



# Past, present and future of problem structuring methods

J Rosenhead

*London School of Economics, London, UK*

To be able to exploit the future opportunities for Operational Research (OR), we need to prepare for them now. To conceptualize alternative futures for OR, we need to understand the potentialities of the present. To understand the present, we need to have a grasp of the past history that gave us the OR that we have, rather than some other analytic practice. OR was thrown up by a situation where traditional management methods were proving inadequate to handle the growing complexity of organizational arrangements. Problem structuring methods (PSMs) in turn were generated out of a sense that the trajectory of OR had led it away from important areas of social decision-making. PSMs have made great strides but are still encountering barriers to acceptance. This paper will explore the factors that presently constrain PSMs, and what developments could take them into new fields.

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## The past of operational research

Problem structuring methods (PSMs) have been one of the growth points for operational research (OR), extending its fundamentally analytic approach into problem domains with which OR had previously failed to, or not purported to, engage. In an earlier paper (Rosenhead and Thunhurst, 1982) it was argued (i) that it was unwise to prognosticate about the future without a solid understanding of the present; and (ii) that such an understanding was unreliable unless present conditions were seen as the outcome of a trajectory of past forces and events. As Marx famously stated ‘Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past’.

This paper will take a basically historical (if not adequately materialist) approach. The first section will undertake a succinct review of some relevant aspects of the history and pre-history of PSMs. The second section will provide perspectives on the current state of PSMs in terms of both practice and methodology—and link them to practical and intellectual tendencies elsewhere in society. The remaining sections will draw some possible inferences for the future development and application of PSMs.

Broadly this will be an account of European and mainly UK developments. There will not be space to examine why it is that professionals and academics in the United States have

so far been unwilling to adopt these methods. But as US publications largely turn a blind eye to overseas developments, it is not unreasonable to reciprocate in kind.

A brief disclaimer. The section on the past of PSMs does not even attempt to identify those many significant books, papers and projects which constitute key building blocks or turning points in the development of the approach. That must be the subject for another paper.

## The past of Problem Structuring Methods

PSMs have a history of, at most, 40 years. Of course, it is no doubt possible to find examples of elegant framing and re-framing of problematic situations from the Bible, if not earlier. However, I take the phrase ‘problem structuring methods’ to refer to the explicit promulgation and use of *methods* designed and intended for use on a class of situations. In the case of particular methods, this consciousness came about from the mid 1960s, and it came to encompass a recognizable family of methods from the late 1980s.

The problematic situations for which PSMs aim to provide analytic assistance are characterized by

- multiple actors,
- differing perspectives,
- partially conflicting interests,
- significant intangibles,
- perplexing uncertainties.

The relative salience of these factors will differ between situations (and different methods are selective in the emphasis given to them). However, in all cases there is a

meta-characteristic, that of complexity, arising out of the need to comprehend a tangle of issues without being able to start from a presumed consensual formulation. For an introduction to PSMs, see Rosenhead and Mingers, 2001.

After the first 15 years or so of PSM's self-conscious existence, they have achieved a substantial if still patchy record of application, covering both the private, public and voluntary sectors. Practice has been disproportionately located in northern Europe and especially the United Kingdom. Mingers and Rosenhead (2004) provide a recent review of practical applications.

The 40 years to date of PSMs were preceded by 30 years in which the traditional methods of OR were the principal repeat-use analytic tools for handling complexity. It is evidently appropriate to look at the experience of that preceding practice as the seedbed of PSMs. But equally OR itself did not 'just happen' around 1936. It was not just a case of lively minds having a bright idea. There were indeed lively minds. But there also needed to be a receptive environment. To understand better the potential of PSMs, therefore, we need to look both at PSM's pre-history, and at the pre-history of Operational Research itself.

### *The pre-history of OR*

OR text-books and definitions tend to represent the subject as a species of abstract rationality whose validity is timeless and universal. But the reality is (a) that it emerged as a self-conscious and continuing practice in Britain in the late 1930s and not in the biblical era, middle ages or even early industrial revolution; (b) that the explicit crystallization of this practice occurred in a national crisis that produced an openness to new ways of working and thinking; and (c) that its post-war survival depended on organizational conditions that were in many ways a continuation of pre-war circumstances—that is, the conditions for the adoption of OR preceded its 'invention'.

