

# A History of Management Science at Imperial College (1955-1989)

## A personal note

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Operational Research/Management Science (OR/MS or ORMS) started at Imperial College as part of the Production Engineering Section within the Mechanical Engineering Department in 1955. In 1971, the Section was reconstituted as the Department of Management Science (DMS), which continued to thrive under that name until 1987, when it became part of the Management School. This note records the background that led to the establishment of the OR/MS programme in 1955 and traces the many developments that took place until 1989, including the rapid growth of the MSc course and the extensive research programme. It further records the close collaboration of DMS with industry and the role it played in setting up the first OR group at a major bank in the UK in 1967 and in launching the new international journal *Omega* in 1972. Difficulties in funding and the aftermath of absorption of OR/MS within the Management School are briefly described.

### The Early Days

My first encounter with OR came during my service with the Israel Defence Forces (1948-1952), when I became commanding officer of an ordinance depot. I had to deal with numerous managerial problems, and particularly those relating to inventory, namely when and how much to order to replenish existing stock. This was a salutary introduction to the classical formula for

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optimal reordering quantities. I concluded then that the formula found in the literature was deficient in many respects, but I was hooked. It took a while, though, before I began publishing articles on the subject [Eilon 1956a, 1956b, 1960, 1961].

I came to Imperial College (IC) in 1952 as a postgraduate student in the Mechanical Engineering Department (there were no courses in management at the College in those days) and was appointed a Research Assistant a year later. I completed my PhD in 1955 under the supervision of the Head of the Department, Professor (later Sir) Owen Saunders. Two years earlier, I had sat for the examinations of the Institution of Production Engineers, which covered a variety of topics in production management, and became an Associate Member (AMIProdE) and later Fellow (FIProdE). During that time I also attended five courses at LSE (the London School of Economics) on economics and allied subjects (for the convenience of IC students, they were all scheduled on one day in the week, Tuesdays, as I recall). Over a three-year period I also took part in the Industrial Administration Seminar at LSE. The Seminar, organized by Professor Ronald Edwards, included industrialists who came to talk about their companies and their strategic problems, and this inspired me to start the Business Policy Seminar at IC a few years later. During those three years I visited as many industrial companies as I could, to study their problems and strategies.

When I was about to finish my Ph.D., Professor Saunders told me of his decision, together with the then Rector of IC, Sir Patrick Linstead, to launch production engineering and management studies as a part of the big expansion of postgraduate education at the College. A Readership was then established to develop and run a new one-year postgraduate course in production engineering, leading to the award of the DIC (Diploma of Membership of Imperial College). American readers should perhaps note that while “course” in the USA means one term’s worth of classes in a particular subject, in Britain “course” is a more flexible term. It often relates to a programme of study, which covers a range of subjects over a period (Thus, a course may even be of one or two years’ duration, leading to the award of a master’s degree). The DIC was the highest postgraduate qualification that the College could award, not the MSc degree, which in those days was mainly awarded by the University of London for research (in due course, all the DIC courses became MSc courses). In April 1955, the University appointed Dr. Nicol Gross as the first Reader in Production Engineering in the Mechanical Engineering

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Department at IC (the authority for senior appointments was vested in the University in those days). He was a very experienced engineer with a Ph.D. from Cambridge, acknowledged as one of the world's experts in the field of welding, with a proven track record in industry.

It was then that Professor Saunders asked me to help Dr. Gross in this new venture. I agreed and was appointed a temporary Lecturer in Production Engineering for one year in the first instance, and this temporary position was later extended for another year. We had six months in which to develop the new course, scheduled to start in October 1955. Production Engineering was defined by the Institution of Production Engineers as a discipline consisting of two major parts. The first was *production technology*, which dealt with mechanical processes involved in making products, and the second *production management* (or *industrial engineering*, as it was called in the USA), which was concerned with the use of resources in an industrial enterprise (including production and distribution).

Nicol Gross's primary interests and background lay in production technology (although he had also had a great deal of managerial experience in industry before he came to IC), while mine was in production management. My earlier experience in the army, my courses at LSE, my studies for the Institution of Production Engineers qualification, and an extensive programme of reading and industrial visits, all led me in that direction. I recall how intrigued I was by the book "Methods of operations research" [Morse and Kimball 1951], which was the first organized text on the subject. The authors argued that the "triumphs of operations research ... must be made available to *scientists and engineers as well as to armed forces*" (emphasis by the authors), because the methods of OR "have important peacetime applications". The success of OR during the war and the immense contribution of the OR pioneers (including Professor Patrick Blackett), had been well documented, and after the war many turned their attention to potential applications in industry. It became clear that inventory control and scheduling were dominant issues for manufacturing companies and that OR techniques could help in allocating resources and in planning stock-holding requirements, and thereby improve industrial performance. That was the area that had interested me even before I came to IC.

And so, this was how we divided the responsibilities between us. Nicol Gross was to look after production technology, leaving me to develop the production management element of the programme. An arrangement was made with LSE to ensure that our students could attend

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selected courses concentrated in one day at LSE for one or two terms to cover topics in economics, accounting and the structure of British industry. We started preparing the lecturing and tutorial material for production management and production technology for the beginning of the new academic year. Every afternoon we met in Nicol's office at 178 Queen's Gate (a red brick Victorian building that, alas, exists no more) to compare notes and plan future work.

We envisaged that the bulk of the lectures and tutorials would be held during the first two terms of the academic year, with the number of contact hours tapering off in the third term to accommodate elective subjects. This would give students flexibility in the choice of electives and allow them to start working on their individual projects (or "special tasks", as they were called) in the third term, during which the examinations were to be held. The projects were to continue during the summer, and students were required to submit their reports (dissertations) by the 16th of September. A board of examiners, including at least two external examiners from other universities, was appointed each year to assess the performance of our students.

Students could choose one of three types of projects: (1) a critical review of the literature, including recent research, on a chosen topic; (2) an investigation of an industrial operation in conjunction with a firm, usually involving a modelling exercise (akin, in many ways, to industrial OR projects); (3) a mini-research topic in production technology, usually carried out in a laboratory. This structure was in line with other DIC courses at IC and was maintained later when they became MSc courses.

We made good progress with our preparations for the launch when Nicol Gross suddenly dropped a bombshell. He had been offered a senior post at British Oxygen, to become Managing Director of one of its major subsidiaries. As it turned out, for him this was a wise decision. He progressed very rapidly at British Oxygen, eventually becoming its joint Managing Director. He departed from IC on October 1, 1955 without giving a single lecture, leaving me to undertake all the lectures and tutorials, both in production management and production technology, as well as supervise the students' projects.

After he tendered his resignation, Nicol continued to help me with my preparations until the end of September. He taught me a great deal and we maintained contact for many years; indeed he became a close family friend. It was too late that summer to advertise for a replacement for Nicol Gross, or to appoint another lecturer, and I was left to hold the fort on my own. It was a

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daunting prospect, particularly as many of the topics, with separate sets of lectures and tutorials, were also made available to final-year mechanical engineering students as an elective subject. Fortunately, in view of Nicol's impending departure, the College decided not to advertise the DIC course and consequently we had only five students when it began in October 1955. One of these students later became a professor at Northwestern University near Chicago and another a director of a research institute in India. Alas, I lost track of the other three.

The College decided not to appoint anyone to the vacant Readership for a while, and in 1956, after the successful completion of the first year of the postgraduate course, the Production Engineering Section was formed, with me as its Head. Thus, Operational Research (OR) at IC, as part of production management, was one of the earliest postgraduate OR courses in the country, albeit under the umbrella of Production Engineering (another postgraduate course in OR was launched at LSE at roughly the same time).

