competition, Costs of Adjustment, and the Behaviour of European Manufacturing Employment", January 1990.
89/59 (OB)	Manfred KETS DE VRIES, Daphna ZEVADI, Alain NOEL and Mihkel TOMBAK	"Locus of control and entrepreneurship: a three-country comparative study", October 1989.	90/03 TM	Arnoud DE MEYER	"Management of Communication in International Research and Development", January 1990.
89/60 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Simulation graphs for design and analysis of discrete event simulation models", October 1989.	90/04 FIN/EP	Gabriel HAWAWINI and Eric RAJENDRA	"The Transformation of the European Financial Services Industry: From Fragmentation to Integration", January 1990.
89/61 (All)	Susan SCHNEIDER and Arnoud DE MEYER	"Interpreting and responding to strategic issues: The impact of national culture", October 1989.	90/05 FIN/EP	Gabriel HAWAWINI and Bertrand JACQUILLAT	"European Equity Markets: Toward 1992 and Beyond", January 1990.

90/06 FIN/EP	Gabriel HAWAWINI and Eric RAJENDRA	"Integration of European Equity Markets: Implications of Structural Change for Key Market Participants to and Beyond 1992", January 1990.	90/17 FIN	Nathalie DIERKENS	"Information Asymmetry and Equity Issues", Revised January 1990.
90/07 FIN/EP	Gabriel HAWAWINI	"Stock Market Anomalies and the Pricing of Equity on the Tokyo Stock Exchange", January 1990.	90/18 MKT	Wilfried VANHONACKER	"Managerial Decision Rules and the Estimation of Dynamic Sales Response Models", Revised January 1990.
90/08 TM/EP	Tawfik JELASSI and B. SINCLAIR-DESGAGNÉ	"Modelling with MCDSS: What about Ethics?", January 1990.	90/19 TM	Beth JONES and Tawfik JELASSI	"The Effect of Computer Intervention and Task Structure on Bargaining Outcome", February 1990.
90/09 EP/FIN	Alberto GIOVANNINI and Jae WON PARK	"Capital Controls and International Trade Finance", January 1990.	90/20 TM	Tawfik JELASSI, Gregory KERSTEN and Stanley ZIONTS	"An Introduction to Group Decision and Negotiation Support", February 1990.
90/10 TM	Joyce BRYER and Tawfik JELASSI	"The Impact of Language Theories on DSS Dialog", January 1990.	90/21 FIN	Roy SMITH and Ingo WALTER	"Reconfiguration of the Global Securities Industry in the 1990's", February 1990.
90/11 TM	Enver YUCESAN	"An Overview of Frequency Domain Methodology for Simulation Sensitivity Analysis", January 1990.	90/22 FIN	Ingo WALTER	"European Financial Integration and Its Implications for the United States", February 1990.
90/12 EP	Michael BURDA	"Structural Change, Unemployment Benefits and High Unemployment: A U.S.-European Comparison", January 1990.	90/23 EP/SM	Damien NEVEN	"EEC Integration towards 1992: Some Distributional Aspects", Revised December 1989
90/13 TM	Soumitra DUTTA and Shashi SHEKHAR	"Approximate Reasoning about Temporal Constraints in Real Time Planning and Search", January 1990.	90/24 FIN/EP	Lars Tyge NIELSEN	"Positive Prices in CAPM", January 1990.
90/14 TM	Albert ANGEHRN and Hans-Jakob LÜTHI	"Visual Interactive Modelling and Intelligent DSS: Putting Theory Into Practice", January 1990.	90/25 FIN/EP	Lars Tyge NIELSEN	"Existence of Equilibrium in CAPM", January 1990.
90/15 TM	Arnoud DE MEYER, Dirk DESCHOOLMEESTER, Rudy MOENAERT and Jan BARBE	"The Internal Technological Renewal of a Business Unit with a Mature Technology", January 1990.	90/26 OB/BP	Charles KADUSHIN and Michael BRIMM	"Why networking Fails: Double Binds and the Limitations of Shadow Networks", February 1990.
90/16 FIN	Richard LEVICH and Ingo WALTER	"Tax-Driven Regulatory Drag: European Financial Centers in the 1990's", January 1990.	90/27 TM	Abbas FOROUGHI and Tawfik JELASSI	"NSS Solutions to Major Negotiation Stumbling Blocks", February 1990.
			90/28 TM	Arnoud DE MEYER	"The Manufacturing Contribution to Innovation", February 1990.