I will flesh this out. (A fuller version of this account will be found in Rosenhead, 1982.) Just as there was not always OR, there was not always management, because there was no need for such an identifiable function or cadre. The handicraft system of production was devoid of managers. Managerial tasks carried out by people who were not engaged in the primary activity of production first occur with the 'putting-out' system, in which as trade became less local it fell progressively under the control of merchants. This control was maintained through the treadmill of debt on which the craft worker was commonly trapped. However, the merchants discovered that the variability in both quantity and quality of product were too uncertain a base to sustain increasingly large scale and frequently international trade.

The early factory system overcame this control problem; by gathering the scattered workers together they became observable. Management now had two principle tasks: strict

supervision and discipline to ensure diligent application, and the recruitment of workers. The former made the latter more difficult, of course, and much of the early workforce was unwilling and recalcitrant. Production methods were initially unchanged—machines and common power sources came later. Even then, managerial control of the production process was quite partial. Frequently work was carried out by internal sub-contract. The subcontractor recruited and 'drove' a gang of workers, and obtained a fixed unit price from the factory owner. This was a method of *avoiding* management. The cost was that management did not gain the knowledge and control to restructure the labour process. Relatively small firms were linked by transactions in the market, and the managerial hierarchy remained vestigial.

In the early stages of the industrial revolution, Britain was in the forefront. The further expansion of managerial functions occurred first in the US (see Chandler, 1977). The continent-wide US railroad system produced the first extended managerial hierarchy. Middle management produced a range of industry-specific skills—for operating, routing, through ticketing, shared traffic, etc. Mass marketing made possible by nation-wide communications produced similar middle management in wholesalers, department stores, mail order firms and chain stores, all internalizing transactions that were previously performed through the market.

A more demanding form of coordination was required when the growing metal-making industries began to bring together the different stages of production on one site. Highly capital intensive, it became crucial to squeeze maximum production from the plant. This imperative produced engineering innovation, more sophisticated accounting, and a devastating attack on craft control and the steelworkers union.

In the metal-working shops, too, during severe competition during the Great Depression, management moved to seize control of the process. Expensive machine tools were unproductive and there were high levels of expensive in-process inventory due both to the complexity of production patterns and to job control by powerful foremen or internal subcontractors. Scientific Management (including time-and-motion studies) developed procedures to deskill the craft worker, bypass the foreman, and recompose work in ways that facilitated quantification, control and speed-up. It also addressed the issue of incentives based on the quantification of output, that could replace craft satisfaction. Henry Ford adapted the same approach to a different manufacturing area, but adding the moving line to physically control the speed of production.

One effect of the Great Depression was horizontal integration through merger in order to maintain profits by controlling price and output. Successful giant enterprises added vertical integration to reduce costs through administrative coordination. But this centralized organization put impracticable burdens on top management, as was shown up

around 1920, when major firms failed to anticipate or respond quickly enough to a sharp recession, and went under. The lesson was learnt first at General Motors and at Dupont. Demand forecasting needed to be institutionalized, and long-term planning became a key function of top management, along with policy formation and capital allocation. Multi-divisional restructuring isolated them from the distractions of operations.

This is by no means the end point of management history, which moves on continually. (I have not touched on the information and communication technologies largely summoned up by organizational priorities, and in turn transforming management possibilities.) What this synopsis indicates is the responsive nature of management developments. Broadly the successes of one advance sow the seeds of the next set of problems, requiring yet further innovations in organizational structure and management technique. The key elements in this story are scale and complexity, and uncertainty and control. Management tools and techniques have been generated to overcome organizational limits to growth.

### *Operational research and its limitations*

Operational research has its own history, starting around 1936 in the UK preparations ahead of the Second World War. This story is now relatively accessible (see for example Kirby, 2003) and I shall not recount it here in any detail. Broadly, it is a story of scientists, many of them subsequently to become distinguished in their original fields, engaging with novel problem situations outside the laboratory. Many of them were socialists who believed that, were it not for capitalism, science could produce benefits for all rather than profits for the few. The war gave them the chance to put this credo into action (Rosenhead, 1989).

Postwar, after a fitful and temporarily unsuccessful start in UK civilian government, OR was adopted with some enthusiasm in heavy industry and public utilities, and then in industry and business more generally. By the 1970s, OR was also becoming a widespread presence in government. The trajectory was different in other developed countries, but resulted in the inclusion of the methods or at least the techniques of OR into the repertoire of major enterprises.