The Section was housed at 14 Prince's Gardens. Another lecturer, Roy Brewer, was appointed to assist me and to undertake the teaching of production technology. He had a special interest in the new field of numerical control of machine tools, which he developed with several research students, and he gave other lecture courses in production technology. This meant that I could concentrate on the production management module and expand the fledgling courses in OR. In 1957 I secured the appointment of Joan Woodward as a part-time lecturer in industrial sociology. She came to IC for one day a week, starting with a ten-hour course in her subject and continued on a part-time basis for five years, dividing her time between IC and Oxford, where she was a tutor in industrial sociology and personnel management. In 1962 she became full-time and was appointed Senior Lecturer, and in 1969 she became Professor and Head of the Industrial Sociology Unit, which was then separated from the Production Engineering Section. She died prematurely in 1971.

From 1957 to 1959, I was in Israel to undertake a long-standing commitment at the Technion, Israel Institute of Technology, where I was appointed Associate Professor, although I returned to IC for short concentrated spells during those two years to give a series of lectures on production management. During my absence, Dr. (later Professor) John Alexander, who was then Lecturer in Applied Mechanics, was asked to look after the Production Engineering Section.

At the Technion, I helped to found the new Faculty (department) of Industrial and

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Management Engineering and was put in charge of a new MSc course in OR. I was assisted by several American visiting professors, including Professor Sebastian Littauer from Columbia University, who brought his OR experience to the new course (his special interests were statistical quality control and inventory control), and Professor Pinchas Naor, who taught statistics and was keenly interested in queueing theory. Our numerous staff discussions about OR, its scope and future, were in many ways typical of those I encountered later in the OR Society in Britain and in similar circles in the USA.

Several industrial projects in Israel enhanced my interest in modelling real operations and convinced me of the need to incorporate this experience into the teaching of OR. One of these projects was at a steel mill in Haifa, Israel, and it led to the publication of two papers, published by the Institution of Mechanical Engineers in Britain [Eilon and Avi-Itzhak 1960; Eilon 1960].

One of these papers was entitled “Case study in the rolling of steel bars” (written with my assistant Benjamin Avi-Itzhak, who later became Professor of OR in Israel and in the USA). The second paper, entitled “Optimizing the shearing of steel bars”, tackled problems of scheduling and sequencing, which proved to be similar to those found in other industries. The modelling exercise involved linear programming at a time when this methodology was at its infancy and hardly tested on real industrial operations. These papers were awarded two Joseph Whitworth prizes by the Institution of Mechanical Engineers.

### **Consolidation**

In 1959, the University of London decided to fill the vacancy of Reader in Production Engineering tenable at IC and Professor Saunders advised me to apply. I did and was duly appointed to the Readership and to become Head of the Production Engineering Section. I returned to London in the summer of that year. There were 13 students then taking the course in Production Engineering and the average annual intake was maintained at about 14 during the next few years.

Soon after my return, the College embarked on a review of the course to consider a programme of expansion, both in teaching and research. A special working party was appointed in 1960 by the Board of Studies, consisting of several professors from various engineering departments, and chaired by the Rector. The working party produced a report, which was endorsed by the Board of Studies, recommending further development of management studies at

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postgraduate level, and this conclusion was cited by the Rector in his letter to the UGC (Universities Grants Committee) dated 20.3.63. The stage was thus set to develop OR in its own right, separately from Production Engineering.

In 1960, two additional lecturers, John King and Roger Hall, were appointed in the field of industrial engineering. Both had graduated from the Production Engineering course the previous year and both had had some industrial experience. In addition to their lecturing and tutorials duties, they were given the task of developing an industrial engineering laboratory, to include analysis of industrial operations, plant layout, quality-control experiments, and other exercises in industrial engineering. Space for the laboratory was cleared at 14 Prince's Gardens, and we eventually occupied the whole building (except for a College flat on the top floor).

In 1961, many subjects were added to the curriculum, primarily in operational research and management. The structure of the course consisted of three elements: The first was a set of compulsory subjects regarded as a core, the second consisted of a wide range of elective subjects, from which the students had to select a minimum number, and the third was a project (alluded to earlier). It soon became clear that the students fell into two distinct categories, namely those interested in production technology and those interested in management and operational research. I therefore decided to launch a new one-year advanced course in Operational Research and Management Studies (called then ORMS for short, equivalent to the term OR/MS found nowadays in the literature). The purpose of the ORMS course was to provide a broad base of managerial subjects to students, primarily those with an engineering background, while at the same time giving them an opportunity to specialize in various OR subjects. To foster closer contact with industry, a two-week course for executives was first run in 1964 and soon afterwards I launched a one-day OR managers seminar, to provide a forum for OR managers from various industries to share their experience and exchange views on the current state of the profession. The seminar was a great success and ran annually for many years.

Roy Brewer was made responsible for running the advanced course in Production Engineering, which then concentrated on production technology, while his students continued to take courses in production management, albeit not with the breadth and depth available to students on the new ORMS course. Thus, the Production Engineering course continued to thrive and in 1964 a special course was added to cater for lecturers at technical colleges, with the aim

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of improving the teaching and research in production engineering at these colleges. The course was ably run by Roy Brewer, until he tragically died prematurely in 1965 (after nine years at IC), just when he was in the process of leaving IC to become Professor of Production Engineering at Bradford University. This sad event created a vacancy, which was filled by John Crookall, who had graduated from the Production Engineering Section in 1961. Several years later, he left IC to become Professor of Manufacturing Systems at Cranfield Institute of Technology.

When the postgraduate course in ORMS was established, IC concluded a reciprocal arrangement with LSE, whereby our students continued to attend lectures on economics and allied subjects at LSE and OR students of LSE came to IC for lectures on production management, including inventory control and scheduling. One of these LSE students was Maurice Shutler, who went on to become a senior member of staff at the Monopolies and Mergers Commission, a Professor at LSE and President of the European Federation of OR Societies (EURO). Another was Phil Wise, who later became the Manager of the OR Group at the National Westminster Bank (he was preceded in that position by Rick Whiteman, a graduate of the ORMS course at IC). The arrangement with LSE was beneficial to both parties and lasted for several years. Further service teaching to the Section was provided by the Applied Mechanics Section on selected production technology topics and the Department of Mathematics did so on statistics.

In 1962, I published two books, one on industrial engineering tables [Eilon 1962a] and the other on production planning and control [Eilon 1962b], and both were translated into several languages. The latter was adopted as a textbook by a few American universities, and in 1989 it was fifth amongst the top 20 books listed by the Management Information Centre of the British Institute of Management. It was also widely used elsewhere; several English editions were reprinted in Japan and India and a Spanish edition was extant for many years in Spain and South America. Oddly enough, even though it had become quite elderly, the book continued to be in demand in India and Spain long after it was declared out of print by its American publisher.

IC renamed the Section in 1961 as the Production Engineering and Management Studies Section. In 1963, the University of London awarded me the degree DSc(Eng), probably the first awarded in the UK in my subject area, and later that year the title Professor of Management Science was conferred on me. The two advanced courses (ORMS and Production Engineering)

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were among the first in the College for which the MSc degree was awarded. A two-year MPhil degree was instituted at the same time to replace the old MSc by research and it became a requirement for all research students to register for the MPhil before an application to transfer to the PhD could be considered.