90/29 FIN/AC	Nathalie DIERKENS	"A Discussion of Correct Measures of Information Asymmetry", January 1990.	90/40 OB	Manfred KETS DE VRIES	"Leaders on the Couch: The case of Roberto Calvi", April 1990.
90/30 FIN/EP	Lars Tyge NIELSEN	"The Expected Utility of Portfolios of Assets", March 1990.	90/41 FIN/EP	Gabriel HAWAWINI, Itzhak SWARY and Ik HWAN JANG	"Capital Market Reaction to the Announcement of Interstate Banking Legislation", March 1990.
90/31 MKT/EP	David GAUTSCHI and Roger BETANCOURT	"What Determines U.S. Retail Margins?", February 1990.	90/42 MKT	Joel STECKEL and Wilfried VANHONACKER	"Cross-Validating Regression Models in Marketing Research", (Revised April 1990).
90/32 SM	Srinivasan BALAK- RISHNAN and Mitchell KOZA	"Information Asymmetry, Adverse Selection and Joint-Ventures: Theory and Evidence", Revised, January 1990.	90/43 FIN	Robert KORAJCZYK and Claude VIALLET	"Equity Risk Premia and the Pricing of Foreign Exchange Risk", May 1990.
90/33 OB	Caren SIEHL, David BOWEN and Christine PEARSON	"The Role of Rites of Integration in Service Delivery", March 1990.	90/44 OB	Gilles AMADO, Claude FAUCHEUX and André LAURENT	"Organisational Change and Cultural Realities: Franco-American Contrasts", April 1990.
90/34 FIN/EP	Jean DERMINE	"The Gains from European Banking Integration, a Call for a Pro-Active Competition Policy", April 1990.	90/45 TM	Soumitra DUTTA and Piero BONISSONE	"Integrating Case Based and Rule Based Reasoning: The Possibilistic Connection", May 1990.
90/35 EP	Jae Won PARK	"Changing Uncertainty and the Time-Varying Risk Premia in the Term Structure of Nominal Interest Rates", December 1988, Revised March 1990.	90/46 TM	Spyros MAKRIDAKIS and Michèle HIBON	"Exponential Smoothing: The Effect of Initial Values and Loss Functions on Post-Sample Forecasting Accuracy".
90/36 TM	Arnoud DE MEYER	"An Empirical Investigation of Manufacturing Strategies in European Industry", April 1990.	90/47 MKT	Lydia PRICE and Wilfried VANHONACKER	"Improper Sampling in Natural Experiments: Limitations on the Use of Meta-Analysis Results in Bayesian Updating", Revised May 1990.
90/37 TM/OB/SM	William CATS-BARIL	"Executive Information Systems: Developing an Approach to Open the Possibles", April 1990.	90/48 EP	Jae WON PARK	"The Information in the Term Structure of Interest Rates: Out-of-Sample Forecasting Performance", June 1990.
90/38 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", (Revised February 1990).	90/49 TM	Soumitra DUTTA	"Approximate Reasoning by Analogy to Answer Null Queries", June 1990.
90/39 TM	Louis LE BLANC and Tawfik JELASSI	"An Evaluation and Selection Methodology for Expert System Shells", May 1990.	90/50 EP	Daniel COHEN and Charles WYPLOSZ	"Price and Trade Effects of Exchange Rates Fluctuations and the Design of Policy Coordination", April 1990.

