"THE NATURAL DRIFT (WHAT HAPPENED TO OPERATIONAL RESEARCH?)"*

by

Charles CORBETT*
and
Luk VAN WASSENHOVE**

N° 92/25/TM

* INSEAD, Boulevard de Constance, Fontainebleau 77305 Cedex, France.

** Professor of Operations Management and Operations Research, INSEAD, Boulevard de Constance, Fontainebleau 77305 Cedex, France.

Printed at INSEAD,
Fontainebleau, France

The Natural Drift

(What Happened to Operational Research?)

Charles Corbett

Ph.D. student, Production and Operations Management

Luk Van Wassenhove

Professor of Operations Management and Operations Research

INSEAD, Fontainebleau, France

April 26, 1992

Abstract

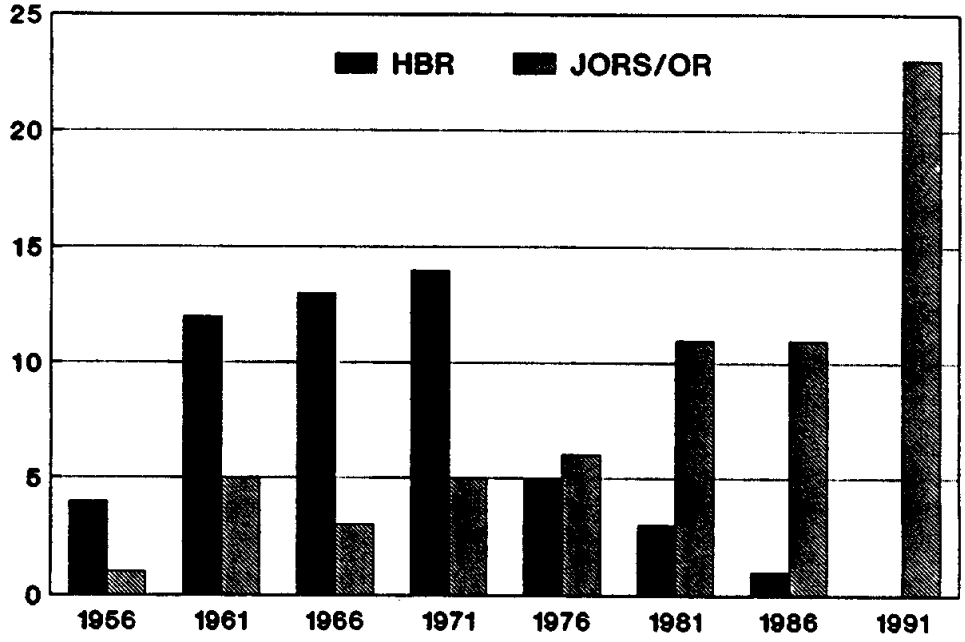
The aim of this paper is to provide a critical view on the growing number of writings about the "crisis" in the OR/MS community. In contrast to most writings found in the OR/MS literature, however, this paper also considers articles from the *Harvard Business Review*, in order to provide a managerial perspective. Six main issues appearing in the debate are distinguished: the scientific versus technological nature of OR/MS, customer relations with users of OR/MS, the learning effect of an OR/MS study, tactical versus strategic importance of OR/MS, tool versus problem-orientation in OR/MS, and the interdisciplinary character of OR/MS. We believe that the problems signalled are due to a phenomenon of "natural drift" between the scientific and the technological natures of OR/MS, as a result of which some fundamental aspects of OR remain underdeveloped. Finding better ways of managing the natural drift is needed to turn the so-called crisis into an opportunity.

1 Introduction

It is not everyone that is born during a World War, pronounced dead at age 30, only to go through a mid-life crisis and be subject of a post mortem 14 years after, still sets out a plan for the next decade the following year and even has his or her existence proved another 4 years later as if nothing had happened. The single fact that the discipline known as Operational Research/ Management Science has pulled off this remarkable feat (Ackoff (1979a), Lilien (1987), Ackoff (1987), CONDOR (1988), and White (1991) respectively) is in itself sufficient reason to take a closer look at some much-discussed aspects of its development until the present day.

Particularly (though by no means exclusively) in recent years, the Operational Research/Management Science (OR/MS) literature has shown a growing interest in the history of the field, but also a growing concern about its future. Much has been written about the future of OR/MS, claiming that future to be bright, expressing some worries or simply stating that the future is past and that OR/MS is dead. Dando & Bennett (1981) note that the dominant feeling in the British OR community evolved from very optimistic in 1963, through optimistic in 1968 and unsure in 1973, to gloomy in 1978. Given that so much is written about the "current crisis in OR/MS", it is reasonable to ask to what extent this debate is truly justified. Surprisingly, writings on the "OR/MS crisis" generally show little or no awareness of opinions expressed in management literature. In this paper, we frequently refer to articles from the *Harvard Business Review*, being the management journal most read by executives, in an attempt to step outside this largely inward-looking debate. Although the *Harvard Business Review* obviously cannot be representative of management attitudes in general, tracing its OR/MS articles provides some interesting insights. To begin with, as Figure 1 shows, the "crisis" debate in the OR/MS literature took off soon after a dramatic drop in attention paid by *HBR* to OR/MS. A more superficial look through all issues of the *Sloan Management Review* reveals a similar pattern. However, a glance at recent editions of the journal *Interfaces* suffices to demonstrate that this decline in attention in general management journals does not coincide with a lack of relevant and highly successful applications of OR/MS. A graph of sales of OR-based software may also show a very different picture than Figure 1. We do not explicitly discuss the huge impact of the advent of computers, decision support systems, etc., on the discipline of OR/MS; it is surprising, however, that the drop in managerial attention

has occurred despite the vastly enhanced implementation possibilities these developments offer.



For the *Harvard Business Review*, all articles largely devoted to methods or applications of OR/MS, considered in a broad sense, are included in the graph. For the *Journal of the Operational Research Society* and *Operations Research*, the graph includes all papers expressing concerns similar to those raised here and those explicitly referring to the "crisis". Only *JORS* and *OR* are included, as hardly any "philosophically" oriented papers have appeared in *Management Science* since the early 1970s, and the other major OR/MS journals were founded considerably later than the two considered here. Including these relatively new journals would inevitably reinforce the above pattern. Obviously, this graph should not be taken too literally, but the overall picture remains suggestive. Remark that, as discussed later, it was in 1973 and more viciously in 1979, that Ackoff pronounced OR/MS dead.

Figure 1: Publication trends

The aim of this paper is to identify the main issues in the OR/MS debate, also taking into consideration the views expressed in *HBR*. We try to explain, in a simple way, a natural underlying cause of the development of OR/MS and the surrounding debate. The key hypothesis is outlined in Section 2, while Section 3 is devoted to a systematic but necessarily far from complete discussion of the different viewpoints found with respect to the main issues distinguished. Section 4 contains an attempt to draw the threads of Section 3 together again and to formulate some conclusions.

2 The natural drift hypothesis

Definitions of operational research and of management science generally revolve (to a certain extent) around the concept of "applying a scientific approach to practical decision problems". For this reason, we consider here the position of OR/MS with respect to this "scientific approach" and these "practical problems". In general, the relation between science and practical problems can be depicted, in a highly simplified way, as follows:

real		applied	basic
world	engineering	sciences	disciplines

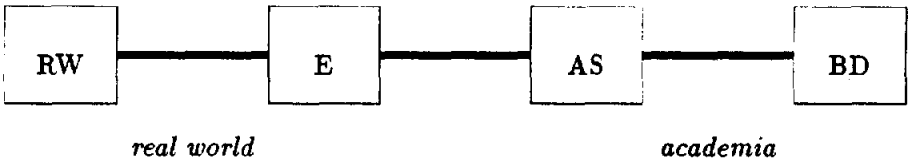
We briefly discuss each of these domains, and the links between them, in turn; obviously the following discussion is no more than a rough outline.

The basic disciplines (BD) include disciplines as chemistry, economics, mathematics, physics, psychology, sociology etc. The highly specialised scientists working in basic disciplines are strictly knowledge-oriented, and not so concerned with direct applicability of their work. Explanatory power but also aesthetics are important value criteria here. In applied sciences (AS), the objective is to develop theories that are potentially applicable, be it to real-world problems, to other applied sciences or to a basic discipline. The orientation is still predominantly towards knowledge, but relevance to someone somewhere is now also an explicit value criterion. The basic disciplines provide knowledge for the applied sciences to use, whereas the applied sciences signal to the basic disciplines which areas are in need of deeper research.

The real world (RW) occupies the other end of the spectrum: executives, politicians, or other citizens, often face a decision situation. (Note that their problem might not be well-defined, but simply a feeling of unease.) Occupants of the real world are oriented towards tackling specific, individual problems. To help them with complex problems, there are the "engineers" (E). The term should not be taken too literally here, but is meant to include both independent consultants and people working in staff departments. Their objective is to add value where no standard simple solution exists; although they are principally problem-oriented, this includes generic problems and not only specific instances. "Engineers" draw upon the knowledge and methods accumulated in

the applied sciences, and, in turn, indicate to applied scientists which areas still need developing. Ideally, "engineers" will have sufficient knowledge of (several) applied sciences to know which approach to use for any problem they encounter, combined with a thorough knowledge of that specific approach in order to be able to apply it. They should also have a deep understanding of the real world, i.e. of how problems are embedded in complex environments.

Natural causes, such as the separation of industry and academia, and the division of institutes into more or less narrowly specialised departments with imperfect internal communication, usually lead the above figure to appear more like



Rather than forming a continuum with free movement of people and ideas, different domains are separated from one another but remain somehow connected. The connections are partly institutional since, for instance, students formed in academic institutes end up working in industry. It is partly accidental since, for instance, some practitioner or consultant may turn to a friend in academia for help with a tough problem. Let us look at these connections as springs, holding the system together. This situation is not serious in itself, as long as the tension in the connecting springs keeps the system balanced. However, again for many natural and obvious reasons such as the difference in dominant orientation and the different types of people employed in both realms, the system can easily be pulled out of equilibrium. Of course, the limited interaction between industry and academia reinforces this natural drift. Another reason to call this drift a natural one relates to the maturity of the field. It is quite natural for a maturing field to deepen its roots by shifting towards basic disciplines (more and more OR groups can be found in computer science or pure math departments). On the other extreme of the spectrum early techniques like linear programming become public knowledge in that they are no longer the province of OR staff groups in industry, but simply another useful internal operational tool for many groups in the company (like calculus or regression analysis). It is clear that the above effects will make the tension in some connecting springs higher than in others, causing a natural drift toward the following situation:

To bring the discussion back to OR/MS, we limit the "real world" to managerial problems (in a very broad sense of the word), and consequently replace "engineers" and "applied scientists" by *"management engineers"* and *"management scientists"* respectively. Although these terms may nowadays have different connotations, Flood (1955), in his Presidential address for the Second National Meeting of The Institute of Management Sciences, would seem to be in agreement with the above outline. In his words (p. 179), "[...] we of TIMS need not be especially concerned with the grand effort at fostering basic science—our main effort should be to adapt existing scientific knowledge, *and the techniques of the scientist*, for the solution of problems of management", and (p. 183) "[...] the knowledge-oriented management scientists are sure to make many discoveries eventually of value to the problem-oriented management engineers and managers".