### **Further Developments**

By 1965, the academic staff of the Section had grown to nine plus six research students, and several important developments then took place. First, the Section moved from 14 Prince's Gardens to the new Mechanical Engineering building in Exhibition Road. The move provided more space for expansion, allowing us to accommodate seminar rooms, the industrial engineering laboratory and a computer room (to house the new IBM 1130 computer, which was acquired shortly afterwards). Members of staff could now be allocated individual offices, an unaffordable luxury in the previous building. The great disadvantage of the move was that the Section became geographically dispersed on four floors in the new building (occupying space on floors 3, 6, 7 and 8), and lost the cosy atmosphere enjoyed at Prince's Gardens. Attempts to rearrange the space in the building, to eliminate or reduce this unfortunate dispersion, failed because of opposition from other occupants of the building.

In 1966, the reciprocal arrangement with LSE was terminated (though some few lectures on tax law and industrial law by Professor Weatcroft and Professor Wedderburn from LSE continued for a while). The teaching of managerial economics, accounting and finance was undertaken from then on by members of staff of the Section, and similarly the teaching of statistics, which had hitherto been given by the Department of Mathematics, was transferred to the Section. Roger Betts and Gerry Salkin took responsibility for teaching these subjects and they were aided in subsequent years by Richard Flavell, Anne Benjamin, Robin Hewins, Ray Tomkins and Val Brophy. Computing and quantitative methods (including those applied to production management) were taught by those mentioned above and Nicos Christofides, John King, Stephen Mathewson, Raj Mallya, George Cosmetatos, Nigel Meade, John Jenkins, John Beasley, Patrick Collins and Alec Lodge. Organizational behaviour was taught by members of staff of the Industrial Sociology Unit for a while, but later transferred to the Section and was taught by John Donaldson and Ernest Weldon. Throughout the '60s, the MSc course was overhauled to give greater emphasis to industrial applications, and this process continued during

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the '70s and '80s.

Another important development at the beginning of the '60s was the emergence of the two new business schools in London and Manchester. Lord Franks was given the task of advising the Government on business education in Britain, and he published his report in 1963. One speculation at the time was that a business school in London would be based either at LSE or at IC, to take advantage of the developments that had already taken place in these schools. In the event, it was decided that the new school would be a separate institution, which both LSE and IC, as cosponsors, would help to establish.

One suggestion was that the Production Engineering Section should be transferred to the new business school (then called the London Graduate School of Business Studies, LGSBS for short), but IC strongly favoured retaining the production management activity. Interestingly, Franks specifically mentioned OR in his report. He said that a new business school would “enable students to understand the relevance of ...techniques in solving management problems... The purpose of the school would not be to turn out specialists, for example in operational research or computer mathematics.” He added that existing activities should not be superseded and argued that the two proposed business schools “will displace little, if any, existing work. It is all needed and more... Indeed, the business schools must be complemented by the extension and greater concentration of present activities”, and “efforts should be increased to establish management research in a number of universities”, including “those concentrating on the new quantitative techniques.”

This was exactly the view held by IC. In his letter of 19.10.65 to the University of London, the Rector referred to the ORMS course and said: “Our own management studies are closely related to engineering and are an important fringe development. No less than 229 qualified men applied for admission to this year’s course, of these forty were selected. Almost all the applicants are engineers or scientists attracted by the special character of the work here, which has a high analytical content, an emphasis on quantitative techniques such as operational research and computer mathematics and a bias towards engineering industries.”

The LGSBS (later renamed the London Business School) was then set up, with the Rector of IC and the Director of LSE becoming members of the governing body to guide and help the new school. It was envisaged that some members of staff would come from the two sponsoring

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institutions, but Professor Saunders was vehemently opposed to my joining the new school and felt that I should continue to develop the ORMS course and expand our research activities at IC. It was then decided that Roger Hall, who had joined us as a Lecturer four years earlier and was well versed in what we had been doing in the production management field, should be seconded to the new venture. He thus became one of the original seven members of the academic staff of the London Business School (after several years there, he went to Canada, where he took a Ph.D. and eventually became a professor). At the same time I insisted that John King, who had joined us with Roger Hall in 1960, should remain in the Section. He later became Reader and a key member of staff, and years later, when he eventually retired from IC, he became a Professor of Production and Operations Management at Holloway College.

The Foundation for Management Education (FME) was established in the '60s by a collaborative effort of several British companies with the aim of providing financial assistance to the development of management courses in British universities. We applied to the Foundation and the University Grants Committee (UGC), and we were given a grant of £20,000 per annum for further development. This grant was over and above the then budget provided by the College, and we received assurances of more money in the new quinquennium 1967-1972 and beyond. The grant was rather modest compared with the sums allocated to the business schools, which were high on the UGC's and FME's list of priorities.

The IC policy document for that period included several statements about ORMS, with references both to the achievements up to 1967 and to the objectives for the future. The document said: "It is intended to expand [the activities of MS] during the next quinquennium, both in student numbers at postgraduate level and in the research area, particularly in the fields of industrial engineering, operational research, management control and industrial sociology. The number of postgraduate courses will not substantially change, but as facilities within the College become available, more subjects of a specialized nature will be added to cover a wide spectrum of management techniques and topics."

The reference to the number of postgraduate courses was related to the forthcoming review of the future of the MSc Production Engineering course. The number of applicants to that course had been falling steadily while the ORMS course was gaining in popularity. The work of the Section had shifted over the years to give increasing prominence to production management and

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to analytical OR methods.

These developments made it clear that the Section was no longer a natural home for production technology and that a new organizational solution had to be found. This was done in 1966 by transferring production technology to the Applied Mechanics Section in the Mechanical Engineering Department, with Professor John Alexander taking charge, while the responsibility for production management remained with the renamed Management Engineering Section (soon thereafter re-named Management Science). This meant that we ran the old style MSc course in Production Engineering for the last time in 1966-1967. The production technology course was reconstituted as a new postgraduate MSc course, with a revised syllabus and greater emphasis on mechanical manufacturing processes, run by the Applied Mechanics Section. This move gave further impetus to the expansion of ORMS and the number of postgraduate students in that course rose in that year to 49.

Another development in 1966 was the launch of a new course in advanced systems analysis, sponsored by the National Computing Centre with the help of the Ministry of Technology and a number of industrial firms. The increase in the use of computers in industry highlighted the need for personnel trained in systems analysis, which was then closely allied to OR. It was, therefore, possible to develop the new course on the foundations of the existing ORMS course, with suitable subjects added to the programme, such as data processing, systems design, information theory, and appraisal of computing equipment. In addition to this development, the Section embarked on a series of short courses for people coming from industry. These courses had two objectives: first to introduce the participants to new ideas and new techniques, and second to make them aware of our research programme and the opportunities for carrying out collaborative projects.

At that time, I decided to introduce the Business Policy Seminar. I realized that most OR work in industry was pitched at the tactical level, whereas a greater impact on corporate performance could be achieved if OR were applied at the strategic level. This conviction led to the suggestion that we should include business policy, as an elective subject, in our management science programme. In American business schools, business policy was then taught (and still is) through a series of case studies, as I had seen at Harvard and the University of Pittsburgh during visits to the USA. Essentially, Professor Edwards's seminars at LSE (which I had attended for three years

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while doing my PhD) also consisted of case studies. But I had reservations about the use of this methodology as a sufficiently effective teaching tool. We therefore organized the new business policy seminar in two parts. The first was a series of lectures, elaborating on basic concepts and material covered elsewhere in MSc course, and this was supplemented by a reading list. The second part consisted of case studies, but these were not the conventional cases taken from textbooks; they were live cases, researched and written by the students themselves.