Operational researchers, and their national associations, had the aspiration for their subject to tackle the major strategic issues of organizations, and indeed of society as a whole. However, with few exceptions practice was dominated by rather routine functions—project planning, logistics, forecasting, manpower planning, etc. Applications of OR to the appraisal of major investment alternatives and other problems nearer the frontier with strategic decision-making were less frequent. Indeed there was an extended period of disciplinary malaise during the 1970s and 1980s concerned with OR's inability to gain entry to the arenas where strategic issues are decided.

With hindsight it is possible to see this limitation of OR's remit as forming a continuum with the pre-war experience of the development of management techniques. Although OR was born in extraordinary circumstances, its survival depended on its accommodation with the more normal conditions of organizational life. These generated a continuing managerial need for the routinization of tasks whose complexity would otherwise produce reliance on unobservable middle management craft skills; and for the provision of information as input to higher-level policy discussions. It can be argued that OR's distinctive contribution was a more holistic approach to 'systems of men, money, material and machines'. Time and motion and its successor work study could examine the operations of an individual worker or a workshop with a view to increasing throughput or decreasing costs, whereas OR had the analytic tools to extend such efficiency or evaluative studies to networks of interacting processes.

The limitations that OR encountered echoes those frustrated aspirations of the socialist pioneers of OR who believed that the positive potential of science should be deployed in the general rather than sectional interests. Their analytic innovation had been adopted by the system whose end they had hoped to see; but within bounds which excluded it from the policy area.

The internal crisis of OR which took place mostly during the 1970s and 1980s was not expressed in these terms, although it can be mapped on to them. Rather the debate was cast in terms of OR's techniques and methodology. Critics such as Ackoff (1979), Checkland (1983) and Churchman (1967) noted the assumption behind standard OR techniques that relevant factors, constraints and the objective function are both established in advance and consensual. Likewise standard formulations of OR methodology (eg: formulate, model, test, solve, implement) took as their foundation the possibility of a single uncontested representation, that of the legitimate decision maker, of the problem situation under consideration. This approach, it has been widely argued, does not prepare OR analysts well for the complexities of the 'swamp' (Schon, 1987).

Traditional OR analysis works well when

- the client organization is structured as a tight hierarchy,
- few of its members are analytically sophisticated,
- the organization or relevant unit performs a well-defined repetitive task generating reliable data,
- there is general consensus on priorities (Greenberger *et al*, 1976).

These conditions describe reasonably well the circumstances in which decisions need to be taken at middle management levels in many large work organizations, where unilateral control is exercised over uncontentious activities. Indeed without traditional OR's assistance many aspects of our complex social arrangements could operate if at all only ineffectually or with unreasonable waste of effort.

However, these conditions are not those that typically characterize strategic decision-making in any organization. So there have arguably been two obstacles to the advance of traditional OR into the field of strategy. One is that the methods and techniques that OR could advance as evidence of its capabilities did not fit well with that context of potential application. The second is that even if appropriate tools and methods had been on offer, that does not necessarily mean that management would cede to them any part of its powers and responsibilities.

Management tools are adopted, as the history sketched out above indicates, only when organizational limits to growth would otherwise threaten the organization's viability. A cautionary tale from that earlier history was ignored or overlooked by OR's 1960s establishment, eager to extend their subject's influence. Frederick Taylor, the key figure in Scientific Management, originally cast his process of work measurement and control within the framework of a larger planning system to be run by his technically skilled engineers. This he saw as rendering conventional management in effect obsolete. Instead of bowing gracefully out of the picture, however, management appropriated those elements of Taylor's approach which they needed, while reserving authority to themselves rather than the technocrats (Taylor, 1947).

Traditional OR's glass ceiling, the product of both internal and external constraints, generally has restricted it to relatively 'tame' problems (Churchman, 1967). Strikingly, when managers with an OR background have been promoted to senior management roles, they have tended to find their OR heritage of relatively little direct applicability in their new responsibilities. This supports the case that a methodological deficiency is implicated in the relative restriction of OR's scope. However, on the analysis advanced in this paper, changing OR's methodology and toolbox could only remove one of the twin obstacles. For a changed approach such as that embodied in PSMs to be adopted, it must engage with aspects of organizational functioning where a continuation of traditional methods threatens viability.