The main objectives of "management engineers" are to help managers understand the situation they are facing and/or to provide answers to specific questions, which are not solvable by standard means, by using an analytical approach. In general the aim is to eliminate unintended irrational decisions and actions and to give the eventual decision a more "scientific" character. Dawes (1988) provides an excellent discussion of how even highly trained professionals frequently and unintentionally make errors of judgement, exposing them to systematic exploitation by others who have succeeded in banishing such irrational judgements. This is not to say that there is no room left for intuition in management. On the contrary, one aim of "management engineering" is to increase managers' understanding and thereby sharpen their intuition, eliminating irrational elements.

A "management engineer" studies the situation from an analytical point of view. He attempts to relate what he sees in the real world to concepts and frameworks developed by management scientists. Together with the managers, he performs thought experiments; they combine observation and theory, and, in doing so, attempt to grasp what is going on around them.

Having outlined the natural drift model, we can formulate the natural drift hypothesis: *operational research, as born during World War II, was equivalent to "management engineering", but, as a result of the natural drift phenomenon, is undergoing an identity crisis; the ensuing polarisation is leaving the middle ground underdeveloped.*

Let us reiterate at this point that the "crisis" in the OR/MS community is not due to the amount of attention paid to the theoretical, mathematical side of the field, but rather to a relative shortage of fundamentally novel approaches and applications, such as should arise from the domain of "management engineering". Note, also, that it is not uncommon to consider the domain of "Operations Research" as extending further than we have done here, to include at least part of both "management engineering" and "management science". Because not all authors discussed here mean the same thing when using the expressions OR and MS, the terminology in this paper is inevitably somewhat confusing. Our aim here is definitely not to provide normative statements concerning the "true" meaning of the terms OR and MS, but simply to point out an area (the one we have labelled "management engineering") that in our view is not developing as rapidly as it should and, as such, is at the root of the current sense of crisis.

3 The debate

This Section contains a systematic discussion of a selection of writings in the OR/MS debate, comprising both early and recent articles in the OR/MS literature and articles from the *Harvard Business Review.* In order to distinguish opinions from the OR/MS literature from those found in *HBR*, most of the references in the text include a mention of the journal involved. We focus on six main issues of the debate. The fundamental issue is, in our view:

- whether OR is a knowledge-oriented science or a problem-oriented technology.

The five other issues distinguished are each derived from this basic issue. They are:

- customer relations with users of OR/MS;
- the learning effect of an OR/MS study;

- the relevance of OR/MS at a strategic level;
- tool-orientation versus problem-orientation in OR/MS;
- the interdisciplinary nature of OR/MS.

A separate section is devoted to each of these issues.

3.1 Science or technology?

The fundamental issue in the "crisis" debate in the OR/MS literature is that of orientation of the field; all other issues boil down to the question whether OR/MS should be primarily a knowledge-oriented science or a problem-oriented technology. In the previous Section we argued that both orientations are needed for survival and growth of OR and MS. For example, research into interior point methods for speeding up Linear Programming may sometimes be purely mathematical in nature, but is of great relevance for "management engineers" when suitably implemented into novel software, and therefore an important contribution to "management science". On the other hand, developing an enormous LP model for a particular refinery and then implementing the fastest available LP code is a typical case of "management engineering", and signals to "management science" that there is a need for extremely fast LP codes. It is our belief that the "crisis" is partly a result of workers of both types not acknowledging the necessity and the achievements of those of the other type, and therefore not letting developments at one end be a guideline for development efforts at the other. This lack of mutual appreciation is particularly serious for workers who stand with one foot on either side of the divide. Precisely these valuable people, who could help in bridging the gap, are often the ones who fall between the cracks.

The problem of the split identity of OR/MS was already noted by Herrmann & Magee (*HBR*, 1953; p. 111): "As an applied science, the work is torn between two objectives: as "applied" it strives for practical and useful work; as "science" it seeks increasing understanding of the basic operation, even when the usefulness of this information is not immediately clear." Flood (*MS*, 1955), quoted above, also clearly recognised this distinction. Symonds (*MS*, 1957; p. 126) writes: "Although operations research and management science are now closely related, they are quite different but complementary in their purposes. Operations research represents the problem-solving

objective; management science the development of general scientific knowledge. Nevertheless, much of our understanding of management science came through operations research, as well as industrial engineering and econometrics." Drucker (*HBR*, 1959) recognised the need for both a knowledge-orientation (p. 30): *"The first need of a management science is, then, that it respect itself sufficiently as a distinct and genuine discipline"*, but also a problem-orientation (p. 148): *"The second requirement for a management science is, then, that it takes its subject matter seriously."* The question whether this second requirement is adequately addressed in modern OR/MS lies at the heart of the debate. Lathrop (*OR*, 1959) does not view OR in itself as a science, and holds that OR workers should always be concerned with applications. King (*OR*, 1966) already expressed concern that this was not happening enough (p. 1177-1178): "Yet, it seems apparent that the long-range acceptance and development of the field intrinsically depends on the solution of problems in the real world and that in turn, such successes can be achieved in quantity only if we can develop and maintain a cadre of practitioners who are competent in mathematics *and* who display the creativity and ingenuity that is so important to the 'real world' aspects of problem solving." Beged-Dov (*MS*, 1966) agrees: "Although they seem to pay lip-service to applications, it is quite easy to establish that the majority of the operations researchers best known in the field are openly proud of their learned papers and almost apologetic when referring to applications." Fierce criticisms of the neglect of real-world aspects of OR are given by Woolsey (*OR*, 1972) and some well-known "OR is dead" papers by Ackoff (*OR*, 1973; *JORS*, 1979a,1979b). Morse (*OR*, 1977), one of the first Presidents of the Operations Research Society of America, signals a trend away from the real world (p. 188): "But if we stick to our original aim of matching our models to reality, rather than trying to make reality fit the preferred model, we can contribute in important ways to many of the serious problems facing this country and the world."

Daudo & Sharp (*JORS*, 1978) argue that OR was and should return to being a technology, drawing on a broad scientific basis; it is not a science in itself. Williams (1986) sees the relationship between OR and economics as being that between engineering and physics. Somewhat more extreme is Eilon (*OMEGA*, 1984; p. 106; also 1987): "Others will prefer to keep conventional OR as it is and to uphold the claim that it should emulate, as far as possible, the generally accepted norms of behaviour expected from scientists. The argument advanced in this paper is that such a stance is no longer adequate and that we should accept the proposed role of the change-agent, with

everything that it entails."

In the early 1980s, the British Operational Research Society established the "Commission on the Future Practice of OR" out of a "widespread apprehension of an impending, or even an actual, crisis confronting operational research" (Report of the Commission, *JORS*, 1986; p. 831). The entire 58-page report is, as the name already shows, practice-oriented; in fact (p. 842), "The main methodological drive, as inferred by the Commission, is pragmatism." The contrast with the US "Committee On the Next Decade in Operations Research" (CONDOR, *OR*, 1988) is striking, as the US Commission does not convey a sense of crisis, and is mainly concerned with the mathematical achievements up to date and promises for the future.

3.2 Customer relations

An issue strongly related to that of dominant orientation, but specifically relevant for applied OR/MS, is that of problems in customer relations. Here we look at three aspects of this issue:

- the frequently recurring theme of communication problems between OR analysts and managers;
- the need for better public relations (PR for OR) and the name of the discipline;
- the need for better understanding of customers' expectations of OR.

3.2.1 Communication between OR analysts and managers

The problems that OR workers encounter in communicating results of their studies to managers were recognized in the 1950s in the *Harvard Business Review*, but only recently seem to attract much attention in the OR/MS literature. Herrmann & Magee (*HBR*, 1953) already note that communication between OR workers and executives is the most serious problem with applied OR. It is interesting to note the change in opinion in *HBR* as to who is responsible for breaking the communication barrier. Roy (*HBR*, 1958) realises that (p. 122): "There is a vital need for a bridge between the two diverse frames of discourse represented by the prevailing loose terminology of the businessman and the precise language of the scientist", but states that both

business management and OR consultants should make an effort to overcome this gap. Bennion (*HBR*, 1961) gives reasons why (p. 100) "more businessmen than not are highly skeptical of, if not downright antagonistic toward" OR, but, in contrast to Roy, he believes that (p. 101) "to correct this regrettable state of affairs, I am prone to feel that the econometrician and the programer [sic], rather than the businessman, must accept responsibility for the first step." Jones (*HBR*, 1966) already finds that communication from the OR side is deteriorating; writing about OR articles for businessmen, he states (p. 180): "As a rough rule of thumb, the early articles tend to be better than later ones; the relationship between the business problem and the technique is frequently clearer in the former; and when they were written, there had been less time for a specialized jargon to develop."

That communication problems occur in both directions, is remarked by Boulden & Buffa (*HBR*, 1970; p. 66): "Unfortunately, the OR staff often did not understand the problem, nor could the manager clearly define it". Although the communication issue does not seem to have greatly bothered the OR/MS community until relatively recently, it certainly does now. Smith & Culhan (*INT*, 1986) discuss the priorities indicated by teachers, researchers and practitioners of OR/MS (p. 32): "[...] more than 50% of the 20 priority issues dealt with communications." In Section 2 the problem of communication between different disciplines was mentioned; Blumstein (*OR*, 1987) observes that, here too, things could be better (p. 98): "in order to perform our missionary function well, we need a continually expanding repertoire of tools. And the users of these methods and techniques need to have a greater influence on development efforts."

3.2.2 The image of OR/MS

The image of OR/MS in the outside world is not what it could be. Compare the striking difference in tone between the following two quotes from *HBR* articles, 22 years apart. Baumol & Sevin (*HBR*, 1957) begin their article by writing (p. 52) "It is difficult to exaggerate the opportunities for reduced marketing costs and increased marketing efficiency, and hence greater profits, which are offered to management by the combined techniques of distribution cost analysis and mathematical programing [sic]." Bishop (*HBR*, 1979), on the other hand, is less euphoric (p. 154): "The modus operandi of the operations researcher is to abstract from some real-world problem a mathematical

problem for which he can find an answer. He then touts that answer as a guidepost to the manager." The ongoing debate shows that the OR/MS community is aware of this problem.

One result has been to call the name of the field into question. Recall that Flood (*MS*, 1955) already used the term "management engineers", at a time when there was no particular reason not to use the term "operations researchers". The very first paragraph of Wagner's (1975) well-known textbook discusses why the name operations research is ambiguous and unfortunate. Lilien's (*INT*, 1987) "mid-life crisis" paper observes that (p. 36) "the term *operations research* has developed a somewhat negative connotation in the late '60s and early '70s. According to the panel, the term *management science* is seen by many managers as a contradiction in terms; managers know that much of what they do is messy, ill-structured, based on poor or biased data, and in need of almost instant resolution." As a possible remedy, he mentions a suggestion by G. Hoffman to use the term "management engineering" for the discipline of MS/OR. The Report of the UK Commission also recognises the problem (p. 854): "An extreme but widely held view—conceivably as many as half OR practitioners hold it—is that the phrase 'operational research' is now understood by clients in so narrow a way, and in a way so unrelated to the actuality of OR in practice, that some new name should be found." The reason for not actually recommending a change of name is that the Commission could not agree upon a suitable replacement. And Weingartner (*OR*, 1987; p. 259): "The view is growing in acceptance; the name of the field, and the name of the society that champions it, ought to be changed." It is not without reason that, in this paper, we make as much use as possible of the term "management engineering", although it is of course not without drawbacks.