The class was divided into several groups. Each group of six to eight students was allocated a specific company to investigate, to collect data on its activities, to assess the market and the competition, to analyse past operations, to indicate the most important issues facing the top management, and to suggest a future strategy. The brief to the groups was: “Your team has been asked by the CEO (chief executive officer) of company X to analyse the performance and strategy of the company and to submit a report with your recommendations for future actions”. Alternatively: “Your team has been asked by the CEO of company Y to analyse the performance and current and future strategies of company X and to submit a report with your findings and conclusions”. The students were given from two to six months to complete this task and then present the report to the whole class, and this was followed by discussion of the major issues.

The report was then sent to the chairman or CEO of the company, who came to the seminar to give his (or her) reactions and analysis of the report, highlight its strengths and weaknesses, and explain the reasons for some past key decisions. The fact that these were real cases, with the main decision-makers available in person to discuss the issues and answer questions, made the seminar alive and quite distinct from case studies found in business policy textbooks. It proved to be hard work and required commitment from all concerned, and the collaboration of the industrialists, who were invited to attend, was vital (we were very fortunate in that respect).

The seminar was greatly appreciated by the students opting to take the seminar and by the guests, while the staff running the course (Roger Betts, who later became a Reader, and myself) found it a most rewarding exercise [Eilon 1999]. The business policy seminars started in 1967 and continued for about 20 years, covering some 120 enterprises. These included Staveley Industries, Vickers, British Oxygen, Viyella International, Gross Cash Registers, ICI, Rootes Motors, Grand Metropolitan Hotels, Shell Transport and Trading, Courtaulds, British Rail, Costain, Hawker Siddley, ICL, British Layland, Lloyds Bank, Ford of Europe, Boots, Reeds,

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Westland, and many others.

In 1967-1968, I was awarded a Professorial Research Fellowship in the Department of Economics at Case Western Reserve University in Cleveland, Ohio. This gave me an opportunity to become acquainted with the research programmes of both the Department of Economics and the Department of OR. In particular, I became involved in a research programme on the measurement of productivity with Professor Bela Gold, who had done pioneering work in industrial and managerial economics.

I brought this work back with me to IC, managed to secure funding from the SSRC (Social Sciences Research Council), and persuaded Professor Gold to come to DMS for a year, and later for a further spell. We embarked (with Judith Soesan, later appointed Lecturer in DMS) on several case studies in the chemical and steel industries. The empirical and theoretical work (carried out in 1970-1974) culminated in the three of us writing the book on applied productivity analysis for industry [Eilon, Gold and Soesan 1979]. The book triggered further research and teaching in this area. My collaboration with Professor Gold continued for many years, and he and his wife (Sonia Gold, also a professor of economics) became lifelong friends.

The work on productivity led to subsequent research into analysis of corporate performance and to the development of a new methodology based on incremental calculus. George Cosmetatos, who had taken a PhD in the Section and joined the staff as Lecturer, was a very effective collaborator and we published several papers on our work [some are cited in Eilon 1984]. George Cosmetatos later left us to become a professor at the Technical University in Athens, where his career flourished and he became a senior member of the university. I continued with my work on corporate performance and published my book “The art of reckoning — analysis of performance criteria” [Eilon 1984]. The book proposed several analytical models for use in managerial economics and I used these models extensively in my consulting work. Following the publication of this book, several research projects were undertaken and further books were written on corporate performance and allied topics [Eilon 1979a, Eilon 1979b, Eilon and Blackwell 1991, Eilon 1992 and Eilon 1999].

From 1968 to 1973, I gave a course of lectures on ORMS to the Engineering Department at the University of Cambridge (in 1970, I was elected Visiting Fellow at what was then University College, Cambridge). I pressed the Engineering Department to emulate the work I had developed

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at IC, but there was no framework for postgraduate courses at the time, and my course was, therefore, designed as one of the final year options, taken as part of the Cambridge Tripos degree. However, the seed was sown and the experience of the Engineering Department led to further developments of business education in Cambridge.

### **The Establishment of DMS (Department of Management Science)**

By 1969, the Section had grown to include 14 academic and 6 nonacademic staff, 62 students on the ORMS course and nine research students and assistants. The work of the Section had become internationally known, with a solid stream of publications. In the early days, OR was largely concerned with inventory control and scheduling of manufacturing operations, but over the years its scope widened to cover applications in nonmanufacturing activities and in service industries, including banking and finance [see, for example, Eilon and Fowkes 1972].

It was against this background that the College decided in 1970 to separate the Management Engineering Section from the Mechanical Engineering Department and create the Department of Management Science (DMS) within the City and Guilds College (which is the engineering college within IC). The new Department of Management Science came into being in 1971, just before the start of the new quinquennium. Thus, it took 16 years from the inception of the original postgraduate course for management science to come of age at IC and achieve departmental status.

In adopting *Management Science* for the name of the new department and for the title of my Chair, IC recognised that management is concerned with the analysis of alternative courses of action, with efficient and effective deployment of resources, with planning, and with execution. It is the art of the possible and the attainable. It should not be concerned just with what managers actually do in the course of their work, but in the main with what managers can and should do. The ability to pose penetrating questions about industrial and business operations, the ability to solve problems and create new opportunities, the ability to project forward and implement plans — these are the major attributes that are vital for management to operate effectively. The aim of management education is to help students acquire a state of mind and such knowledge that would expedite the development of these attributes.

Most business schools would subscribe to these sentiments. However, we felt that there was a sharp distinction between business schools and our ORMS programme. At business schools,

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most subjects are of a descriptive nature and many students have only a limited, if any, knowledge of mathematics or aptitude for quantitative methods, whereas an ORMS programme needs to highlight quantitative modelling as a primary tool in the analysis of industrial and business operations.

For most people, the term *Management Science* is synonymous with that of *Operational Research*, but my preference for the former was to emphasize our concern with real managerial problems, rather than just with mathematical models. The dilemma of whether to choose the term *Management Science* or *Operational Research* was, in some ways, reminiscent of dilemmas that had taken place in the USA. Perhaps the most comprehensive and appealing definition of OR was the one proposed by the British OR Society in the early '60s (and cited in many issues of its *Journal Operational Research Quarterly*):

“OR is the attack of modern science on complex problems in the direction and management of large systems of men, machines, materials, and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system, incorporating measurement of factors such as chance and risk, with which to predict and compare the outcome of alternative decisions, strategies and control. The purpose is to help management determine its policy and actions scientifically.”

As for management science, its objectives were, as defined in the 1950's by The Institute of Management Sciences (TIMS), “to identify, extend and unify scientific knowledge that contributes to the understanding and practice of management”. It is clear why for many professionals and commentators these definitions suggest that OR and MS are synonymous. For various reasons, however, OR was regarded as being concerned solely with theoretical and mathematical techniques (and some may argue that this applies even today).

TIMS was set up in 1953 as a reaction to the perceived obsession of the Operations Research Society of America (ORSA) with theoretical mathematical modelling (indeed, some people in American universities had long regarded OR as just a branch of applied mathematics). The founders of TIMS expressed the hope that more attention would be paid to the use of modelling *in practice* and that professionals would endeavour to formulate solutions to real problems encountered in business and industry.

Given this background, I opted for the term *management science*. It is noteworthy that after many years of coexistence and friendly rivalry, the two societies, TIMS and ORSA, eventually

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amalgamated in 1995, creating a single body called INFORMS (the Institute for Operations Research and the Management Sciences). As stated in its promotional material of the new institution, INFORMS is “dedicated to advancing the development and dissemination of all aspects of Operations Research and the Management Sciences”.

