

Management sciences: operational research units

[Business](#), [Management](#)



The academic phase of early MS/OR is outlined and a time-based framework to map the evolution of four MS/OR discourses informing a set of MOMs currently in use is advanced. At an undergraduate level the review is based on a sample taken from universities and Colleges Admissions Services (AAAS) of business and management studies degrees and at a postgraduate level the review considers a sample of MBA programmes offered by six UK universities.

Results indicate that most of the MBA courses include a core unit in quantitative methods in the first year and that universities are still at issue teaching the 'hard' end of the MS spectrum, the type of problem solving methods developed in the 1950s and 1960s. Business courses incorporating units containing systemic thinking and management sciences methodologies developed from the 1950s to now (e. G. : soft systems methodology, viable systems model, cognitive mapping), are rarely taught at undergraduate (UG) level; and at post-graduate (PG) level they have been confined to a handful of institutions in the UK.

The paper highlights the fact that MOMs associated with the soft and critical end of the spectrum are still lacking of credibility amongst the designers of management education at both undergraduate and graduate management education. Conclusions from the survey results are drawn and an agenda for further research is proposed. Keywords Management science? Survey? Quantitative methods? Soft systems? Hard systems? Management education? Operational research A. Pacer-Cares (&) R.

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Cyst Pratt Action Rest (2011) 24: 379-395 Introduction Quantitative Methods (KM) and the classical type of management science/operational research (MS/OR) approaches are a set of tools that form the basis of many quantitative business applications in almost every area of management: market research, sales forecasting, stock control, financial analysis, production and scheduling amongst others.

Most of business and management undergraduate degrees and business post graduate courses have units related to KM, statistical methods and MS/OR in their syllabus to inform and equip future managers with the basics of quantitative techniques. However, the field of management science/operational research has evolved and changed from its early beginnings (when it was linked to the so-called classical MS/OR and their optimization modeling aid to decision making) towards a much broader outlook.

Nowadays, especially in the I-J, the term MS is regarded in a much broader umbrella in which the early classical OR techniques are practiced together with an increasing number of much more 'softer' and 'critical' MS/OR approaches. So, in this paper, management sciences methodologies (MS) are regarded as a generic term to group well known classical methods (quantitative approaches and optimization techniques) and also methodologies from soft and critical tradition in MS/OR.

After sketching the historical context in which MS/OR has evolved, the academic phase of early MS/OR is outlined; and a time-based framework to describe the evolution of MS is proposed together with a classification of four groups of Mams currently in use. The paper aims first to investigate the input of the quantitative techniques units/modules in under-graduate business studies and post graduate (Mambas) programmer across a sample of British universities.

At an undergraduate level the review is based on the study of the curriculum content of a random sample of business studies degrees and t a postgraduate level the review considers a sample of MBA programmer offered in the ASK. Results of the survey are discussed, general conclusions from the mapping of MS/OR discourses and from the survey are drawn; and some points for further research are proposed. Despite the importance of the content of KM and management science in business degrees, we found little evidence of research on the input of KM and MS/OR units into business degrees; apart from an early paper by Stray et al. 1994) and Whiskies et al. (1994) this is an area very much under researched. So, in this paper we set out to investigate to what extent KM or 'hard' lassie MS/OR approaches together with the most recent 'softer' methodologies developed in MS/OR community are still considered important in undergraduate and postgraduate business and management degrees. The Early Academic Phase of Operational Research/Management Sciences Operational Research origins dates back to 1939 when the British command in charge of the operations in the Battle of Britain assembled a team of scientists to study military operations.

The successful work of the team headed by P. M. S. Blackett influenced US military strategists and similar groups were created in America under f operational research started both in the US and the UK after businesses were persuaded by early practitioners of OR and began to perceive the OR techniques as relevant to the decision making process. This phase took place mainly in the 1940s when a number of management and business schools started to offer management science courses. 81 The term Operational Research was first mentioned at the height of the Battle of Britain. According to Cook and Shutter (1991): the team was given an office in Operational Quarters, where it remained until radar was proving its value in the Battle of Britain in 1940. To identify the room and the non-uniformed scientist using it, the phrase 'operational research' was coined for the six-man team, and the door labeled to that effect. It meant 'research into operations' or perhaps 'research within operational headquarters. It carried no broader connotations'.