Rinnooy Kan (*EJOR*, 1989) sees better visibility of the discipline ("PR for OR", p. 283) as the solution to the image problem. A powerful argument in favour of applying OR/MS is the continuous narrowing of profit margins due to fierce global competition. Reducing manufacturing costs by 1%, or increasing delivery reliability by 1%, can make all the difference. One particular strength of OR/MS studies is the ability to expose unnecessary costs and to streamline operations, and even if the change is only marginal percentage-wise, it can prove a highly lucrative or even essential investment. A sense of urgency, such as an attempt to survive, is noted by Telgen (1988) as a necessary condition for OR to be appropriate.

3.2.3 What does the customer *really* want?

Despite the repeated appeal in the OR/MS literature for more attention to applications, little fundamental knowledge on the process of an OR study is available. Case studies found in literature rarely describe the actual development of the project. A very basic question is how an OR study can be made to meet the customer's wishes. In the next Section we see that OR studies can provide anything between clear answers to specific questions and an increase in the customer's understanding of his/her situation. Naturally, the entire organisation of the project should hinge on whether the customer expects to receive a "black box" computer program with some efficient problem-solving algorithms, or whether he/she expects to gain more insight into his/her operations.

A useful concept, in Fortuin, van Beek & Van Wassenhove (1989), is the "OR cycle", describing the phases a typical OR study would go through: from realisation that there is a problem to problem description, model building and data gathering, selection of a solution method, validation, and, finally, implementation. However, they remark that the OR study may have solved the wrong problem (recall Boulden & Buffa's (*HBR*, 1970) remarks about OR teams not understanding the problem), and that the problem may have changed during the study, so that the implemented solution must be contrasted with the current problem, and, if necessary, the cycle must be passed through again.

The customer must not only obtain the desired benefits from the OR study, i.e. it must meet his quality requirements; it must also do so within the specified budget and time limit. As time-based competition is becoming increasingly important in business, OR studies should attempt to keep up with this trend and produce the desired results faster. This is obviously incompatible with repeated time-consuming iterations through the OR cycle, so the two types of errors distinguished above must be avoided, by speeding up the OR process and by improving the problem definition stage. Whereas the danger of the problem having changed is reduced by the speeding up, the danger of solving the wrong problem remains. Errors of this sort will normally occur during the steps involving problem description and model building, and can be avoided through more frequent and better communication with the customer; Brown (*HBR*, 1970) too recognises the danger in the "arms'-length approach" (p. 86) which he considers characteristic of much OR.

Thinking about OR/MS in marketing terms may be helpful. Market segmentation is needed to distinguish between different types of customers (large vs. small firms, private vs. government, strategic vs. operational etc.) in order to optimally cater for their wishes. Jackson & Keys (*JORS*, 1984) discuss how different types of OR are suitable for different types of situations. Key questions are how OR/MS can provide a value-added service to the customer, and how OR/MS should evolve to gain and hold onto competitive advantage over other concepts managers could invest their scarce time and money in.

3.3 Learning from OR

Many *HBR* articles consider the learning effect of an OR study to be more important than the actual results. The Report of the UK Commission contains some highly interesting observations (*JORS*, 1986; p. 841-842):

"34. The Commission found significant amounts of O.R. in practice with one or more of the following aims:

- to help structure 'messes' or messy problems;
- to research into the facts of an uncertain topic;
- to help an understanding of a sphere of activity;
- [...]

35. It is noteworthy that the above list does not include, directly at least, optimizing operations or obtaining cost savings. While improving efficiency in some general sense is no doubt a driving force behind much O.R. in practice, it is achieved indirectly. Almost all practitioners with whom the Commission spoke think that the main benefits of O.R. stem from enhancing the client's understanding of his own problems. Practitioners commonly see their role as helping their client do his job better, not doing it for him."

This fact does not seem to have received much attention in the OR/MS literature, and little has been written about how this learning process works. Therefore, we believe that fundamental research is urgently needed into how and what executives can learn from OR studies.

Preparing for future decisions is seen by Salveson (*HBR*, 1957) as the main use of OR. Baumol & Sevin (*HBR*, 1957; p. 58): "While a linear program usually will not compute a correct optimum because the changes it suggests will go too far, there is yet a very strong presumption that it will correctly indicate the best directions of change." An article probing deeper into the interaction between OR and management is Roy (*HBR*, 1958), who writes (p. 120): "In short, and oversimplified, the OR method means getting behind the "art of doing business" and probing into what makes up that important but elusive thing called "business judgment." "

More explicit is Bennion (*HBR*, 1961), who considers the most valuable aspects of models to be (p. 100) "(1) The capacity of the models to improve management's *understanding* of highly complex problems, which can scarcely fail to enhance the quality of the necessary value judgments management makes. (2) The undeniable fact that the most valuable use of such models usually lies less in turning out the answer in an uncertain world than in shedding light on how much difference an alteration in the assumptions and/or variables used would make in the answer yielded by the models." Hayes (*HBR*, 1969) elaborates on this, and considers this the advantage of OR over other kinds of tools (p. 108): "I believe that the greatest impact of the quantitative approach will *not* be in the area of problem *solving*, although it will have growing usefulness there. Its greatest impact will be on problem *formulation: the way managers think about their problems* [...] In this sense, the results that "quantitative people" have produced are beginning to contribute in a really significant way to the *art* of management."

According to Brown (*HBR*, 1970), the main benefits of decision theory analysis are not the numerical results, but the fact that it clarifies the relevant issues, makes implicit assumptions explicit, and provides a framework for communication. Boulden & Buffa (*HBR*, 1970) conclude that (p. 83) "Decision making is facilitated because the manager interacts with the model, not because decision-making logic is built into the model itself." In Jones's (*HBR*, 1970) words (p. 78): "In business decision making, "getting there is more than half the fun." Thus many discussions of attempts to apply new mathematical methods to solving business problems end up with the conclusion that the real benefit was not the specific answer but the increased awareness of organizational problems and opportunities. This was achieved through the discipline of formulating the problem in a new vocabulary and structure." Geoffrion (*HBR*, 1976) too defends the use of OR by arguing that computer models can deepen managers' insights.

Ackoff (*JORS*, 1979b; p. 189) recognises this fact: "*the principal benefit of planning comes from engaging in it*". He suggests using the concept of "idealised design", giving managers a direction to follow, even if the target itself may be unreachable. (Compare this with Baumol & Sevin's (*HBR*, 1957) views on Linear Programming).

Reading these comments, it is hard to escape the feeling that the OR/MS community has failed to adequately recognise how it could be of greatest value to managers, and it seems high time to develop in detail the implications of these remarks for applied OR. One approach attempting to fill this need is the systems approach, as described by e.g. Checkland (1981). He sees traditional OR/MS, or "hard systems thinking", as a special case of "soft systems thinking"; in the latter, the emphasis is on accepting different existing views of reality (or "Weltanschauung") in order to increase understanding of the behaviour of the system concerned. Clearly, the preciseness or "hardness" of the methodology to be employed in any situation is limited by the preciseness of the problem definition; in many cases, a combination of "soft" and "hard" approaches may be necessary to achieve the best results. Jackson (*JORS*, 1987) argues that accepting such different approaches, not necessarily "hard", as essential parts of management science, is essential for the discipline to survive in the long run.

3.4 OR/MS at the strategic level

It has been demonstrated beyond question that OR/MS can be highly useful in supporting tactical decisions; whether or not OR/MS can be applied in strategic situations is subject to debate. This issue is obviously strongly related to that of learning from OR: if an OR project is not capable of enabling executives to better understand their situation, it has little chance of having an impact at the strategic level. Furthermore, a field that is not at ease with itself, that has problems communicating with executives, that is reputed to be predominantly mathematical in nature and tool-oriented, will generally not be considered a useful aid in strategic situations. Many well-known examples, dating back to World War II, show the incorrectness of such a view of OR.

Salveson (*HBR*, 1957) even states that OR is primarily suitable for strategic decisions (p. 93): "Operations research has little, if any, role in making current operating decisions or actions. One

sufficient reason is that, in the event of a current decision, there simply is not time for OR to help." A similar viewpoint comes from Platt & Maines (*HBR*, 1959; p. 120). Hayes & Nolan (*HBR*, 1970), however, take a different view; they believe that, while OR had proved useful in operating situations, trying to extend these smaller models to large corporate models led to "disaster by addition" (p. 105).

Ackoff (*JORS*, 1979a) claims that, for reasons we discuss in the next Section, OR has been dispersed to lower levels within organisations. Weingartner (*OR*, 1987) is concerned that to have any impact on the higher levels within organisations, "We must certainly avoid coming across as members of a priesthood, as practitioners of occult arts" (p. 258). Rinnooy Kan (*EJOR*, 1989) also expresses his worries that OR ought to concentrate on achieving more strategic success (p. 283): "For instance, what will happen if tactical, short term planning procedures have been automated and organizations scrutinize their long term planning problems? Will our profession have anything of substance to offer them beyond what is available today?" Kirkwood (*OR*, 1990) feels strongly about the importance of performing strategic projects (p. 750): "[...] we should encourage those who are applying OR approaches to strategic problems. If the OR community does not recognize and support this work, then the practitioners doing the work will migrate to other communities. This will mean lost opportunities for OR professionals to work on interesting issues, and less visibility for operations research with corporate and government top management."

Naturally, the emphasis found in *HBR* on the learning effect of OR indicates that those authors believed that OR is a valuable support in strategic decision-making; after all, for "simple", operational decisions, insight and understanding are less relevant. As an aside, one might feel that if the discipline intends to play a larger role in strategic decisions, the name "operational research" is not so fortunate.

3.5 The rule of the tool, or managing messes?

Originally, OR was entirely oriented towards real-world problems, but then at that time there simply were no "OR tools". In the early days, there was a rush to develop the much-needed tools, and that this development has been extremely successful cannot be disputed, as is demonstrated

by the wealth of techniques OR workers currently have at their disposal. However, many of the contributers to the OR/MS debate seem to think that the focus has shifted too far towards "Analysis in Wonderland", and away from the real world; the discipline would have neglected Drucker's (*HBR*, 1959) second requirement, that OR/MS take its subject matter seriously.

Wagner (*OR*, 1971) indeed warns that there may be too much emphasis on techniques in OR, and too little on the problems they are supposed to solve. Ackoff (*OR*, 1973) emphasizes the distinction between mathematical models and managers' messes, and argues that the tools used in OR/MS are out-of-date, and no longer capable of dealing with the "messes" faced by managers. Note that Ackoff uses the term "problem" to denote a well-defined, abstracted version of a messy real-world situation. In his words (p. 670-671): "[...] accounts are given about how messes were murdered by reducing them to problems, how problems were murdered by reducing them to models, and how models were murdered by excessive exposure to the elements of mathematics." Morse's (*OR*, 1977) warning against trying to fit reality to the models has been quoted above, as has Bishop's (*HBR*, 1979) rather cynical view of the "modus operandi of the operations researcher".