### **Other Noteworthy Developments**

In the early '60s, I was asked by the P-E Consulting Group to help in developing an OR Group, headed by Tom Poole, who had taken his MSc at DMS. He and his staff made many contributions to consulting assignments undertaken by P-E. (David Nicolson, an ex-IC man, was Chairman of P-E and a member of the Governing Body of IC and an enthusiastic supporter of our work. Several years later, helped me to raise money from industry towards a building for DMS. The fund, valued at half a million pounds by the late '80s, was used to refurbish a building for the newly established Management School).

The association with P-E was very fruitful in helping us to set up student projects with various firms, and it provided useful teaching material for the MSc course. My experience led me to encourage members of staff to engage in consulting, which benefited them financially and professionally. The interaction between research, consultancy, and student projects stimulated many publications from DMS over the years; in my case, it led to the publication of 16 books (some shown in the list of references) and about 300 papers and articles on various topics.

One of the notable research programmes, which started in the '60s, was in the field of distribution. I embarked on this work with the able assistance of Carl Watson-Gandy, then Lecturer (he later became Senior Lecturer at Shrivenham), and Nicos Christofides, a Research Assistant (who later became Professor of OR at DMS). The three of us concentrated our efforts on solving key problems in depot location and vehicle scheduling. Depot location was Carl's research field, in which he later became an acknowledged authority, and vehicle scheduling was an area that Nicos was interested in, along with graph theory (he later published many papers and lectured extensively in many countries in these and allied areas). This work led to the jointly written book *Distribution Management - Mathematical Modelling and Practical Analysis* [Eilon, Watson-Gandy and Christofides 1971]. This book was regarded at the time as a key text for courses and research in the field. It was further used to generate many student projects in the field of distribution.

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Nicos Christofides and Gerry Salkin (who later became a Reader) became active in mathematical programming and its applications, mainly in banking and finance (contributions to this important work were also made by Richard Flavell, Robin Hewins, Val Brophy and John Beasley). In the '90s, Nicos Christofides and Gerry Salkin went on to lead the Centre for Quantitative Finance, which had many PhD students. Other important research areas were simulation, conducted by Stephen Mathewson (who later became Senior Lecturer and an internationally known authority in the field), and forecasting, to which Nigel Meade made many contributions. Work in production planning and inventory control continued, primarily with the efforts of John King and Raj Mallya.

In 1976, I was invited to become one of the Founding Fellows of the newly established Fellowship of Engineering (which later became the Academy of Engineering), created with the inspiration of the Duke of Edinburgh. This was a great honour and I was for many years the only member of the OR Society to become a Fellow of that body.

In 1977, a role-playing and negotiating exercise was introduced for new entrants to the MSc course. It was held at the beginning of the academic year during a weekend away from the College. Its purpose was two-fold: to introduce a competitive business game to highlight to the students the need for diagnostic and analytical tools, and to provide a congenial atmosphere for students to work in teams and to get to know one another. The exercise proved to be a great success and was run for many years. The first weekend was held at Beatrice Webb House near Dorking. Later, the weekend school was sponsored for several years by the NatWest Bank and ran at the bank's training centre at Heythrop Park in Oxfordshire, and for two years it was sponsored by the Ford Motor Company and ran at its Marketing Training School near Dagenham.

Another development in 1977 was the introduction of a joint honours undergraduate course with the Department of Chemistry and the Department of Chemical Engineering and Chemical Technology. This provided final year students in these departments an opportunity to study management subjects, including OR, as part of their degree programmes, and in some ways this replicated the management option that I had introduced into the Tripos degree in Cambridge a few years earlier. In 1978, DMS also became heavily involved in teaching MS subjects as part of the new four-year course of the Mechanical Engineering Department.

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A series of annual Departmental prizes were established during the '70s: The Nicol Gross Memorial Prize, donated by British Oxygen, was designated for the best all-round student in DMS, and the British Airways Prize was established for excellence of a student project. The NatWest prize was set up for excellent performance in the examinations of the MSc course, and finally the Ford Prize was awarded to a student in DMS for excellence of a project on a subject of interest to manufacturing industry. These prizes served as great encouragement to the hard working students in the Department.

Our extensive work in the field of banking and finance, which had started in the early '70s, then led us to plan a new MSc course in finance and technology, which we hoped to start in 1982. However, by then the Government instituted cuts in funding for the university sector and imposed severe restrictions on the level of student intake. The moratorium on expansion meant that admissions to the existing MSc course had to be restricted, in spite of a rise in the number of applications for admission, and plans for the new MSc course in finance and technology had to be shelved. However, those plans later became the foundation for the development of the Centre for Quantitative Finance in the '90s.

In 1982, eleven years after the establishment of DMS, the OR Society awarded me the Silver Medal. The medal is beautifully designed, with the words "for merit" inscribed on it. The Awards Committee Citation, a gratifying accolade given by one's peers, was a great boost to the staff, offering an explicit acknowledgement of the teaching and research at DMS [Figure 1].

### **OR at NatWest**

During the '50s, the attention of management science was largely confined to manufacturing industry. The widening scope of applications to other areas became evident in the '60s, and perhaps the most spectacular development took place in banking and finance. The advent of computers provided the prospect of a revolution in banking, where manual processing of colossal amounts of transactions and data became increasingly incapable of coping with the rapid growth of business.

The National Provincial Bank started to computerize the bank's manual systems, but soon realized that it needed to do more than just install computers. Ralph Hopps, who was the manager in charge of "automation", as it was then called, sought my advice in 1967. Following my recommendations, and further discussions with the bank's Chief Executive, I was asked to



**Figure 1: Award of the Silver Medal of the Operational Research Society to Professor Sam Eilon in 1982.**

**The Awards Committee Citation reads as follows [Journal of the Operational Research Society, 1982]:**

**"Professor Samuel Eilon has contributed richly to the development of operational research in the United Kingdom over the last near thirty years. He has practised successfully, he has built up an outstanding university department at Imperial College and he has written extensively and influentially.**

**"As a practitioner and as an advisor to practicing O.R. groups, Professor Eilon has blended a keen analytic capability with an equally developed awareness of what actions are possible and what effects they might have on other actors in the system under consideration. His practical work has motivated much of his published theoretical work and he has drawn on it also to write many stimulating books and articles of a more general but no less valuable kind.**

**"The same approach has led to a university department which is respected internationally. High standards in both teaching and research have blended with an awareness of society's needs to produce a lively adaptive department. The teaching success is testified by the success of the department's former students. The research of the department has led to contributions to many important fields of O.R. and has developed several new fields of application.**

**"Professor Eilon's record of achievement is one of which he can be justly proud and one which the Society acknowledges as outstanding by awarding him its Silver Medal."**

set up an OR group at the bank, and this venture provided opportunities for student projects for many years to come. The bank later merged with the Westminster Bank to form the National Westminster Bank (NatWest). This became the first OR group in the City of London (where many of the British financial institutions operate) and it was later emulated by many other banks and financial institutions.

The fledgling OR group at NatWest started with three analysts, all graduates of DMS, and a programme of annual recruitment of DMS graduates in subsequent years was set in motion. This meant that over several years, a healthy group was established with well-qualified analysts.

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Initially, the OR Group was headed by a banker with no knowledge of OR but with a great deal of experience in banking and intimate knowledge of how the bank worked. He acted as a general overseer and I helped in the supervision and conduct of the various projects undertaken by the Group.

In due course, the analysts matured enough for one of their number to become the manager of the expanding Group, with several managers appointed to assist him. I continued to advise and guide the OR Group for many years, and to advise the Chief Executive and other senior managers at NatWest about OR and what it could do for various divisions and subsidiaries of the bank. Eventually, I retired from that job in 1990, after serving the bank for 24 years.