Cook and Shutter (1991: 2) Operational research in its origins had a multi-disciplinary approach to complex problems and the so called 'golden-era' of operational research was full of applications of this kind. Since then has been a trend to associate OR with the use of mathematical models and statistical analysis. The teaching of such classical OR techniques such as linear programming, simulation, queuing theory was initiated in the US and its popularization continued in the late 1940s and the early 1950s when the first OR textbooks were published by Kickoff and Churchman (Churchman et al. 1957; Daunting 1963). The late 1940s witnessed the start of management science degrees in America which mainly included the OR/MS techniques discussed

in these textbooks. In the early sass, the trend in American OR/MS was towards a more 'goal seeking oriented techniques that become highly structured or 'harder' in its approach to problems. The other strand of management sciences at this stage was constituted by the set of methods that Auckland (1981) calls 'aids to decision making, the two main being systems analysis (RAND Corporation) and systems engineering (Bell laboratories).

On the academic side, American management education institutions absorbed these approaches to form the base of very technical orientated careers such as industrial engineering and systems engineering. Almost in parallel with the development of management sciences, these careers flourish in the US in the sass and were well established in the sass. Table 1 adapted from Lawrence et al. (2002) and Keys (1995) highlights some of the crucial historical events behind the development of MS/OR to the present time.

As it can be seen, most of the so-called 'classical' OR developments have occurred in the US, especially in the sass and sass. Around these years, linear programming, PERT-CPM, industrial dynamics (later Systems dynamics), integer programming, queuing theory, amongst others were created and subsequently enjoyed a huge popularity in almost every business school business schools. Essentially, borrowing Lawrence et al. (2002) and Keys (1995) data, we identify five historical stages in OR/MS development starting in 1900: (1) Beginnings; (2) Emerging; (3) Growth/stability; (4) Critique of OR/MS; and (5) New debates in OR/MS. The

30 year period starting with the end of the second world war is normally called the 'golden-era' of OR at least in its classical applications form; this era, as shown in Table 1 roughly comprises the years 1945-1975 and is characterized by emergence, growth and stability as regards OR applications on both sides of the Atlantic.

This growth, according to Keys (1995) is expressed in three important events: 1) OR is accepted as support to management; (2) professional bodies started to become established on both sides of the Atlantic; and (3) the provision of academic programmes gained acceptance especially in the States where university degrees in OR started earlier than in the I-J. In the early 1950s the critique to OR applications started to be more noticeable and the debate in I-J circles intensified. The 1950s and 1960s witnessed the emergence of new debates in OR and 382 Table 1 Management science/operational research time line 1.

Early beginnings *1890 Frederick Taylor develops the field of 'scientific management' applying scientific approach to improving operations in a production setting (industrial engineering) *1900 Henry Gantt develops a control chart approach for minimizing machine job completion times (Project Scheduling) Andrey A. Markov studies how systems change over time (Markov Processes) The general assignment approach is developed (Networks) *1910 F. W. Harris develops approaches to determine the optimal inventory quantitative order (Inventory Theory) E. K.

Erlang develops a formula for determining the average waiting time for telephone callers (Queuing Theory) *1920 William Shewhart introduces the

concept of control charts H. Dodge and H. Rooming develop the technique of acceptance sampling (Quality Control) *1930 Jon von Neumann and Oscar Northeastern develop strategies for evaluating competitive situations (game theory) 2. Emerging OR era *1940 Second World War provides the impetus for the scientific and multidisciplinary approaches to complex problems including applications of mathematical modeling for solving mathematical problems.

After the war, OR was not easily accepted in the US whereas in the I-J, due to the fact that many industries were nationalized, OR teams maybe with its social aspirations were allowed to develop George Daunting evolves the simplex method for solving problems with a linear objective and linear constrains (linear programming) The first electronic computer is developed OR Club is founded by Blackest, Goodbye, Dastard and Gordon in London 1947 *1950 Operational Research Quarterly (ORG), published in the I-J, March 1950 H. Kuhn and A. W.