A well-known and outspoken article in the OR/MS debate is Ackoff's (*JORS*, 1979a) "The Future of Operational Research is Past". Ackoff holds academic OR and the relevant professional societies primarily responsible for what he perceives as the decline of the discipline; they brought about that (p. 94) "[...] OR came to be identified with the use of mathematical models and algorithms rather than the ability to formulate management problems, solve them, and implement and maintain their solutions in turbulent environments." In other words (p. 95), "In the first two decades of OR, its nature was dictated by the nature of the problematic situations it faced. Now the nature of the situations it faces is dictated by the techniques it has at its command." He adds (p. 95): "What this dispersion signifies is that OR has been equated by managers to mathematical masturbation and to the absence of any substantive knowledge or understanding of organizations, institutions or their management." Managers have lost interest in OR, because (p. 100) "[T]he unit in OR is a problem, not a mess. Managers do not solve problems; they manage messes." Eilon (*OMEGA*, 1984) holds a similar viewpoint, and the Report of the UK Commission (*JORS*, 1986) also points in the same direction. Daniel (*EJOR*, 1987; p. 271) concludes that "the adaptive OR group itself has proved to be the most enduring and useful 'tool' of all."

In his "OR, a Post Mortem", Ackoff (*OR*, 1987) pushes his discussion of tool versus problem orientation further. To these two categories, which he calls input and output orientation respectively, he adds the category of market orientation, meaning that a discipline is defined in terms of the class of users addressed, rather than the tools used (inputs) or the problems that can be solved (outputs). He then claims that OR was originally a market-oriented profession, but became output-oriented during the early 1960s, and is nowadays even input-oriented. P. 474: "The field's introversion drove it into a catatonic state in which it died mercifully, but it has yet to be buried." Although Ackoff's views are not uncontroversial, he does seem to describe a natural drift-type phenomenon and the potential fatal outcome.

A much more tool-oriented impression is given by the USA Commission (*OR*, CONDOR, 1988), whose report focusses on past and future development of tools, and by Hansen (*EJOR*, 1989), who argues that there is no crisis in OR, pointing to the undisputably successful development of many new techniques as evidence.

Many of the criticisms claim that OR/MS tends to abstract too much from real-world problems, in order to allow more analytical sophistry. The general (though not universal) warning against letting tools become the dominant orientation in OR/MS (the rule of the tool) seems justified, as this requires that potential customers are familiar with the OR/MS toolbox in order to decide whether or not to commission an OR study. This way, OR/MS teams will only receive projects for which they already have the tools, thereby limiting growth opportunities for OR/MS in both theoretical and practical directions.

Of course, the importance of tools should not be underestimated either: the profession would never have got very far without them, nor will it get much further without continuous development of new tools. Weingartner (*OR*, 1987) signals that researchers will no longer consider individual problems as being independent of each other, but attempt to develop solutions that can be used more than once. This development of general tools is necessary; designers, for example, also use general tools to create a unique design. Theoretically relatively under-researched areas are problem description and model building, as Zimmermann (1985) states: "The contents and scope of operations research has been described and defined in many different ways. Most of the people working in operations research will agree, however, that the modelling of problem situations and

the search for optimal solutions to these models are undoubtedly important parts of it. The latter activity is more algorithmic, mathematical, or formal in character. The former comprises many more disciplines than mathematics, has been more neglected than mathematical research in operations research and, therefore, would probably need more new advances in theory and practice."

An important, but not often recognised, aspect of OR/MS tools, is noted by Blumstein (*OR*, 1987; p. 98): "We must recognize, however, that our patents on the tools we like to think of as our own have largely expired." It is true that tools as Linear Programming, PERT charts, simulation, etc., have been developed by the OR/MS community, but, due to their own success, have now become public property. These tools are now used by many people who are not trained as OR/MS workers, and straightforward application of such tools is no longer the exclusive property of OR/MS. Development of fundamentally new tools and new ways of applying existing tools is a necessary condition to prevent OR/MS from eventually being sold out. This coincides with Telgen's (1988) view of OR; he also notes that OR tools are increasingly being used as black boxes, e.g. while Linear Programming methods are included in spreadsheet packages, most users have no idea of the underlying algorithm.

3.6 The interdisciplinary character of OR/MS

When OR emerged during World War II, there were obviously no specially trained "OR workers"; the field was inherently interdisciplinary, uniting scientists from diverse disciplines. Recalling our earlier definition of "management engineering", it is clear that very few individuals can hope to meet all those requirements; interdisciplinary teams are therefore a prerequisite. Being at the heart of OR/MS, the question of interdisciplinarity has received much attention in the debate. A mathematical approach, whether this means using mathematical (but not necessarily sophisticated) techniques or simply an analytical style, is an essential characteristic of OR/MS, but it is precisely the dominance of mathematics over other disciplines that has attracted much criticism. It is by no means the case that every single individual in the OR/MS community should be interdisciplinary, only the OR/MS community as a whole. (Note the plural ending in The Institute of Management Sciences.) From the following, it becomes clear that in particular the behavioural

sciences are deemed to have been neglected by the OR/MS community.

Beged-Dov (*MS*, 1966) expresses his concern (p. B-586): "Perhaps the single greatest obstacle to the establishment of OR as a powerful discipline noted for actual accomplishments is the fact that an ever increasing number of narrow specialists in mathematics and natural sciences impart to our profession undesirable dogmas and outlooks", while Morse (*OR*, 1977) also observes a (p. 187) "narrowing in outlook of many operations research workers". Dando & Sharp (*JORS*, 1977) are worried about the (p. 943) "present difficulties OR workers have with problems involving major Social or Behavioural features". Van Beek (1978) explicitly calls for more attention for behavioural sciences, as Ackoff (*JORS*, 1979a) implicitly also does. The importance of interdisciplinarity is underlined by the UK Commission (*JORS*, 1986; p. 844): "The Commission observed that much successful OR appears to be done in teams drawn from across an organization, seeded with one or more OR practitioners, who will play a key but not necessarily overtly central role in the structuring of the decision-forming process as the work progresses." And Pierskalla (*OR*, 1987; p. 155): "If OR/MS is to grow, it must deal analytically and realistically with human behavior." It must "reach out to new areas of knowledge and to new approaches, and integrate them into our field." For Telgen (1988), multidisciplinarity is one of the 4 essential characteristics of OR. Thornton (1989) illustrates its interdisciplinary nature in discussing some opportunities for OR in the 1990s: environmental issues, global strategies, human resource management, and, particularly, "improving organizational responsiveness so that short-term opportunities can be capitalized upon quickly in a rapidly-changing world" (p. 2).

Not only should OR/MS learn from and integrate other disciplines; Blumstein (*OR*, 1987) believes that if OR/MS workers become closely involved in and introduce the OR/MS paradigm to newly developing and not yet fully mathematised fields, such as organisation theory, production, and finance, they may bring about a paradigm shift in those fields. White (*OR*, 1991), in his "existence theorem" paper, claims that (p. 188) "[...] OR/MS should become a component of any liberal education curriculum", or, "[...] OR/MS must be configured as a service discipline". He sees OR/MS taking the same place as (relatively) mature disciplines as mathematics, economics, etc.

4 Conclusions

This paper was largely motivated by the observation that OR/MS is not attracting managers' attention the way it used to, as reflected by, among others, the shift away from OR/MS in the *Harvard Business Review*. Although competition for managers' attention is fierce, a permanent stronghold there is essential for long-term survival of OR/MS as a practically relevant discipline (who else will pay?). We believe that the discipline can and should fight harder, and hope that this paper has identified some of the main areas towards which our efforts should be directed. Having illustrated the natural drift phenomenon above by systematically discussing various viewpoints on OR/MS, we can draw several conclusions.

First, one could perhaps think of the sense of crisis as if it were caused by OR/MS "reaching the next stage in the product life-cycle", gradually changing from a highly innovative approach to a more mature management tool. In doing so, its members are finding the boundaries of the field, inevitably leading to some disillusionment. However, this does not constitute failure, but is a consequence of success. Analogously, one might ask whether alchemists, despite having laid part of the basis of chemistry, failed just because they never managed to produce gold?

Second, any individual in the OR/MS world is at liberty to choose where in the six-dimensional space defined by the six main issues distinguished above to position him/herself, but the field as a whole must take care not to stray from an acceptable balance of orientations. The area of "management engineering" seems relatively underpopulated, both in terms of people and in terms of theory. Not all current practical OR work would be considered as "worthy of OR" by the rest of the community. Theoretical work in OR seems to have shifted towards "management science", leaving the middle ground of "management engineering" underdeveloped. The existence of different paradigms within the OR/MS world should be recognised by the professional societies, and each paradigm should be catered for and its development stimulated. While a separation of paradigms into distinct fields (with their own societies) is potentially harmful, mutual acceptance is a must. The impression imposes itself that, in Great Britain, the Operational Research Society is closer to "management engineering" than the Operations Research Society of America, which lies further towards the basic disciplines. The desirability of a shift towards the British model is currently being debated within the Dutch OR Society.

Third, education. We have not treated this as a separate point here, but much has been written about the role of education in the current "crisis". Education in OR is in general a largely academic affair, and therefore perhaps not perfectly balanced with respect to the main issues discussed. A key problem is that it is not always clear whether students are being trained to be researchers in "management science" or practitioners in the real world; the type of education needed in both cases is too different to be combined in one curriculum.

Fourth, some areas in need of research can be identified, all typical fundamental aspects of "management engineering". The need to better understand the process by which managers can learn from an OR study has been mentioned above. It is equally important to know more about customers' expectations of OR studies and how these can best be met. Empirical research investigating factors influencing success of OR projects, such as Tilanus (*EJOR*, 1985), can be valuable, but is not very widespread. The importance of research into the art of modelling has been noted by Mitchell (1973) and Zimmermann (1985). In short, the foundations need to be laid to arrive at a "methodology of management engineering".

Finally, the formulation of the natural drift hypothesis implies that a similar phenomenon can occur in all branches of science. A natural question is then to ask whether they are all undergoing a crisis. It would be interesting to know how they are coping with their "natural drifts", and who is responsible for their success or failure to do so. In the case of OR/MS, managers have no incentive, time or money to tackle the problem, and experience suggests that the academic community is not ideally placed to do so either. Maybe we should be looking for an "Operational Research Competitiveness Action" (ORCA), in the form of an international cooperation between academia, industry, the professional societies, and governments, who together can provide the people, the problems, the publicity and the funding needed.

To conclude, we repeat that natural forces operate to cause the natural drift described in Section 2. Where these forces have left OR/MS has been outlined in Section 3, from which it is impossible to emerge feeling that all is well. However, nearly all the problems mentioned can be avoided if ways are found to manage the natural drift; by clarifying, accepting, and exploiting the differences in orientation that exist and hopefully always will exist within the OR/MS community. The future of OR/MS is neither bright nor past, it is simply ours to shape.