The work of the OR Group was written up in the *London Times* on 20.10.87 (by then the Group had grown to 30 staff). A more detailed paper was published earlier in the Journal of OR Society, written by the manager of the Group Rick Whiteman (also a graduate of DMS) and his deputy Phil Wise, who later took over as manager [Whiteman and Wise 1981].

My long association with NatWest and the work of my colleague Gerry Salkin established a strong foundation for our interest in applying OR to finance. Gerry had come to the Department early on as a Lecturer to teach accounting, statistics, and finance, and this proved a powerful combination for our subsequent development of teaching and research in this area. He established extensive contacts with many company treasurers, who were keen to support a wide range of student projects.

Our joint efforts paved the way for a thriving research programme with numerous PhD students, many of whom went on to take senior positions in banking and industry (including my own son, Amir, who became a senior executive at several merchant banks and a director of Easyjet Group). Many kept in contact with DMS and in turn were instrumental in sponsoring further students and commissioning new research projects. This programme became the nucleus of what later became the Centre for Quantitative Finance.

### **Omega**

Another important development, which took place at the beginning of the '70s, also made a great impact on the work of DMS, on its research programme and on its reputation, was the launch of *Omega, the International Journal of Management Science*.

I had become a Departmental Editor of the journal *Management Science* (TIMS' flagship

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publication) in 1969, a position which I then held for eight years. This experience made me realize that all the prominent journals in MS and OR were the official publications of learned societies in the UK and the USA and it was inevitable that their editorial policies would be greatly influenced, if not dictated, by their respective parent bodies. I also felt that their contents were dominated by narrow mathematical modelling and by prescriptive techniques. I became increasingly uncomfortable with the outpouring of sterile theoretical papers that had no relevance to real industrial and business applications.

As I pointed out then [Eilon 1988]: “A serious gulf was developing between academics and practitioners. The academics were mainly interested in publishing theoretical papers that could contribute weight to their own c.v.s, and thereby brighten their promotion prospects, and this was encouraged by the prevailing refereeing system, which heavily relied on academic referees, who had similar standards and aspirations. As a result, most practitioners became increasingly disenchanted with what they regarded as incomprehensible literature, which did very little to serve their needs.” The time was ripe for a new journal in management science, and I had two main aims in mind. First, it was important to encourage publication of material relevant to real industrial situations, including case studies and examples of applications of theory. Second, there was a need to cut the horrendously long lead times in publishing (delays of one to three years were quite common, largely due to a very inefficient refereeing process).

I had a long series of discussions with Macmillan in London, and we even agreed on a title (*Decision*), but after many months of deliberations, we could not agree on publishing policy. In particular, I was not satisfied that I would be allowed complete editorial freedom, which I felt was absolutely essential for the proposed new Journal (apparently Macmillan expected that papers would be assembled by the editor and passed on to the publisher for final approval).

Then, in January 1972, I had a chance meeting with Robert Maxwell of Pergamon Press. I told him about my ideas for a new journal and he immediately offered to publish it as a bimonthly. He gave an undertaking (which he later scrupulously honoured) of complete editorial freedom and his only stipulation was that the journal should be in the black within four years of its launch (in fact, it became profitable after two years). And thus, *Omega, the international journal of Management Science* was born.

It took several months to set up editorial procedures, to appointment an Editorial Board, and

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to prepare for the first issue, which appeared at the beginning of 1973. Two Assistant Editors (later called Associate Editors) were appointed to assist me, both members of staff at DMS, Roger Betts and Roger Tilley. In 1974, Richard Flavell (then Lecturer in DMS, who Later became Reader) took over from Roger Tilley, and this meant that two senior members of staff were helping me to arrive at equitable editorial decisions and to maintain high standards. After several years, Nigel Meade, Senior Lecturer in the Department, took over from Richard Flavell, and worked diligently with me and with Roger Betts throughout the rest of my spell with the journal.

*Omega* was a great boost to the Department and helped to reinforce its international reputation. In December 1993, we completed 21 volumes; 22 years had passed since the initial agreement to publish the journal, and it was time for me to move on. Following the announcement of my imminent retirement, I received numerous messages from all over the world, from academics and others, praising the journal and its contribution to the profession (some urging me to stay on). I retired as Chief Editor at the beginning of 1994, when George Mitchell took over, and happily the journal continued to thrive under his guidance. The editorship of *Omega* had been, for me and for DMS, a most satisfying experience.

### **The SERC Saga**

Financial support for students came from several sources. Some students were self-supporting while others were sponsored by companies, which the students joined after completing their MSc. A fair number of our students were awarded advanced course studentships by the Science and Engineering Research Council (SERC), where for some reason, OR was assigned to the Mathematics Committee. This was a further indication of how OR was perceived by many to be a branch of mathematics, and it proved (in my view) to be a disastrous decision. In the '70s, the competition for advanced studentships from the SERC was relatively low, and the SERC could allocate a fairly large number of awards for distribution to OR centres at universities. As the MSc course in Management Science at IC expanded, so did the number of SERC studentships allocated to us, which by 1980 reached 24, the highest number (by a very wide margin) allocated to any institution.

The expansion of DMS was reflected by the number and range of interests of the staff. The annual report of 1985 listed the following staff [Imperial College 1985].

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## *Professor and Head of Department*

Sam Eilon

## *Professor*

Nicos Christofides

## *Readers*

Roger Betts

Richard Flavell

John King

Gerry Salkin

## *Senior Lecturer*

Stephen Mathewson

## *Lecturers*

John Beasley	John Jenkins
Anne Benjamin	Alec Lodge
Val Brophy	Raj Mallya
Colin Clubb	Nigel Meade
Patrick Collins	Ray Tomkins
John Donaldson	Carl Watson-Gandy
Robin Hewins	Ernest Weldon

In addition, George Cosmetatos, who had been a Lecturer in DMS and then became a professor at Athens, was Visiting Lecturer.

The expansion of DMS and the large number of student applications to join the MSc course should have normally led to our allocation of SERC studentships to rise. But this allocation came under pressure when MSc courses in various branches of mathematics began to develop in British universities, and generated their own demand for studentships. By 1982, the number of SRC studentships allocated to us was halved; one of the main reasons given by the Mathematics Committee was its concern that “much of the [MS] course material covered areas [was] inappropriate for SERC support”, namely that was inappropriate for OR. It became clear that the Mathematics Committee was primarily interested in the teaching of mathematical subjects and did not regard other subjects as important or necessary for an OR course.

I protested vigorously to SERC in my letter of 1.3.82. I wrote: “It is not sufficient for the OR scientist to be well versed only in the tools and techniques of OR, to the exclusion of other

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subject areas that are essential for an understanding of the broader industrial context within which OR has to function. Many of the failures of OR in the past can (as pointed out by Ackoff, Rivett, Tocher, Cook, Dando and Sharp, and many others) be attributed to a narrow interpretation of what comprises OR. It is not, in our view, simply restricted to problem formulation, model-building and computational manipulation alone, important though these may be. It is concerned also with implementation and the broader context in which that implementation has to take place.”

Nonetheless, in 1985 the allocation of studentships was halved again to six studentships. In addition to this quota, we were allocated several “instant awards”, which were open to all-corners and allocated on merit. The statistics over an eight-year period revealed a drastic reduction in the total awards to DMS: 27 in 1978 (including 5 instant awards) declining to 13 in 1985 (including seven instant awards).