### PSMs—what is the question?

So if PSMs are the answer, what is the question?

#### *The demands of PSMs*

As already indicated in the previous section, PSMs are appropriate for situations characterized by multiple actors, differing perspectives, partially conflicting interests, significant intangibles and perplexing uncertainties. They can operate in such contexts because they

- are designed for deployment in a group format,
- permit the simultaneous consideration of alternative perspectives,

- are participative in nature, with interaction among participants, and between participant and facilitator(s),
- iterate between analysis of judgmental inputs and the application of judgement to analytic outputs,
- allow closure when participants are satisfied with the progress achieved, rather than requiring commitment to a comprehensive solution of all the interacting strands that make up the problematic situation.

Evidently, methods like this can only work if those people who must in some way take responsibility for acting on the commitments reached (whether to implement particular aspects of an agreed scheme of action, or to recommend them to the relevant decision makers) are willing to invest very substantial amounts of their time. The dynamics of group decision-making is such that with a problem of any complexity and a group of non-trivial size it will be unusual to reach closure in under a full day.

Organizational actors who have the required level of responsibility are likely to be under heavy time pressure. (Different arguments but with a similar outcome apply to community OR projects, where participants are often only able to take part after the end of the normal working day.) Furthermore, the problem structuring focus of the process makes the group's outputs harder to predict in advance even in broad terms – because the interactive group process will generate not only the answer but before that the question. This means that the outcome has an unusual degree of uncertainty, generally unwelcome to decision-makers. They will, therefore, need to be clear (a) that the issue is of significance; and (b) that there is not a less resource intensive way of resolving it.

Why (and when) should busy and perhaps important people willingly put themselves in such a situation? Some reasons can be looked for in changes in the way the world's business is transacted, and some in the way that people (including those who transact the business) think about their circumstances.

#### *The changing organizational environment*

The practical changes in the organizational context over recent decades are well rehearsed. Globalization has reduced the scope for firms trading in single markets, and has increased the inter-dependency of the world's economies. Information and communications technologies have speeded up the process of action and reaction and hence the rate of change. Turbulence rather than stability has become the commonsense perspective on the future. The reach of organizational hierarchies has been reduced, with an attenuation of central planning and more reliance on speed of manoeuvre. Organizational alliances between autonomous entities have become more prominent. Government has reduced its delivery capability, relying more on contracting for services, or on offering incentives to elicit

cooperative behaviour (Ciborra, 2002; Clerk and Newman, 1997).

This is a very different world to the one in which traditional OR reached maturity. Substantial islands of well-defined functions under unitary control do still exist (notably in logistics), but elsewhere the commanding heights of large command-and-control organizations which OR dreamed of scaling with algorithmic ropes have been gradually eroded while we were still polishing our crampons. With them goes the residual hope that significant organisations might be run as optimizing machines. But that had in any case proved to be a chimera, even when bureaucratic dinosaurs ruled the organizational jungle.

Practical changes in the social world (of which the organizational world is one manifestation) are not independent of changes in ideas about that world. They reinforce each other. At the level of the airport bookstall, for example, popular science works on complexity appear to justify, even compel, the abandonment of large-scale top-down planning. Mutual interaction between relatively autonomous fragments is claimed, on the supposed authority of natural science, to be the best way to find excellent solutions to tough problems (Kaufman, 1995; Stacey, 1992).

At the cultural level, the same period has seen the rise of postmodernism, with expressions from architecture and philosophy through to literature and music (Harvey, 1989). Postmodernism denies the legitimacy of large-scale visions, of looking beneath the surface for the causes of things, of the notion of progress towards 'better' answers that can either be agreed on by all or be determined by science. In these and other ways the very idea of analysts making model-based recommendations to singular bosses with the power to implement has been undermined. In fact, there is a democratizing strand to postmodernist thinking which chimes well with PSM's openness to multiple voices.

PSMs can be seen as a reaction to this new circumstance—or rather as one of the currents and eddies that together constitute this new circumstance. As a reformulation of a methodology previously based on unitary perspectives it was not alone. At very much the same time urban planning and policy analysis began to talk of an 'argumentative turn', in which interaction between partisans with different perspectives was the basis of planning, rather than its nemesis (Fischer and Forester, 1993). When PSMs began to rise to prominence in the late 1980s they were quite often viewed by traditional practitioners as outlandish and threatening, in that they purported to bring subjectivity within the previously scientific domain of OR. However, in the broader perspective of practical and intellectual developments in the larger world, PSMs can be seen as offering a possible role for analysis in a context where the previous certainties were becoming the exception rather than the rule.