References

Ackoff, R.L., "Science in the Systems Age: Beyond IE, OR, and MS", *Operations Research*, May-June 1973, pp. 661-671

Ackoff, R.L., "The Future of Operational Research is Past", *Journal of the Operational Research Society*, Vol. 30, No. 2, 1979a, pp. 93-104

Ackoff, R.L., "Resurrecting the Future of Operational Research", *Journal of the Operational Research Society*, Vol. 30, No. 3, 1979b, pp. 189-199

Ackoff, R.L., "OR, a Post Mortem" (President's Symposium), *Operations Research*, Vol. 35, No. 3, May-June 1987, pp. 471-474

Baumol, W.J. & C.H. Sevin, "Marketing Costs and Mathematical Programming", *Harvard Business Review*, September-October 1957, pp. 52-60

Beged-Dov, A.G., "Why Only Few Operations Researchers Manage", *Management Science*, Vol. 12, No. 12, August 1966, pp. B580-B591

Bennion, E.G., "Econometrics for Management", *Harvard Business Review*, March-April 1961, pp. 100-112

Bishop, J.E., "Integrating critical elements of production planning", *Harvard Business Review*, September-October 1979, pp. 154-160

Blumstein, A., "The current missionary role of OR/MS" (President's Symposium), *Operations Research*, Vol. 35, No. 6, November-December 1987, pp. 926-929

Boulden, J.B. & E.S. Buffa, "Corporate models: on-line, real-time systems", *Harvard Business Review*, July-August 1970, pp. 65-83

Brown, R.V., "Do managers find decision theory useful?", *Harvard Business Review*, May-June 1970, pp. 78-89

Checkland, P.B., *Systems Thinking, Systems Practice*, John Wiley, 1981

Commission on the Future Practice of Operational Research, Report of the, *Journal of the Operational Research Society*, Vol. 37, No. 9, 1986, pp. 829-886

CONDOR, "Operations Research: The Next Decade", *Operations Research*, Vol. 36, No. 4, July-August 1988, pp. 619-637

Dando, M.R. & P.G. Bennett, "A Kuhnian crisis in management science?", *Journal of the Operational Research Society*, Vol. 32, No. 2, 1981, pp. 91-104

Dando, M.R. & R.G. Sharp, "Operational Research in the U.K. in 1977: The Causes and Consequences of a Myth?", *Journal of the Operational Research Society*, Vol. 29, No. 10, 1978, pp. 939-949

Daniel, D.W., "Half a century of operational research in the RAF", *European Journal of Operational Research*, No. 31, 1987, pp. 271-275

Dawes, R.M., *Rational Choice in an Uncertain World*, Harcourt Brace Javanovich, 1988

Drucker, P.F., in "Thinking Ahead", *Harvard Business Review*, January-February 1959, pp. 25-152

Eilon, S., "Types of OR workers" (editorial), *OMEGA*, Vol. 12, No. 2, 1984, pp. 99-107

Eilon, S., "OR Is Not Mathematics" (editorial), *OMEGA*, Vol. 15, No. 2, 1987, pp. 87-92

Flood, M.M., "The Objectives of TIMS", *Management Science*, Vol. 2, No. 2, 1955, pp. 178-184

Fortuin, L., P. van Beek & L. Van Wassenhove, "Operationele Research kan meer voor u doen dan u denkt!", *Het Ingenieursblad*, No. 4, 1989, pp. 51-62

Geoffrion, A.M., "Better Distribution Planning With Computer Models", *Harvard Business Review*, July-August 1976, pp. 92-99

Hansen, P., "A short discussion of the OR crisis", *European Journal of Operational Research*, No. 38, 1989, pp. 277-281

Hayes, R.H., "Qualitative insights from quantitative methods", *Harvard Business Review*, July-August 1969, pp. 108-119

Hayes, R.H. & R.L. Nolan, "What kind of corporate modeling functions best?", *Harvard Business Review*, May-June 1974, pp. 102-111

Herrmann, C.C. & J.F. Magee, " "Operations Research" for Management", *Harvard Business Review*, July-August 1953, pp. 100-112

Jackson, M.C., & P. Keys, "Towards a System of Systems Methodologies", *Journal of Operational Research*, Vol. 35, No. 6, 1984, pp. 473-486

Jackson, M.C., "Present Positions and Future Prospects in Management Science", *OMEGA*, Vol. 15, No. 6, 1987, pp. 455-466

Jones, C.H., "Applied Math for the Production Manager", *Harvard Business Review*, September October 1966, pp. 20-182

Jones, C.H., "At last: real computer power for decision makers", *Harvard Business Review*, September-October 1970, pp. 75-89

King, W.R., "On the Nature and Form of Operations Research", *Operations Research*, Vol. 15, No. 6, November-December 1967, pp. 1177-1180

Kirkwood, C.W., "Does Operations Research address strategy?", *Operations Research*, Vol. 38, No. 5, September-October 1990, pp. 747-751

Lathrop, J.B., "Operations Research Looks to Science", *Operations Research*, Vol. 7, No. 4, July-August 1959, pp. 423-429

Lilien, G.L., "MS/OR: A Mid-Life Crisis", *Interfaces*, Vol. 17, No. 2, March-April 1987, pp. 35-38

Mitchell, G.H., "The State of Research in OR", *Operational Research Quarterly*, Vol. 24, No. 1, March 1973, pp. 3-8

Morse, P.M., "ORSA Twenty-Five Years Later", *Operations Research*, Vol. 25, No. 2, March-April 1977, pp. 186-188

Pierskalla, W.P., "Creating growth in OR/MS" (President's Symposium), *Operations Research*, Vol. 35, No. 1, January-February 1987, pp. 153-156

Platt, W.J. & N.R. Maines, "Pretest Your Long-Range Plans", *Harvard Business Review*, January-February 1959, pp. 119-127

Rinnooy Kan, A.H.G., "The future of Operations Research is bright", *European Journal of Operational Research*, No. 38, 1989, pp. 282-285

Roy, H.J.H., "Operations Research in Action", *Harvard Business Review*, September-October 1958, pp. 120-128

Salveson, M.E., "High-Speed Operations Research", *Harvard Business Review*, July-August 1957, pp. 89-97

Smith, R.D. & R.H. Culhan, "MS/OR Academic and Practitioner Interactions: A Promising New Approach", *Interfaces*, Vol. 16, No. 5, September-October 1986, pp. 27-33

Symonds, G.H., "The Institute of Management Sciences: Progress Report", *Management Science*, Vol. 3, No. 2, January 1957, pp. 117-130

Telgen, J., "Verzin een list!", Inaugural Lecture, University of Twente (NL), 1988

Thornton, P., "Business in the 1990s: Emerging opportunities for the OR practitioner" (editorial), OR Insight, Vol. 2, No. 3, July-September 1989, pp. 1-2

Tilanus, C.B., "Failures and successes of quantitative methods in management", *European Journal of Operational Research*, Vol. 19, 1985, pp. 170-175

Van Beek, P., "Operationele Research: begin van het einde of ...einde van het begin?", Inaugural Lecture, Agricultural Unviersity of Wageningen (NL), 1978

Wagner, H.M., "The ABC's of OR", *Operations Research*, Vol. 19, No. 6, October 1971, pp. 1259-1281

Wagner, H.M., *Principles of Operations Research*, Prentice-Hall, 1975

Weingartner, H.M., "The Changing Character of Management Science", *OMEGA*, Vol. 15, No. 3, 1987, pp. 257-262

White, J.A., "An existence theorem for OR/MS", *Operations Research*, Vol. 36, No. 2, March-April 1991, pp. 183-193

Williams, H.P., "Optimization is Best", Inaugural Lecture, University of Southampton (GB), 1986

Woolsey, R.E.D., "Operations Research and Management Science Today, or, Does an Education in Checkers Really Prepare One for a Life of Chess?" (Letter to the Editor), *Operations Research*, Vol. 20, No. 3, May-June 1972, pp. 729-737

Zimmermann, H.-J., *Fuzzy Set Theory - and Its Applications*, Kluwer Academic Publishers Group, Dordrecht, 1985