I quoted these figures and protested again in my letter of 13.2.85 to the Committee. It was perfectly clear that following a change in the composition of the OR Panel, there was a change of perception in 1982 by Panel and the Mathematics Committee as to what OR was all about. They completely ignored the positive reports and high praise for DMS expressed by a succession of distinguished external examiners. Members of the Panel disavowed the commitments made by their predecessor. I said in my letter: "This is a damaging and quite unjustifiable attack on the premier centre of OR postgraduate education in the country, but what is even more serious is the damage that will inevitably be inflicted on the OR profession and its future in this country." I reiterated the philosophy of our programme and added:

“Our students should have a modicum of understanding of managerial economics, accounting, finance (which, incidentally, has quite a mathematical bias on our course), and organisational behaviour. Courses that purport to turn out OR scientists without these ingredients are — in our view — deficient and do disservice to OR. Detailed knowledge of OR techniques and proofs of some basic theorems or algorithms have become less important nowadays with the advent of computers... and sophisticated packages. The most advanced techniques in decision theory or mathematical programming are useless on their own, if the analyst fails to comprehend the meaning of costs, the measurement of inputs and outputs, and the problems associated with the implementation of change. Those on the Panel [the OR Panel of the Mathematics Committee], who do not agree with this view and adhere to the old-fashioned concept of OR as a mere collection of mathematical techniques, are oblivious to what has happened to OR in practice, to what OR analysts actually do, to surveys of OR practitioners highlighting their deficient preparedness for real life.”

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All these protests were, alas, to no avail. The Mathematics Committee concluded that its prime responsibility was to support mathematics per se and not to look after OR, which it must have regarded as a fringe activity. This attitude reaffirmed my conviction that the committee should not have been given the responsibility for OR within SERC. I said so in my letter of 23.10.85 to the SERC: “The realisation that OR does not equal applied mathematics must lead to the conclusion that either the OR Panel, as presently constituted under the Mathematics Committee, is the wrong body to make awards, or that awards should be available from other bodies as well”. I warned, though, of the risk that reliance on support from multiple sources could result in each source relying on others for action, leaving OR to fall between several stools.

The Mathematics Committee chose to ignore all these protestations and continued to reduce the number of studentships allocated to DMS. The SRC agreed in principle to my suggestion that OR should be moved to a joint committee of SERC and ESRC (Economics and Social Sciences Research Council), but in practice the joint committee was given very limited resources and could not support OR on any significant scale. The outcome was that OR was progressively downgraded at SERC in the level of support given to MSc and research programmes. This limited support put a serious constraint on university departments seeking to develop OR at the postgraduate level.

The number of MSc courses ceased to expand and the number of students began to decline. OR began to migrate, often as a minor subject, to undergraduate programmes in mathematics or economics. At the same time, the big expansion in the business schools sector (eventually every university had one) meant that OR (often under the name “quantitative methods”) became one of the many subjects that business students could choose to include in their studies.

From 1980 to 1985, the number of applicants to DMS was steady at between 600 and 700 a year, with the number of MSc students fluctuating between 60 and 100. In 1985, DMS was credited with 196 FTEs (full-time equivalents), including the credit given for service teaching to other departments at IC. The MSc course at DMS was still in a healthy state, with 104 students, 13 research students and 21 academic staff. We set ourselves a target of about 85 students, which we easily met throughout the ‘80s. We had the largest and one of the most prominent programmes in ORMS in Western Europe, an achievement that members of staff were deservedly proud of. The program became quite a large and complex activity to administer, and I

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was fortunate to have had the loyal and able support of several Assistant Directors (first, Roger Tilley, followed by John Jenkins and finally Anne Benjamin), and Jennifer Everett, who was my secretary for some 20 years,

In spite of the eroding level of SERC support, we continued to attract many high quality students. However, I was concerned by the fact that the decline in available SERC studentships caused the proportion of overseas students to increase (of the 104 MSc students, only 57 came from the UK or the EEC).

MSc courses in OR elsewhere fared even worse and the total output of UK students from MSc courses in OR was way below the country's needs. This raised questions about the future of the OR profession in British industry. There is little doubt in my mind that the SERC policy towards OR and the rising tide of the business schools were the main contributors to the decline of OR in British universities.

### **Anniversaries**

In 1980, DMS celebrated its 25-year anniversary and in 1985 its 30-year anniversary. The 25th anniversary was marked by a cartoon, drawn by the well-known cartoonist Sallon, showing all the academic members of staff serving in DMS at that time [Figure 2].

The annual report for 1979, coinciding with the 25th anniversary, summarized the main research projects carried out by staff and research students. These projects covered the following topics (listed here in an arbitrary order): the use of financial and management ratios for analysis of productivity and corporate performance, problems of fluctuating exchange rates and their effects on organizations trading internationally, large scale corporate models, job shop scheduling, multi-product batch production models, depot-location problems and vehicle scheduling (including large scale traveling salesman problems and dynamic knapsack problems), two-dimensional cutting models to minimize waste, development of heuristic methods to solve various combinatorial problems, simulation models, mathematical programming, forecasting methods, economics and management of energy resources, and many others.

The achievements of DMS and its international recognition were extolled in the many tributes we received on the occasion of the two anniversaries, it was gratifying to receive so many messages of goodwill. Some are reproduced below.

***Professor Jerry Lieberman, President of TIMS and later Provost of Stanford University.*** It

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Figure 2: Anniversary of DMS 1980

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gives me immense pleasure to record my sincere congratulations to the Department of Management Science of Imperial College on its 25th anniversary. Sam Eilon has developed a leading Department, which has made a lasting impact on the profession, and its international reputation is ample evidence of its great and many achievements.

I first came across Sam Eilon many years ago, when I was still at Columbia University in New York. He was following up some research that I had started in what was considered then a novel but obscure field of inventory depletion, which was subsequently found to have several interesting areas of application. I have kept in close touch with him ever since.

In 1970 I came to the Department as a sabbatical visitor and have the fondest memories of the generous hospitality given to me and my family. I was greatly impressed by the wide range of activities that the Department encompassed and by the genuine desire of the staff to investigate problems of concern to management. The emphasis on problem orientation has been a most fruitful inspiration for much of the teaching and research work of the Department, without in any way diluting its important contributions to the development of new theory. Sam and the Department have enriched my life, professionally and otherwise.

Over the past decade I was glad to play host, here at Stanford, to Sam and several of his colleagues. I greatly value these ties of friendship, and I look forward to my next sabbatical visit to the Department in 1981.

***Brian Haley, Professor of OR at the University of Birmingham, who became President of the OR Society and President of IFORS.*** Those who have not experienced the efficient, but sympathetic, chairmanship of Sam Eilon, or the care and concern of his colleagues for actions which are in the best interests of a student, will not fully appreciate my view that Management Science at Imperial College is one of the best organised courses in the field in the country.

The Department of Management Science is a clear success on these grounds alone and in congratulating it on the achievement of the last 25 years, may I also express the wish that it will maintain its varied interests, resist any pressure to be judged by solely academic standards and further develop its external activities. The flourishing of this department will help others and will encourage great interest in Management Science.

***Tom Frost, Deputy Chief Executive (later Chief Executive), NatWest Bank.*** Thirty years ago, the field of Operations Research and Management Science was in its infancy. The use of

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quantitative models for reaching decisions about resource allocations was an expansion of science and engineering to new domains. It was a risk worth taking to establish an academic department of Management Science, but few schools had the vision and confidence to make a full commitment. Imperial College's Department of Management Science was in the vanguard of that movement. Motivated and sustained by Sam Eilon, the department was one of the few in the UK and USA to recognise the social importance of promoting rational methods for management. Congratulations to Sam Eilon and the Department of Management Science of the Imperial College of Science and Technology for what they have accomplished over the 30 intervening years.