Tucker determine required conditions for optimality for problems with a non-linear structure (Non linear Programming) Ralph Common develops a solution procedure for problems in which some variables are required to be integer values (Integer programming) Project Evaluation Review Technique (PERT) and Critical Path Method (CPM) are developed (Project Scheduling) In May 1952: The Operations Research Society of America (ROSA) and in December 1953: The Institute of Management Science (TIMES); two professional societies dealing with management science are established.

November 1952: First issue of Operations Research October 1954: First issue of Management Science Richard Bellman develops a methodology for solving multistage decision problems (Dynamic programming) 1954, Operational Research Society (OURS) is founded in the I-J 1957 First International OR conference in the I-J, organized by the OURS, ROSA and TIMES yes Pratt Action Rest (2011) 24: 379-395 Table 1 continued *1960 John D. C.

Little proves a theoretical relationship between the average length of a waiting line and the average time a customer spends in line (Queuing Theory) 1957 Jay Forester: Industrial Dynamics Specialized simulation languages such as CONSCRIPT and GAPS are developed (Simulation) Integer Programming: Branch and Bound, A. H. Land and A. G. Doll (1960) 4. Critique of OR 5. New debates in OR *1970 The microcomputer is developed Kickoff, R. (1979), The future of OR is past, Journal of operational Research Society, 30, 2. *1980 N. Carmaker develops a new procedure or solving large-scale linear programming problems. Linear Programming) The personal computer is developed; specialized management science software packages that can run on microcomputers are developed. I-J Soft Tradition in OR establishes: Auckland (1981, 1999) Systems Thinking, Systems Practice, Wiley; Eden et al. (1983) Spreadsheet packages begin to play a major role in modeling and solving management science models. *1990 January, 1995: TIMES and ROSA merge to form the Institute of Operations Research and Management Science (INFORMS) Critical and Pluralistic Systems Thinking influences MS in the I-J: Flood and Jackson (1991);

Jackson (1992, 1997); Mangers (AAA, Bibb) *2000 The post-modern approaches in management science: Tacked A and White, L. Partnership and Participation Decision- making in a multi-agency setting, Wiley, Chester, 2000 (Adapted from: Lawrence et al. (2002); Keys (1995); and Informs website: <http://www.Informs.Org>) although the centre of these latter debates had been mainly the I-J, there are signs that the debate had extended to other European countries. The development of the one followed by American institutions; it started mainly through the establishment of management sciences degrees.

Although engineering degrees such as Industrial engineering were never created in I-J management education, OR techniques and methods were incorporated first into management science and later into business studies careers. However, the emphasis was more practical than the courses in America. It is interesting to note that some Spanish and Latin American institutions have followed the American model and offer engineering based management careers with a very strong mathematical and analytical input in the curriculum.

The reason for this can be seen as an extension of the strong mathematical based education that s prevalent in other European countries, Pacer-Cares (1999); Barbour (1989); Barbour and Lawrence (1990, 1997). Current Situation of Management Science: Mapping the Development of Management Sciences In this section, a map of the development of some of the main systems based methodologies (SUB) associated with systems

thinking in the I-J is proposed to further understand the influence between systems thinking and MS/OR in the I-J.

We follow the four sociological paradigms introduced by Jackson: functionalist; interpretative; emancipators; and post-modern. We borrow Jackson's framework but qualified and changed it slightly and placed these developments in the context of management science practice along the four paradigms suggested by Jackson (2003): (i) the optimization/normative paradigm: problem-solving methods (1940-1960); (ii) the interpretative/learning paradigm: improving-situation methodologies (1960-1980); (iii) the critical paradigm: interdenominational emancipators systems methodologies (1980-1990); (iv) the post-modern management science/systems thinking.