INSEAD WORKING PAPERS SERIES

1988

88/01	Michael LAWRENCE and Spyros MAKRIDAKIS	**"Factors affecting judgemental forecasts and confidence intervals"**, January 1988.
88/02	Spyros MAKRIDAKIS	**"Predicting recessions and other turning points"**, January 1988.
88/03	James TEBOUL	**"De-industrialize service for quality"**, January 1988.
88/04	Susan SCHNEIDER	**"National vs. corporate culture: implications for human resource management"**, January 1988.
88/05	Charles WYPLOSZ	**"The swinging dollar: is Europe out of step?"**, January 1988.
88/06	Reinhard ANGELMAR	**"Les conflits dans les canaux de distribution"**, January 1988.
88/07	Ingemar DIERICKX and Karel COOL	**"Competitive advantage: a resource based perspective"**, January 1988.
88/08	Reinhard ANGELMAR and Susan SCHNEIDER	**"Issues in the study of organizational cognition"**, February 1988.
88/09	Bernard SINCLAIR-DESGAGNÉ	**"Price formation and product design through bidding"**, February 1988.
88/10	Bernard SINCLAIR-DESGAGNÉ	**"The robustness of some standard auction game forms"**, February 1988.
88/11	Bernard SINCLAIR-DESGAGNÉ	**"When stationary strategies are equilibrium bidding strategy: The single-crossing property"**, February 1988.
88/12	Spyros MAKRIDAKIS	**"Business firms and managers in the 21st century"**, February 1988
88/13	Manfred KETS DE VRIES	**"Alexithymia in organizational life: the organization man revisited"**, February 1988.
88/14	Alain NOEL	**"The interpretation of strategies: a study of the impact of CEOs on the corporation"**, March 1988.
88/15	Anil DEOLALIKAR and Lars-Hendrik RÖLLER	**"The production of and returns from industrial innovation: an econometric analysis for a developing country"**, December 1987.
88/16	Gabriel HAWAWINI	**"Market efficiency and equity pricing: international evidence and implications for global investing"**, March 1988.
88/17	Michael BURDA	**"Monopolistic competition, costs of adjustment and the behavior of European employment"**, September 1987.
88/18	Michael BURDA	**"Reflections on "Wait Unemployment" in Europe"**, November 1987, revised February 1988.
88/19	M.J. LAWRENCE and Spyros MAKRIDAKIS	**"Individual bias in judgements of confidence"**, March 1988.
88/20	Jean DERMINE, Damien NEVEN and J.F. THISSE	**"Portfolio selection by mutual funds, an equilibrium model"**, March 1988.
88/21	James TEBOUL	**"De-industrialize service for quality"**, March 1988 (88/03 Revised).
88/22	Lars-Hendrik RÖLLER	**"Proper Quadratic Functions with an Application to AT&T"**, May 1987 (Revised March 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.
88/24	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.
88/25	Everette S. GARDNER and Spyros MAKRIDAKIS	"The future of forecasting", April 1988.
88/26	Sjur Didrik FLAM and Georges ZACCOUR	"Semi-competitive Cournot equilibrium in multistage oligopolies", April 1988.
88/27	Murugappa KRISHNAN Lars-Hendrik RÖLLER	"Entry game with resalable capacity", April 1988.
88/28	Sumantra GHOSHAL and C. A. BARTLETT	"The multinational corporation as a network: perspectives from interorganizational theory", May 1988.
88/29	Naresh K. MALHOTRA, Christian PINSON and Arun K. JAIN	"Consumer cognitive complexity and the dimensionality of multidimensional scaling configurations", May 1988.
88/30	Catherine C. ECKEL and Theo VERMAELEN	"The financial fallout from Chernobyl: risk perceptions and regulatory response", May 1988.
88/31	Sumantra GHOSHAL and Christopher BARTLETT	"Creation, adoption, and diffusion of innovations by subsidiaries of multinational corporations", June 1988.
88/32	Kasra FERDOWS and David SACKRIDER	"International manufacturing: positioning plants for success", June 1988.
88/33	Mihkel M. TOMBAK	"The importance of flexibility in manufacturing", June 1988.
88/34	Mihkel M. TOMBAK	"Flexibility: an important dimension in manufacturing", June 1988.
88/35	Mihkel M. TOMBAK	"A strategic analysis of investment in flexible manufacturing systems", July 1988.
88/36	Vikas TIBREWALA and Bruce BUCHANAN	"A Predictive Test of the NBD Model that Controls for Non-stationarity", June 1988.
88/37	Murugappa KRISHNAN Lars-Hendrik RÖLLER	"Regulating Price-Liability Competition To Improve Welfare", July 1988.
88/38	Manfred KETS DE VRIES	"The Motivating Role of Envy : A Forgotten Factor in Management", April 88.
88/39	Manfred KETS DE VRIES	"The Leader as Mirror : Clinical Reflections", July 1988.
88/40	Josef LAKONISHOK and Theo VERMAELEN	"Anomalous price behavior around repurchase tender offers", August 1988.
88/41	Charles WYPLOSZ	"Assymetry in the EMS: intentional or systemic?", August 1988.
88/42	Paul EVANS	"Organizational development in the transnational enterprise", June 1988.
88/43	B. SINCLAIR-DESGAGNÉ	"Group decision support systems implement Bayesian rationality", September 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	
88/48	Michael BURDA	"Reflections on 'Wait unemployment' in Europe, II", April 1988 revised September 1988.
88/49	Nathalie DIERKENS	"Information asymmetry and equity issues", September 1988.
88/50	Rob WEITZ and Arnoud DE MEYER	"Managing expert systems: from inception through updating", October 1987.
88/51	Rob WEITZ	"Technology, work, and the organization: the impact of expert systems", July 1988.
88/52	Susan SCHNEIDER and Reinhard ANGELMAR	"Cognition and organizational analysis: who's minding the store?", September 1988.
88/53	Manfred KETS DE VRIES	"Whatever happened to the philosopher-king: the leader's addiction to power, September 1988.
88/54	Lars-Hendrik RÖLLER and Mihkel M. TOMBAK	"Strategic choice of flexible production technologies and welfare implications", October 1988
88/55	Peter BOSSAERTS and Pierre HILLION	"Method of moments tests of contingent claims asset pricing models", October 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.
88/57	Wilfried VANHONACKER and Lydia PRICE	"Data transferability: estimating the response effect of future events based on historical analogy", October 1988.
88/58	B. SINCLAIR-DESGAGNÉ and Mihkel M. TOMBAK	"Assessing economic inequality", November 1988.
88/59	Martin KILDUFF	"The interpersonal structure of decision making: a social comparison approach to organizational choice", November 1988.
88/60	Michael BURDA	"Is mismatch really the problem? Some estimates of the Chelwood Gate II model with US data", September 1988.
88/61	Lars-Hendrik RÖLLER	"Modelling cost structure: the Bell System revisited", November 1988.
88/62	Cynthia VAN HULLE, Theo VERMAELEN and Paul DE WOUTERS	"Regulation, taxes and the market for corporate control in Belgium", September 1988.
88/63	Fernando NASCIMENTO and Wilfried R. VANHONACKER	"Strategic pricing of differentiated consumer durables in a dynamic duopoly: a numerical analysis", October 1988.
88/64	Kasra FERDOWS	"Charting strategic roles for international factories", December 1988.
88/65	Arnoud DE MEYER and Kasra FERDOWS	"Quality up, technology down", October 1988
88/66	Nathalie DIERKENS	"A discussion of exact measures of information assymetry: the example of Myers and Majluf model or the importance of the asset structure of the firm", December 1988.
88/67	Paul S. ADLER and Kasra FERDOWS	"The chief technology officer", December 1988.

<u>1989</u>

89/01	Joyce K. BYRER and Tawfik JELASSI	"The impact of language theories on DSS dialog", January 1989.
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.
89/04	Kasra FERDOWS and Arnoud DE MEYER	**"Lasting improvement in manufacturing performance: In search of a new theory"**, January 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.
89/06	Mihkel M. TOMBAK and B. SINCLAIR-DESGAGNÉ	**"Coordinating manufacturing and business strategies: I"**, February 1989.
89/07	Damien J. NEVEN	**"Structural adjustment in European retail banking. Some view from industrial organisation"**, January 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.
89/09	Damien NEVEN, Carmen MATUTES and Marcel CORSTJENS	**"Brand proliferation and entry deterrence"**, February 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.
89/11	Manfred KETS DE VRIES and Alain NOEL	**"Understanding the leader-strategy interface: application of the strategic relationship interview method"**, February 1989.
89/12	Wilfried VANHONACKER	**"Estimating dynamic response models when the data are subject to different temporal aggregation"**, January 1989.
89/13	Manfred KETS DE VRIES	**"The impostor syndrome: a disquieting phenomenon in organizational life"**, February 1989.
89/14	Reinhard ANGELMAR	**"Product innovation: a tool for competitive advantage"**, March 1989.
89/15	Reinhard ANGELMAR	**"Evaluating a firm's product innovation performance"**, March 1989.
89/16	Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN	**"Combining related and sparse data in linear regression models"**, February 1989.
89/17	Gilles AMADO, Claude FAUCHEUX and André LAURENT	**"Changement organisationnel et réalités culturelles: contrastes franco-américains"**, March 1989.
89/18	Srinivasan BALAK-RISHNAN and Mitchell KOZA	**"Information asymmetry, market failure and joint-ventures: theory and evidence"**, March 1989.
89/19	Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN	**"Combining related and sparse data in linear regression models"**, Revised March 1989.
89/20	Wilfried VANHONACKER and Russell WINER	**"A rational random behavior model of choice"**, Revised March 1989.
89/21	Arnoud de MEYER and Kasra FERDOWS	**"Influence of manufacturing improvement programmes on performance"**, April 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.
89/26	Charles BEAN, Edmond MALINVAUD, Peter BERNHOLZ, Francesco GIAVAZZI and Charles WYPLOSZ	"Macroeconomic policies for 1992: the transition and after", April 1989.
89/27	David KRACKHARDT and Martin KILDUFF	"Friendship patterns and cultural attributions: the control of organizational diversity", April 1989.
89/28	Martin KILDUFF	"The interpersonal structure of decision making: a social comparison approach to organizational choice", Revised April 1989.
89/29	Robert GOGEL and Jean-Claude LARRECHE	"The battlefield for 1992: product strength and geographic coverage", May 1989.
89/30	Lars-Hendrik ROLLER and Mihkel M. TOMBAK	"Competition and Investment in Flexible Technologies", May 1989.
89/31	Michael C. BURDA and Stefan GERLACH	"Intertemporal prices and the US trade balance in durable goods", 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.
89/33	Bernard SINCLAIR-DESGAGNÉ	"Design flexibility in monopsonistic industries", May 1989.
89/34	Sumantra GHOSHAL and Nittin NOHRIA	"Requisite variety versus shared values: managing corporate-division relationships in the M-Form organisation", May 1989.
89/35	Jean DERMINE and Pierre HILLION	"Deposit rate ceilings and the market value of banks: The case of France 1971-1981", May 1989.
89/36	Martin KILDUFF	"A dispositional approach to social networks: the case of organizational choice", May 1989.
89/37	Manfred KETS DE VRIES	"The organisational fool: balancing a leader's hubris", May 1989.
89/38	Manfred KETS DE VRIES	"The CEO blues", June 1989.
89/39	Robert KORAJCZYK and Claude VIALLET	"An empirical investigation of international asset pricing", (Revised June 1989).
89/40	Balaji CHAKRAVARTHY	"Management systems for innovation and productivity", June 1989.
89/41	B. SINCLAIR-DESGAGNE and Nathalie DIERKENS	"The strategic supply of precisions", June 1989.
89/42	Robert ANSON and Tawfik JELASSI	"A development framework for computer-supported conflict resolution", July 1989.
89/43	Michael BURDA	"A note on firing costs and severance benefits in equilibrium unemployment", June 1989.
89/44	Balaji CHAKRAVARTHY and Peter LORANGE	"Strategic adaptation in multi-business firms", June 1989.
89/45	Rob WEITZ and Arnoud DE MEYER	"Managing expert systems: a framework and case study", June 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.
89/50	Jean DERMINE	"The specialization of financial institutions, the EEC model", August 1989.
89/51	Spyros MAKRIDAKIS	"Sliding simulation: a new approach to time series forecasting", July 1989.
89/52	Arnoud DE MEYER	"Shortening development cycle times: a manufacturer's perspective", August 1989.
89/53	Spyros MAKRIDAKIS	"Why combining works?", July 1989.
89/54	S. BALAKRISHNAN and Mitchell KOZA	"Organisation costs and a theory of joint ventures", September 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.
89/57	Taekwon KIM, Lars-Hendrik RÖLLER and Mihkel TOMBAK	"Market growth and the diffusion of multiproduct technologies", September 1989.
89/58 (EP,TM)	Lars-Hendrik RÖLLER and Mihkel TOMBAK	"Strategic aspects of flexible production technologies", October 1989.
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.
89/60 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Simulation graphs for design and analysis of discrete event simulation models", October 1989.
89/61 (All)	Susan SCHNEIDER and Arnoud DE MEYER	"Interpreting and responding to strategic issues: The impact of national culture", October 1989.
89/62 (TM)	Arnoud DE MEYER	"Technology strategy and international R&D operations", October 1989.
89/63 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Equivalence of simulations: A graph approach", November 1989.
89/64 (TM)	Enver YUCESAN and Lee SCHRUBEN	"Complexity of simulation models: A graph theoretic approach", November 1989.
89/65 (TM, AC, FIN)	Soumitra DUTTA and Piero BONISSONE	"MARS: A mergers and acquisitions reasoning system", November 1989.
89/66 (TM,EP)	B. SINCLAIR-DESGAGNÉ	"On the regulation of procurement bids", November 1989.
89/67 (FIN)	Peter BOSSAERTS and Pierre HILLION	"Market microstructure effects of government intervention in the foreign exchange market", December 1989.