### *SWOT on PSMs*

The preceding discussion suggests that PSM's strengths are likely to be methodological, and also that threats to its growth could arise from a failure to map onto pivotal decision areas where current decision support is perceived as inadequate. Given the as yet rather moderate pace of the advance of PSMs, it may be that this mapping is, at least as yet, imperfect. However, there are other possible interpretations.

As a device to provoke discussion I have organized some of the relevant factors within a loose SWOT framework below:

#### *Strengths:*

Analytic basis for handling subjectivities and difference,  
 Recognition of the existence of a client system,  
 Acceptance of the significance of non-quantitative uncertainties,  
 Participation leading to group ownership of problem formulation and its consequences,  
 Spreading name recognition for some methods, and an established literature,  
 Intellectually lively, with developing methodology and research agenda.

#### *Weaknesses:*

Concentration on nonroutine situations inhibits institutionalization,  
 Non-transferability of the workshop experience can cause implementation problems,  
 Unpredictability of outputs,  
 Limited scope for evaluating the effectiveness of PSMs.

#### *Opportunities:*

Provision of analytically-based procedures in a larger fad-infested management arena (see Jackson, 1995),  
 Acceptability in potential client organizations of workshop-based approaches,  
 Extension of clientele to non-managerial groups,  
 Exchange of methods and application areas with neighbouring fields,  
 Improving the quality of public debate on policy,  
 An established field with as yet scarcely explored research opportunities.

#### *Threats:*

Base of skilled practitioners is limited, and apprenticeship-based growth is slow,  
 In an academic climate characterized by competitive evaluation of research output, faculty posts are vulnerable to the higher publication rate possible in traditional OR,  
 Age profile of key originators and proponents of methods,  
 Other approaches to strategy involve less jargon and paraphernalia,

Difficulty in accessing ‘wicked’ problems from a historic base in handling tame ones.

Many of these entries suggest possible avenues for entrepreneurial, institutional or research activity.

### The future of PSMs

Operational research has a singularly bad record at seizing the opportunities that hard work or good luck put in its way. Little relative impact has been made in such areas as Business Process Re-Engineering, or Total Quality Management, despite some evident openings. The same can be said of attempts to address the HIV/AIDS epidemic. Arguably many of these opportunities have not been recognized due to a predominant narrow view of what constitutes an ‘OR problem’.

Some areas of possible expansion/application for PSMs can be identified by applying the dual tests: are the potential applications in significant areas? And are those areas handled inadequately at present?

#### *Development planning methods*

Third world planning has been through a paradigm shift comparable with that of OR. Its newer more participatory approach has developed a number of methods, some diagrammatic, others using easily available objects (eg seeds or pebbles) to represent or rank options or outcomes. Like PSMs, there is a strong emphasis on group work, iterative learning, ownership of process and outcome; and on low data requirements, diversity of tools, and accessibility and transparency. These methods—of which Rapid Rural Appraisal (RRA) and Participative Rural Appraisal (PRA) (see Chambers, 1997) are the most widely used—do not incorporate any element of cause-effect modelling, which in principle would appear to have the potential to increase their power. They also have a well-established place in development planning practice. In principle the incorporation of PSMs into their repertoire could augment their effectiveness.

#### *Community operational research*

In 1987, the British Operational Research Society set-up the Community Operational Research Unit to work with disadvantaged groups. This initiative has generated a body of experience of model-based work for diverse grass roots organizations (see Midgley and Ochoa, 2004).

A considerable proportion of the reported work has made use of PSMs, indeed a much higher proportion than with applications for more conventional clients. This is not hard to understand. One of the defining characteristics of what constitutes a potential client for Community OR was that it should operate non-hierarchical through consensus or

democracy. Furthermore the groups commonly consist of members without analytic training or experience. So the potential advantage of PSM’s transparent and accessible methods is evident.

Given the extent of disadvantage in Britain, as in other developed countries, the potential for this type of work exceeds by orders of magnitude the experience to date.