90/51 EP	Michael BURDA and Charles WYPLOSZ	"Gross Labour Market Flows in Europe: Some Stylized Facts", June 1990.	90/63 SM	Sumantra GHOSHAL and Eleanor WESTNEY	"Organising Competitor Analysis Systems", August 1990
90/52 FIN	Lars Tyge NIELSEN	"The Utility of Infinite Menus", June 1990.	90/64 SM	Sumantra GHOSHAL	"Internal Differentiation and Corporate Performance: Case of the Multinational Corporation", August 1990
90/53 EP	Michael Burda	"The Consequences of German Economic and Monetary Union", June 1990.	90/65 EP	Charles WYPLOSZ	"A Note on the Real Exchange Rate Effect of German Unification", August 1990
90/54 EP	Damien NEVEN and Colin MEYER	"European Financial Regulation: A Framework for Policy Analysis", (Revised May 1990).	90/66 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Computer Support for Strategic and Tactical Planning in Mergers and Acquisitions", September 1990
90/55 EP	Michael BURDA and Stefan GERLACH	"Intertemporal Prices and the US Trade Balance", (Revised July 1990).	90/67 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Integrating Prior Cases and Expert Knowledge In a Mergers and Acquisitions Reasoning System", September 1990
90/56 EP	Damien NEVEN and Lars-Hendrik RÖLLER	"The Structure and Determinants of East-West Trade: A Preliminary Analysis of the Manufacturing Sector", July 1990	90/68 TM/SE	Soumitra DUTTA	"A Framework and Methodology for Enhancing the Business Impact of Artificial Intelligence Applications", September 1990
90/57 FIN/EP/ TM	Lars Tyge NIELSEN	Common Knowledge of a Multivariate Aggregate Statistic", July 1990	90/69 TM	Soumitra DUTTA	"A Model for Temporal Reasoning in Medical Expert Systems", September 1990
90/58 FIN/EP/TM	Lars Tyge NIELSEN	"Common Knowledge of Price and Expected Cost in an Oligopolistic Market", August 1990	90/70 TM	Albert ANGEHRN	"Triple C': A Visual Interactive MCDSS", September 1990
90/59 FIN	Jean DERMINE and Lars-Hendrik RÖLLER	"Economies of Scale and Scope in the French Mutual Funds (SICAV) Industry", August 1990	90/71 MKT	Philip PARKER and Hubert GATIGNON	"Competitive Effects in Diffusion Models: An Empirical Analysis", September 1990
90/60 TM	Peri IZ and Tawfik JELASSI	"An Interactive Group Decision Aid for Multiobjective Problems: An Empirical Assessment", September 1990	90/72 TM	Enver YÜCESAN	"Analysis of Markov Chains Using Simulation Graph Models", October 1990
90/61 TM	Pankaj CHANDRA and Mihkel TOMBAK	"Models for the Evaluation of Manufacturing Flexibility", August 1990	90/73 TM	Arnoud DE MEYER and Kasra FERDOWS	"Removing the Barriers in Manufacturing", October 1990
90/62 EP	Damien NEVEN and Menno VAN DIJK	"Public Policy Towards TV Broadcasting in the Netherlands", August 1990	90/74 SM	Sumantra GHOSHAL and Nitin NOHRIA	"Requisite Complexity: Organising Headquarters- Subsidiary Relations in MNCs", October 1990

90/75 MKT	Roger BETANCOURT and David GAUTSCHI	"The Outputs of Retail Activities: Concepts, Measurement and Evidence", October 1990	90/87 FIN/EP	Lars Tyge NIELSEN	"Existence of Equilibrium in CAPM: Further Results", December 1990
90/76 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", Revised October 1990	90/88 OB/MKT	Susan C. SCHNEIDER and Reinhard ANGELMAR	"Cognition in Organisational Analysis: Who's Minding the Store?" Revised, December 1990
90/77 MKT	Wilfried VANHONACKER	"Testing the Koyck Scheme of Sales Response to Advertising: An Aggregation-Independent Autocorrelation Test", October 1990	90/89 OB	Manfred F.R. KETS DE VRIES	"The CEO Who Couldn't Talk Straight and Other Tales from the Board Room," December 1990
90/78 EP	Michael BURDA and Stefan GERLACH	"Exchange Rate Dynamics and Currency Unification: The Ostmark - DM Rate", October 1990	90/90 MKT	Philip PARKER	"Price Elasticity Dynamics over the Adoption Lifecycle: An Empirical Study," December 1990
90/79 TM	Anil GABA	"Inferences with an Unknown Noise Level in a Bernoulli Process", October 1990			
90/80 TM	Anil GABA and Robert WINKLER	"Using Survey Data in Inferences about Purchase Behaviour", October 1990			
90/81 TM	Tawfik JELASSI	"Du Présent au Futur: Bilan et Orientations des Systèmes Interactifs d'Aide à la Décision," October 1990			
90/82 EP	Charles WYPLOSZ	"Monetary Union and Fiscal Policy Discipline," November 1990			
90/83 FIN/TM	Nathalie DIERKENS and Bernard SINCLAIR-DESGAGNE	"Information Asymmetry and Corporate Communication: Results of a Pilot Study", November 1990			
90/84 MKT	Philip M. PARKER	"The Effect of Advertising on Price and Quality: The Optometric Industry Revisited," December 1990			
90/85 MKT	Avijit GHOSH and Vikas TIBREWALA	"Optimal Timing and Location in Competitive Markets," November 1990			
90/86 EP/TM	Olivier CADOT and Bernard SINCLAIR-DESGAGNE	"Prudence and Success in Politics," November 1990			