<u>1990</u>

90/01 TM/EP/AC	B. SINCLAIR-DESGAGNÉ	"Unavoidable Mechanisms", January 1990.
90/02 EP	Michael BURDA	"Monopolistic Competition, Costs of Adjustment, and the Behaviour of European Manufacturing Employment", January 1990.
90/03 TM	Arnoud DE MEYER	"Management of Communication in International Research and Development", January 1990.
90/04 FIN/EP	Gabriel HAWAWINI and Eric RAJENDRA	"The Transformation of the European Financial Services Industry: From Fragmentation to Integration", January 1990.
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.
90/07 FIN/EP	Gabriel HAWAWINI	**"Stock Market Anomalies and the Pricing of Equity on the Tokyo Stock Exchange"**, January 1990.
90/08 TM/EP	Tawfik JELASSI and B. SINCLAIR-DESGAGNÉ	**"Modelling with MCDSS: What about Ethics?"**, January 1990.
90/09 EP/FIN	Alberto GIOVANNINI and Jae WON PARK	**"Capital Controls and International Trade Finance"**, January 1990.
90/10 TM	Joyce BRYER and Tawfik JELASSI	**"The Impact of Language Theories on DSS Dialog"**, January 1990.
90/11 TM	Enver YUCESAN	**"An Overview of Frequency Domain Methodology for Simulation Sensitivity Analysis"**, January 1990.
90/12 EP	Michael BURDA	**"Structural Change, Unemployment Benefits and High Unemployment: A U.S.-European Comparison"**, January 1990.
90/13 TM	Soumitra DUTTA and Shashi SHEKHAR	**"Approximate Reasoning about Temporal Constraints in Real Time Planning and Search"**, January 1990.
90/14 TM	Albert ANGEHRN and Hans-Jakob LÜTHI	**"Visual Interactive Modelling and Intelligent DSS: Putting Theory Into Practice"**, 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.
90/16 FIN	Richard LEVICH and Ingo WALTER	**"Tax-Driven Regulatory Drag: European Financial Centers in the 1990's"**, January 1990.
90/17 FIN	Nathalie DIERKENS	**"Information Asymmetry and Equity Issues"**, Revised January 1990.
90/18 MKT	Wilfried VANHONACKER	**"Managerial Decision Rules and the Estimation of Dynamic Sales Response Models"**, Revised January 1990.
90/19 TM	Beth JONES and Tawfik JELASSI	**"The Effect of Computer Intervention and Task Structure on Bargaining Outcome"**, February 1990.
90/20 TM	Tawfik JELASSI, Gregory KERSTEN and Stanley ZIONTS	**"An Introduction to Group Decision and Negotiation Support"**, February 1990.
90/21 FIN	Roy SMITH and Ingo WALTER	**"Reconfiguration of the Global Securities Industry in the 1990's"**, February 1990.
90/22 FIN	Ingo WALTER	**"European Financial Integration and Its Implications for the United States"**, February 1990.
90/23 EP/SM	Damien NEVEN	**"EEC Integration towards 1992: Some Distributional Aspects"**, Revised December 1989
90/24 FIN/EP	Lars Tyge NIELSEN	**"Positive Prices in CAPM"**, January 1990.
90/25 FIN/EP	Lars Tyge NIELSEN	**"Existence of Equilibrium in CAPM"**, January 1990.
90/26 OB/BP	Charles KADUSHIN and Michael BRIMM	**"Why networking Fails: Double Binds and the Limitations of Shadow Networks"**, February 1990.
90/27 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.
90/30 FIN/EP	Lars Tyge NIELSEN	"The Expected Utility of Portfolios of Assets", March 1990.
90/31 MKT/EP	David GAUTSCHI and Roger BETANCOURT	"What Determines U.S. Retail Margins?", February 1990.
90/32 SM	Srinivasan BALAK-RISHNAN and Mitchell KOZA	"Information Asymmetry, Adverse Selection and Joint-Ventures: Theory and Evidence", Revised, January 1990.
90/33 OB	Caren SIEHL, David BOWEN and Christine PEARSON	"The Role of Rites of Integration in Service Delivery", March 1990.
90/34 FIN/EP	Jean DERMINE	"The Gains from European Banking Integration, a Call for a Pro-Active Competition Policy", April 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.
90/36 TM	Arnoud DE MEYER	"An Empirical Investigation of Manufacturing Strategies in European Industry", April 1990.
90/37 TM/OB/SM	William CATS-BARIL	"Executive Information Systems: Developing an Approach to Open the Possibles", April 1990.
90/38 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", (Revised February 1990).
90/39 TM	Louis LE BLANC and Tawfik JELASSI	"An Evaluation and Selection Methodology for Expert System Shells", May 1990.
90/40 OB	Manfred KETS DE VRIES	"Leaders on the Couch: The case of Roberto Calvi", April 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.
90/42 MKT	Joel STECKEL and Wilfried VANHONACKER	"Cross-Validating Regression Models in Marketing Research", (Revised April 1990).
90/43 FIN	Robert KORAJCZYK and Claude VIALLET	"Equity Risk Premia and the Pricing of Foreign Exchange Risk", May 1990.
90/44 OB	Gilles AMADO, Claude FAUCHEUX and André LAURENT	"Organisational Change and Cultural Realities: Franco-American Contrasts", April 1990.
90/45 TM	Soumitra DUTTA and Piero BONISSONE	"Integrating Case Based and Rule Based Reasoning: The Possibilistic Connection", May 1990.
90/46 TM	Spyros MAKRIDAKIS and Michèle HIBON	"Exponential Smoothing: The Effect of Initial Values and Loss Functions on Post-Sample Forecasting Accuracy".
90/47 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.
90/48 EP	Jae WON PARK	"The Information in the Term Structure of Interest Rates: Out-of-Sample Forecasting Performance", June 1990.
90/49 TM	Soumitra DUTTA	"Approximate Reasoning by Analogy to Answer Null Queries", June 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.
90/52 FIN	Lars Tyge NIELSEN	"The Utility of Infinite Menus", June 1990.
90/53 EP	Michael Burda	"The Consequences of German Economic and Monetary Union", June 1990.
90/54 EP	Damien NEVEN and Colin MEYER	"European Financial Regulation: A Framework for Policy Analysis", (Revised May 1990).
90/55 EP	Michael BURDA and Stefan GERLACH	"Intertemporal Prices and the US Trade Balance", (Revised July 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
90/57 FIN/EP/ TM	Lars Tyge NIELSEN	Common Knowledge of a Multivariate Aggregate Statistic", July 1990
90/58 FIN/EP/TM	Lars Tyge NIELSEN	"Common Knowledge of Price and Expected Cost in an Oligopolistic Market", August 1990
90/59 FIN	Jean DERMINE and Lars-Hendrik RÖLLER	"Economies of Scale and Scope in the French Mutual Funds (SICAV) Industry", August 1990
90/60 TM	Peri IZ and Tawfik JELASSI	"An Interactive Group Decision Aid for Multiobjective Problems: An Empirical Assessment", September 1990
90/61 TM	Pankaj CHANDRA and Mihkel TOMBAK	"Models for the Evlauation of Manufacturing Flexibility", August 1990
90/62 EP	Damien NEVEN and Menno VAN DIJK	"Public Policy Towards TV Broadcasting in the Netherlands", August 1990
90/63 SM	Sumantra GHOSHAL and Eleanor WESTNEY	"Organising Competitor Analysis Systems", August 1990
90/64 SM	Sumantra GHOSHAL	"Internal Differentiation and Corporate Performance: Case of the Multinational Corporation", August 1990
90/65 EP	Charles WYPLOSZ	"A Note on the Real Exchange Rate Effect of German Unification", August 1990
90/66 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Computer Support for Strategic and Tactical Planning in Mergers and Acquisitions", September 1990
90/67 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Integrating Prior Cases and Expert Knowledge In a Mergers and Acquisitions Reasoning System", September 1990
90/68 TM/SE	Soumitra DUTTA	"A Framework and Methodology for Enhancing the Business Impact of Artificial Intelligence Applications", September 1990
90/69 TM	Soumitra DUTTA	"A Model for Temporal Reasoning in Medical Expert Systems", September 1990
90/70 TM	Albert ANGEHRN	"'Triple C': A Visual Interactive MCDSS", September 1990
90/71 MKT	Philip PARKER and Hubert GATIGNON	"Competitive Effects in Diffusion Models: An Empirical Analysis", September 1990
90/72 TM	Enver YÜCESAN	"Analysis of Markov Chains Using Simulation Graph Models", October 1990
90/73 TM	Arnoud DE MEYER and Kasra FERDOWS	"Removing the Barriers in Manufacturing", October 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
90/76 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", Revised October 1990
90/77 MKT	Wilfried VANHONACKER	"Testing the Koyck Scheme of Sales Response to Advertising: An Aggregation-Independent Autocorrelation Test", October 1990
90/78 EP	Michael BURDA and Stefan GERLACH	"Exchange Rate Dynamics and Currency Unification: The Ostmark - DM Rate", October 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
90/87 FIN/EP	Lars Tyge NIELSEN	"Existence of Equilibrium in CAPM: Further Results", December 1990
90/88 OB/MKT	Susan C. SCHNEIDER and Reinhard ANGELMAR	"Cognition in Organisational Analysis: Who's Minding the Store?" Revised, December 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
90/90 MKT	Philip PARKER	"Price Elasticity Dynamics over the Adoption Lifecycle: An Empirical Study," December 1990

<u>1991</u>

91/01 TM/SM	Luk VAN WASSENHOVE, Leonard FORTUIN and Paul VAN BEEK	"Operational Research Can Do More for Managers Than They Think!," January 1991
91/02 TM/SM	Luk VAN WASSENHOVE, Leonard FORTUIN and Paul VAN BEEK	"Operational Research and Environment," January 1991
91/03 FIN	Pekka HIETALA and Timo LÖYTTYNIEMI	"An Implicit Dividend Increase in Rights Issues: Theory and Evidence," January 1991
91/04 FIN	Lars Tyge NIELSEN	"Two-Fund Separation, Factor Structure and Robustness," January 1991
91/05 OB	Susan SCHNEIDER	"Managing Boundaries in Organisations," January 1991
91/06 OB	Manfred KETS DE VRIES, Danny MILLER and Alain NOEL	"Understanding the Leader-Strategy Interface: Application of the Strategic Relationship Interview Method," January 1990 (89/11, revised April 1990)