Our adapted framework for the methodologies suggests four paradigms in the general placement of management sciences and systems thinking in the I-J: (a) optimization: problem-solving methods (1940-1960); (b) learning: improving-situation methodologies (1960-1980); (c) critical: intervention-empowering emancipators systems methodologies (1980-1990); and (d) pluralistic and multi-methodological: use of multi-methodologies and pluralistic approaches (1990-present).

Using the dimensions of time and these paradigms as they unfolded in management sciences and the systems movement over the last decades, a framework was constructed as shown in Fig. 1. It depicts the emergence and development of the main systemic methodologies in the I-J, showing the major direct and indirect influences between them over the last six decades.

The emergence of approaches using a positivistic epistemology and structured to problem-solving can be located in the late sass and and the USA and with the developments of systems engineering/systems analysis in the USA.

During the sass and sass, a number of soft systems thinking methodologies emerged in the I-J. Perhaps the most influential were Iceland's soft systems methodology (Auckland 1981, 1999; Pluralistic paradigm:

Multidimensionality/ Critical/Pluralism Critical Systems Paradigm:

Intervention Empowering Methodologies Critical Systems Methodologies

Systems of Systems Methodologies/ Total Systems Intervention, Jackson and

Flood, 1991 , Critical Systems Practice, Jackson, 1997. Methodology's,

Mangers, 1997.

KEY: Critical Systems Thinking, Habeas, 1970, 74; Mangers, 1980; Lurch,

1987. METHODOLOGIES THEORETICAL DEVELOPMENTS Learning Paradigm

Theory of personal constructs, Kelly, 1955 Soft Thinking: Strangulation's

Methodologies Appreciative Systems, Vickers, I-J, 1965, 70. Soft Systems

Methodology, Auckland, Lancaster, I-J, 1981. 90 Cognitive Mapping/ SODA,

Eden, et al, 1983, 1998, 2002. MAJOR INFLUENCE INDIRECT INFLUENCE

General Systems Theory, Building, 1956, Bertelsmann, 1973 Cybernetics,

Wiener, US, 1948; Shabby, US, 1956.

Management Cybernetics, Beer, I-J, 1959. Socio-Technical Systems, Emery

and Trust, Atavistic Institute, 1965. Social Systems Design, Churchman, USA,

1979. Interactive Planning System, Kickoff, US, 1981. Organizational

Cybernetics/ Viable Systems Model, Beer, I-J, 1979-; 81-84 The Systems

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Approach, Churchman, 1971 Optimization Paradigm Hard Thinking: Problem-solving Methods/ Techniques RAND (USA Systems Engineering, Jennings, 1969. Systems Dynamics, Forrester, US, 1961. 1940 1950 1960 1970 1980 1990 2000 Fig. The systems movement emergence of management science methodologies: major and indirect influences 385 Auckland and Schools 1990), and cognitive mapping developed by Eden et al. (1983). In the late sass and sass, critical systems thinking (COST) became prominent in the UK when total systems intervention' developed by Flood and Jackson embraced the COST commitments in systems practice (Flood and Jackson 1991). Finally, the more cent debate in OR and systems communities in the UK is around the use of methodologies in combination and acknowledging various paradigms.

The term pluralistic/ multi-paradigmatic thinking has been coined to name the approaches under this approach Jackson 1997, 1999, 2003; and Mangers AAA, b, and Mangers 1999. A brief description of each paradigm follows. The Optimization Paradigm (1940-1960): Problem-solving Methods Auckland (1981, 1999) locates the emergence and development of this paradigm in the late sass and sass. It was mainly an extension into management of what was the positivistic epistemology in the natural sciences.

The belief that organizations had an objective quality similar to that taken as given in the natural sciences, certainly underpinned the early developments of classical OR/MS methods and techniques. These approaches relied on the assumption that the decision maker acts in full possession of rationality or 'bounded rationality (Simon 1947). The ability to choose between different

alternatives might grant a fully comprehensive knowledge of what the problem is and how to resolve it. Associated with classic operational research/management sciences techniques and the so called 'hard' approaches.