Now, it's 1985. Many schools have introduced excellent operations research and management science curricula, but none have duplicated the unique qualities of Sam Eilon's shop where—breadth of vision integrates engineering perspective and management goals and—a coherent philosophy motivates all analyses and model-building techniques.

**Neil O'Sullivan, Director, Ford of Europe Inc.** It is a particular pleasure to add my congratulations to the many that the Department will receive to mark its 30th anniversary as a pacemaker in modern management techniques. My own involvement with the Department dates back over five years and, during that time, I have witnessed the strong leadership of Sam Eilon and his colleagues. There is a real family atmosphere, giving extra support to those far from home or facing problems in meeting the challenge of a demanding programme.

For a number of years, Ford has recruited business graduates from the best of the British and Continental centres, including the Department [of Management Science at IC]. The emphasis throughout is on quality; these high calibre people can make an effective contribution very early in their careers and have the capacity for rapid progress to senior management positions.

**Bela Gold, Professor of Technology and Management, Claremont Graduate School, Claremont, California.** During my two periods as a Visiting Professor in Imperial College's Management Science Department, I found it to be one of the most innovative and stimulating environments encountered in the United States or anywhere abroad.

It has achieved and maintained such status as a result of Samuel Eilon's continuing drive to keep expanding the range of business activities covered, as well as the array of analytical approaches being explored, combined with his pressure to carry out such efforts through to the

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point of practical applications. Thus, Professor Eilon's widely recognised contributions to the progress of operations research and management science have been significantly reinforced by his role in the developing capabilities of his faculty associates and of successive cohorts of carefully selected students from all over the world.

One of the most impressive accomplishments of the Department has been its success in building on a demanding foundation of basic concepts and tools to develop students' ability and commitments to adapt and extend insights and methods to meet the distinctive requirements of complex operations. This reflects not only effective teaching, but, even more, response to the intellectual leadership and experiences of a faculty heavily immersed in such practical applications challenges. It was no surprise, therefore for me to encounter innumerable evidences of the high regard for the Department's performance from the many business leaders familiar with the capabilities of its students as well as of its faculty.

What a splendid record of achievements to celebrate on its 30th birthday!

### **End Game**

In 1975, the Rector of IC, Sir Brian (later Lord) Flowers asked Sir David Huddie, a former Managing Director of Rolls Royce, to undertake a review of the development of so-called nontechnical (nonengineering and nonscience) subjects at IC. The Rector also asked Sir David "to consider what organisational structures would be conducive to bringing about such developments in a coherent and orderly manner." He reported a year later and recommended that a department of social science be created, comprising industrial sociology and economics. In 1978, Aubrey Silberston, an official Fellow at Nuffield College, Oxford, was appointed Professor of Economics, and the new Department of Social and Economic Studies was set up, headed by Professor Dorothy Wedderburn. She left the College three years later, and Professor Silberston then took over as Head in 1981.

By the mid-'80s, business education in British universities mushroomed. Every university either had or was going to have a business school, and business studies became the most popular master's degree course for postgraduate students. After many years of apathy (even derision at times) from employers towards business education at universities, the climate changed dramatically and recruitment of business graduates grew by leaps and bounds. An MBA (Master of Business Administration) became a coveted qualification, which greatly enhanced

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employment prospects and promised increasing financial rewards.

Until 1985, IC was content with the DMS programme. However, some people in the College, including the new Rector Sir Eric Ash, felt that combining DMS and the Department of Social and Economic Studies would create a strong base from which to mount a challenge to the best business schools in the country. As I was due to retire in 1989, and as Professor Silberston was to retire in 1987, the College authorities took the opportunity to examine a proposal for merging the two departments into one school. With the two heads of departments to be soon out of the way, the issue could be settled with the long-term interest of IC in mind. They thought the title *management school* was preferable to *business school*, presumably to distinguish it from other schools in the country.

I was implacably opposed to the merger. I had no personal hostility to the subjects covered by the Department of Social and Economic Studies or to members of its staff. On the contrary, I had insisted many years earlier on the introduction of industrial sociology and managerial economics into the ORMS programme, and I had excellent personal relationships with members of that Department, including Professor Aubry Silberston, who had been a friend for many years. However, I felt very strongly that a merger would lead to the loss of the distinctive character and unique contribution of management science by becoming diluted within a larger and more diverse school. Also, it was difficult to see how a business (or management) school at IC, with its limited space and financial resources, could compete with the powerful and well-endowed “first division” business schools on the international scene. The distinctive framework of our DMS programme made it possible for us to make a notable contribution and to maintain a unique position, in spite of relatively limited resources. Within a business (or management) school, there was a distinct danger that our MSc course would be distorted beyond recognition, or even be scrapped and replaced by a conventional MBA programme, indistinguishable from many found elsewhere.

My view did not prevail. The two departments were merged and the new Management School was set up in 1987 with Professor David Norburn as its Director. Professor Silberston retired and I was to retire two years later. David Norburn immediately set out to put his stamp on the new school and took steps to replace the MSc in Management Science with a new MBA, to be awarded after a one-year course. My worst fears were about to materialize.

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In the summer of 1987, I completed 30 years as Head of DMS (and its forerunner, the Section within the Department of Mechanical Engineering) — a milestone by any standard. The incorporation of Management Science into the Management School and the loss of its separate identity meant that I had the unique distinction of having been both the first and the last Head of the Department of Management Science at IC. As I had never had a sabbatical year before, I applied for one for the academic year 1987-1988, using the creation of the Management School as a suitable opportunity. It also meant that I would be away when the initial steps were taken to set up the school. I went to Australia for conferences and workshops at Brisbane, Melbourne and Sydney. Later in 1988, I went to McMaster University in Canada, where I gave a series of lectures and seminars to graduate students and to industrialists.

I returned to the Management School at IC in 1988 and offered to give some courses, also to continue to run the Business Policy Seminar and the OR managers seminars, but my offer was not taken up. I used the time that academic year to continue with my research, which later culminated in the publication of two books, *The global challenge of innovation* [Eilon and Blackwell 1991], and *Management practice and mispractice* [Eilon 1992]. I also started planning what proved to be a mammoth work in three volumes, *Management science anthology* [Eilon 1995].

I retired from the College in 1989 after 37 years at IC. It was the norm for a retiring Professor or Head of Department to be offered a Senior Research Fellowship. The position does not carry any financial rewards, but it provides the Fellow with a “base”, a desk and access to the library. It would have, therefore, been natural for me to be appointed a Fellow in the Management School (where Aubrey Silberston had been appointed a Senior Research Fellow on his retirement).

However, I was deeply disappointed by David Norburn’s negative attitude towards Management Science and his repeated derogatory comments on the achievements of DMS. I was also very critical of the way the School was developing and strongly disapproved of the dismantling of the MSc in Management Science. Professor Tom Husband, the then Head of the Department of Mechanical Engineering, invited me to become a Senior Research Fellow in his Department and I gladly accepted. Thus, I returned to the Department of Mechanical Engineering, where my career at IC originally began in the '50s, and I continued there with my

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research and writing. I completed *Management science anthology* [Eilon 1995], and my most recent book, *Management strategies — a critique of theories and practice*, was published just before the end of the millennium [Eilon 1999].

Shortly after my retirement from the College, I was invited to become a Member of the Monopolies and Mergers Commission, where I served for seven years (1990-1997), but that is another story.

### Postscript

This paper is based on information taken from the following sources: a book published on the occasion of the Centenary of the City and Guilds College [Whitworth 1984] (the chapter on Management Science in that book was written by John King), an editorial in *Omega* published 15 years after the launch of the journal [Eilon 1988], two annual reports of DMS [Imperial College, 1979 and 1985] and further material from my files.

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