91/07 EP	Olivier CADOT	"Lending to Insolvent Countries: A Paradoxical Story," January 1991
91/08 EP	Charles WYPLOSZ	"Post-Reform East and West: Capital Accumulation and the Labour Mobility Constraint," January 1991
91/09 TM	Spyros MAKRIDAKIS	"What can we Learn from Failure?", February 1991
91/10 TM	Luc Van WASSENHOVE and C. N. POTTS	"Integrating Scheduling with Batching and Lot-Sizing: A Review of Algorithms and Complexity", February 1991
91/11 TM	Luc VAN WASSENHOVE et al.	"Multi-Item Lotsizing in Capacitated Multi-Stage Serial Systems", February 1991
91/12 TM	Albert ANGEHRN	"Interpretative Computer Intelligence: A Link between Users, Models and Methods in DSS", February 1991
91/13 EP	Michael BURDA	"Labor and Product Markets in Czechoslovakia and the Ex-GDR: A Twin Study", February 1991
91/14 MKT	Roger BETANCOURT and David GAUTSCHI	"The Output of Retail Activities: French Evidence", February 1991
91/15 OB	Manfred F.R. KETS DE VRIES	"Exploding the Myth about Rational Organisations and Executives", March 1991
91/16 TM	Arnoud DE MEYER and Kasra FERDOWS et.al.	"Factories of the Future: Executive Summary of the 1990 International Manufacturing Futures Survey", March 1991
91/17 TM	Dirk CATTRYSSE, Roelof KUIK, Marc SALOMON and Luk VAN WASSENHOVE	"Heuristics for the Discrete Lotsizing and Scheduling Problem with Setup Times", March 1991
91/18 TM	C.N. POTTS and Luk VAN WASSENHOVE	"Approximation Algorithms for Scheduling a Single Machine to Minimize Total Late Work", March 1991
91/19 MKT	Vikas TIBREWALA and Bruce BUCHANAN	"An Aggregate Test of Purchase Regularity", March 1991
91/20 MKT	Darius SABAVALA and Vikas TIBREWALA	"Monitoring Short-Run Changes in Purchasing Behaviour", March 1991
91/21 SM	Sumantra GHOSHAL, Harry KORINE and Gabriel SZULANSKI	"Interunit Communication within MNCs: The Influence of Formal Structure Versus Integrative Processes", April 1991
91/22 EP	David GOOD, Lars-Hendrik RÖLLER and Robin SICKLES	"EC Integration and the Structure of the Franco-American Airline Industries: Implications for Efficiency and Welfare", April 1991
91/23 TM	Spyros MAKRIDAKIS and Michèle HIBON	"Exponential Smoothing: The Effect of Initial Values and Loss Functions on Post-Sample Forecasting Accuracy", April 1991 (Revision of 90/46)
91/24 TM	Louis LE BLANC and Tawfik JELASSI	"An Empirical Assessment of Choice Models for Software Evaluation and Selection", May 1991
91/25 SM/TM	Luk N. VAN WASSENHOVE and Charles J. CORBETT	"Trade-Offs? What Trade-Offs?" April 1991
91/26 TM	Luk N. VAN WASSENHOVE and C.N. POTTS	"Single Machine Scheduling to Minimize Total Late Work", April 1991
91/27 FIN	Nathalie DIERKENS	"A Discussion of Correct Measures of Information Asymmetry: The Example of Myers and Majluf's Model or the Importance of the Asset Structure of the Firm", May 1991
91/28 MKT	Philip M. PARKER	"A Note on: 'Advertising and the Price and Quality of Optometric Services', June 1991
91/29 TM	Tawfik JELASSI and Abbas FOROUGHI	"An Empirical Study of an Interactive, Session-Oriented Computerised Negotiation Support System (NSS)", June 1991

91/30 MKT	Wilfried R. VANHONACKER and Lydia J. PRICE	"Using Meta-Analysis Results in Bayesian Updating: The Empty Cell Problem", June 1991
91/31 FIN	Rezaul KABIR and Theo VERMAELEN	"Insider Trading Restrictions and the Stock Market", June 1991
91/32 OB	Susan C. SCHNEIDER	"Organisational Sensemaking: 1992", June 1991
91/33 EP	Michael C. BURDA and Michael FUNKE	"German Trade Unions after Unification - Third Degree Wage Discriminating Monopolists?", June 1991
91/34 FIN	Jean DERMINE	"The BIS Proposal for the Measurement of Interest Rate Risk, Some Pitfalls", June 1991
91/35 FIN	Jean DERMINE	"The Regulation of Financial Services in the EC, Centralization or National Autonomy?" June 1991
91/36 TM	Albert ANGEHRN	"Supporting Multicriteria Decision Making: New Perspectives and New Systems", August 1991
91/37 EP	Ingo WALTER and Hugh THOMAS	"The Introduction of Universal Banking in Canada: An Event Study", August 1991
91/38 EP	Ingo WALTER and Anthony SAUNDERS	"National and Global Competitiveness of New York City as a Financial Center", August 1991
91/39 EP	Ingo WALTER and Anthony SAUNDERS	"Reconfiguration of Banking and Capital Markets in Eastern Europe", August 1991
91/40 TM	Luk VAN WASSENHOVE, Dirk CATTRYSSE and Marc SALOMON	"A Set Partitioning Heuristic for the Generalized Assignment Problem", August 1991
91/41 TM	Luk VAN WASSENHOVE, M.Y. KOVALYOU and C.N. POTTS	"A Fully Polynomial Approximation Scheme for Scheduling a Single Machine to Minimize Total Weighted Late Work", August 1991
91/42 TM	Rob R. WEITZ and Tawfik JELASSI	"Solving A Multi-Criteria Allocation Problem: A Decision Support System Approach", August 1991
91/43 SM	Sumantra GHOSHAL and Christopher BARTLETT	"Building Transnational Capabilities: The Management Challenge", September 1991
91/44 SM	Sumantra GHOSHAL and Nitin NOHRIA	"Distributed Innovation in the 'Differentiated Network' Multinational", September 1991
91/45 MKT	Philip M. PARKER	"The Effect of Advertising on Price and Quality: An Empirical Study of Eye Examinations, Sweet Lemons and Self-Deceivers", September 1991
91/46 MKT	Philip M. PARKER	"Pricing Strategies in Markets with Dynamic Elasticities", October 1991
91/47 MKT	Philip M. PARKER	"A Study of Price Elasticity Dynamics Using Parsimonious Replacement/Multiple Purchase Diffusion Models", October 1991
91/48 EP/TM	H. Landis GABEL and Bernard SINCLAIR-DESGAGNE	"Managerial Incentives and Environmental Compliance", October 1991
91/49 TM	Bernard SINCLAIR-DESGAGNE	"The First-Order Approach to Multi-Task Principal-Agent Problems", October 1991
91/50 SM/TM	Luk VAN WASSENHOVE and Charles CORBETT	"How Green is Your Manufacturing Strategy?" October 1991
91/51 MKT	Philip M. PARKER	"Choosing Among Diffusion Models: Some Empirical Guidelines", October 1991
91/52 EP	Michael BURDA and Charles WYPLOSZ	"Human Capital, Investment and Migration in an Integrated Europe", October 1991
91/53 EP	Michael BURDA and Charles WYPLOSZ	"Labour Mobility and German Integration: Some Vignettes", October 1991
91/54 TM	Albert ANGEHRN	"Stimulus Agents: An Alternative Framework for Computer-Aided Decision Making", October 1991

91/55 EP/SM	Robin HOGARTH, Claude MICHAUD, Yves DOZ and Ludo VAN DER HEYDEN	"Longevity of Business Firms: A Four-Stage Framework for Analysis", November 1991
91/56 TM/EP	Bernard SINCLAIR-DESGAGNE	"Aspirations and Economic Development", November 1991
91/57 MKT	Lydia J. PRICE	"The Indirect Effects of Negative Information on Attitude Change", November 1991
91/58 OB	Manfred F. R. KETS DE VRIES	"Leaders Who Go Crazy", November 1991
91/59 OB	Paul A. L. EVANS	"Management Development as Glue Technology", November 1991
91/60 TM	Xavier DE GROOTE	"Flexibility and Marketing/Manufacturing Coordination", November 1991 (revised)
91/61 TM	Arnoud DE MEYER	"Product Development in the Textile Machinery Industry", November 1991
91/62 MKT	Philip PARKER and Hubert GATIGNON	"Specifying Competitive Effects in Diffusion Models: An Empirical Analysis", November 1991
91/63 EP	Michael BURDA	"Some New Insights on the Interindustry Wage Structure from the German Socioeconomic Panel", December 1991
91/64 FIN	Jean DERMINE	"Internationalisation of Financial Markets, Efficiency and Stability", December 1991

<u>1992</u>

92/01 MKT/EP/TM	Wilfried VANHONACKER	"CONPRO*DOGIT: A New Brand Choice Model Incorporating a Consideration Set Formation Process", January 1992
92/02 MKT/EP/TM	Wilfried VANHONACKER	"The Dynamics of the Consideration Set Formation Process: A Rational Modelling Perspective and Some Numerical Results", January 1992
92/03 OB	Manfred F.R. KETS DE VRIES	"The Family Firm: An Owner's Manual", January 1992
92/04 SM	Philippe HASPESLAGH and David JEMISON	"Making Acquisitions Work", January 1992
92/05 TM	Xavier DE GROOTE	"Flexibility and Product Diversity in Lot-Sizing Models", January 1992 (revised)
92/06 FIN	Theo VERMAELEN and Kees COOLS	"Financial Innovation: Self Tender Offers in the U.K.", January 1992
92/07 TM	Xavier DE GROOTE	"The Flexibility of Production Processes: A General Framework", January 1992 (revised)
92/08 TM	Luk VAN WASSENHOVE, Leo KROON and Marc SALOMON	"Exact and Approximation Algorithms for the Operational Fixed Interval Scheduling Problem", January 1992
92/09 TM	Luk VAN WASSENHOVE, Roelof KUIK and Marc SALOMON	"Statistical Search Methods for Lotsizing Problems", January 1992
92/10 SM	Yves DOZ and Heinz THANHEISER	"Regaining Competitiveness: A Process of Organisational Renewal", January 1992
92/11 TM	Enver YUCESAN and Sheldon JACOBSON	"On the Intractability of Verifying Structural Properties of Discrete Event Simulation Models", February 1992
92/12 FIN	Gabriel HAWAWINI	"Valuation of Cross-Border Mergers and Acquisitions", February 1992
92/13 TM	Spyros MAKRIDAKIS and Michèle HIBON et.al.	"The M2-Competition: A Budget Related Empirical Forecasting Study", February 1992
92/14 MKT	Lydia PRICE	"Identifying Cluster Overlap with NORMIX Population Membership Probabilities", February 1992

92/15 MKT	Vikas TIBREWALA, Peter LENK and Ambar RAO	**"Nonstationary Conditional Trend Analysis: An Application to Scanner Panel Data"**, February 1992
92/16 TM	Xavier DE GROOTE and Yu-Sheng ZHENG	**"A Sensitivity Analysis of Stochastic Inventory Systems"**, March 1992
92/17 TM	Xavier DE GROOTE and Evan L. PORTEUS	**"An Approach to Single Parameter Process Design"**, March 1992
92/18 TM	Xavier DE GROOTE	**"Information Disclosure and Technology Choice"**, March 1992
92/19 FIN	Jean DERMINE	**"Deposit Insurance, Credit Risk and Capital Adequacy: A Note"**, March 1992
92/20 TM	Tawfik JELASSI and Michèle SANGLIER	**"Information, Systèmes Complexes et Technologies de l'Information"**, March 1992
92/21 SM	Paul J. VERDIN and Peter J. WILLIAMSON	**"From Barriers to Entry to Barriers to Survival"**, March 1992
92/22 MKT	Christian PINSON	**"Semiotics of Marketing"**, April 1992
92/23 TM	Luk VAN WASSENHOVE, Jacqueline RUWAARD and Marc SALOMON	**"On Coordination of Product and Waste Flows in Distribution Networks: Model Formulations and Solution Procedures"**, April 1992
92/24 TM	Luk VAN WASSENHOVE and F. J. C. DEBETS	**"A Guided Tour through Applications of OR-Techniques to Environmental Problems"**, April 1992