Jackson (2003) places some of the systems-based methodologies of this paradigm in what he calls Systems approaches for 'Improving Goal Seeking and Viability. In addition to the classical OR methods (linear programming, simulation, queuing theory, PERT/CPM, etc.), the methodologies more currently associated with this approach are: Systems Dynamics; Organizational Cybernetics; and Complexity Theory The classic MS/OR or 'hard' approach has not been included in this group because this is a method that does follow a positivistic epistemology as oppose to the systemic approach prevalent in the other paradigms.

A clarification is needed here, following Mangers (AAA) and Auckland (1981); we distinguish methods from methodologies in management sciences. In that respect, we consider, for instance, linear programming or stochastic analysis to be methods or techniques that are widely used in management science but we do not consider as methodologies let alone systemic methodologies mainly because of their strong positivistic underpinning.

Although we acknowledge that these issues are contested in the MS/OR communities but it is important to indicate that although some approaches that have its origins in positivist epistemology, have become more accepting of softer notions; this is particularly the case of systems dynamics (SD) and the viable systems model (VS.). For instance, there is strong evidence that

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commentators from the SD field such as Lane (1999, 2000); Evening (1996); and Evening et al. (AAA, b) have incorporated notions of interpretive epistemology and indeed from the soft systems tradition.

An important platform that has been useful to this movement has been the practice of multi-methodology where these are combined or used in combination, Mangers (AAA). The Learning Paradigm (1970-1980): Situation-Improving Systems Methodologies Learning (Auckland 1981) and interpretive Jackson 1982; Mangers 1980, 1984) are the key characteristics that underpin the methodologies involved in this group. Kickoff (1993) calls this the 'design approach' comprising methods that attempt to dissolve systems of problems or messes.

He argues that these methodologies differ substantially to those of the 'research approach' in that they aim to tackle the context or environment where the mess takes place and trying to alleviate or dissolve the systems of problems rather than solving it. Jackson (2003) groups the methodologies of this paradigm under Systems approaches that 'Explore Purposes'; here he includes 'Strategic Assumption Surfacing and Testing' developed by Mason and Midriff (1981) and 'Interactive Planning' proposed by Kickoff (1981).

The most known methodologies that have been developed in the I-J and the US are: Soft Systems Methodology (Auckland 1981, 1999) Interactive Planning (Kickoff 1981) Strategic Assumption (Churchman 1971, 1979) Cognitive Mapping, SODA (Eden and Ackermann 1998, 2001) Viable Systems Diagnosis (Beer 1979, 1981) The Critical Paradigm (1980-1990):

Intervention-Empowering Systems Methodologies During the sass, a new set of theologies appeared in the I-J systems movement, based on critical systems thinking (COST), Jackson 1992; Flood and Jackson 1991).

The underlying philosophy is based on an assumption that social systems are intrinsically oppressive and unequal. Here, the focus of systems thinking is value-driven, and should concentrate on the issue of inequality. The emergence of this paradigm has been driven by the collaboration between Michael Jackson and Robert Flood at Hull/Humidifiers in the early sass. It might be argued that the main feature of these approaches is a focus on empowering the involved actors.

COST provides the philosophical underpinnings for the methodologies in this group, providing a framework for how best to address a coercive context and in which the social and organizational world are intrinsically oppressive and unequal. The two best known approaches are: critical systems heuristics (Lurch 1983, 1987); and total systems intervention (as developed by Flood and Jackson).

The Pluralistic Paradigm (1990-Present): Multi-paradigmatic and Pluralistic Thinking In the early sass an interesting debate in the OR and systems communities in the I-J arose concerning the value of using more than one theology (combining them or using parts of them); both systems academics and practitioners have been debating the possibility of combining methodologies from different paradigms, consciously taking account of particular strengths and weaknesses.

Two of the more fully-formed current approaches to multi-methodology are: (1) Critical Systems and critical pluralism/complementarily as initiated by Flood and Jackson and lately developed into 'coherent pluralism' by Jackson (1999); and, 387 Multi-paradigm multi-methodology/Critical pluralism developed by Mangers (AAA, b). The first years of the new millennia have witnessed the appearance of post-modern approaches in management science.