#### *Large group interventions*

PSMs are at present limited to relatively small groups—practitioners of different methods do not quite converge on the limit, but no one suggests that more than 15 members should be accommodated. However, there is a range of situations where substantially larger groups convene for the discussion of mutual problems—for example to identify the scope of a problem and/or to agree on a strategy. There has recently been a proliferation of methods for large group interventions, including *Open Space Technology*, *Future Search*, and *Team Syntegrity* (see Bunker and Alban, 1997; Pratt *et al*, 1999).

These methods have clear similarities with PSMs. Each of the approaches aims to liberate creative thought by bringing together diverse experiences, knowledge bases and experience. Each aims to generate collaborative action towards a desired future. This suggests the possibility of synergy. Large group methods employ elaborate procedures to enable face-to-face conversations in smaller groups to be integrated into larger processes of consensus formation. However, they do not have the benefit of the interactive and transparent modelling to support decision that is PSMs distinguishing characteristic. There does appear to be a potential for mutual borrowing resulting in an enlarged potential.

#### *Design of information systems*

For many years information systems design was dominated by technical concerns. Essentially the aim was taken as the computerization of some existing manual system. From this perspective the task was seen as developing efficient solutions to problems that were assumed to be clear and well-defined. This approach works well for basic operations such as payroll and transactions processing, but more ambitious applications have all too often led to costly (and frequently high profile) disasters. There are a variety of reasons for these repetitive failures, among which are the fragmentation of relevant knowledge among different stakeholders, and the political as well as rational dialogue which is needed to establish a workable system.

These characteristics appear to play to the strengths of PSMs, and indeed this area has become a significant field of application for SSM (Stowell, 1995; Checkland and Holwell, 1998). Other methods, however, do not seem to have been adopted, despite their potential. For example, SODA could help to establish the differing perceptions that are held of the

factors that should be taken into account, and their linkages. Where sequential development of a system is envisaged, or where uncertainties exist about the purposes to be served or the contexts in which it will be applied, either robustness analysis or Strategic Choice Approach seem to have the potential to add value.

### Risk management

Risk management has become a major area of concern for the corporate world, and in a sense more generally. Gone are the days when the corporate risk manager's almost exclusive concern was with insurance. Uncertainty is now seen as pervasive, with the result that almost any issue may be re-conceptualized as a risk issue. Especially at the strategic level, the existence of irreducible uncertainties is only one of two interacting dimensions of the problem. The other is the diversity of perceptions of actors involved in the decision process. This is especially significant of course where, as is the case with growing frequency, inter-organizational stakeholders are involved.

The combination of uncertainties with a plurality of viewpoints does suggest a potential role for PSMs. The relatively under-developed nature of the non-reductionist risk management methods available to management points in the same direction. There is some reported experience of the application of PSMs in this context (Horlick-Jones *et al*, 2001), but the potential is almost untapped and untested.

### In conclusion

For over 30 years, and especially during the past 15 years, Problem Structuring Methods have been accumulating a track record of practical experience. In the process they have been gaining in methodological sophistication. The potential for their use, however, still far outstrips their applications to date. The challenge for practitioners and developers is to identify those opportunities where the potential of the method marries up with a managerial need that remains poorly served.

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### References

- Ackoff RL (1979). The future of operational research is past. *J Opl Res Soc* **30**: 93–104.
- Bunker BB and Alban BT (1997). *Large Group Interventions: Engaging the Whole System for Rapid Change*. Jossey-Bass: San Francisco.
- Chambers R (ed) (1997). *Whose Reality Counts? Putting the Last First*. Intermediate Technology Publications: London.

- Chandler AD (1977). *The Visible Hand: The Managerial Revolution in American Business*. Harvard University Press: Cambridge, Mass.
- Checkland PB (1983). OR and the systems movement: mappings and conflicts. *J Opl Res Soc* **34**: 661–675.
- Checkland P and Holwell S (1998). *Information, Systems and Information Systems: Making Sense of the Field*. Wiley: Chichester.
- Churchman CW (1967). Wicked problems. *Mgmt Sci* **14**: 141–142.
- Ciborra C (2002). *The Labyrinth of Information: Challenging the Wisdom of Systems*. Oxford University Press: Oxford.
- Clerk J and Newman J (1997). *The Managerial State: Power, Politics and Ideology in the Remaking of Social Welfare*. Sage: London.
- Fischer F and Forester J (eds) (1993). *The Argumentative Turn in Policy Analysis and Planning*. UCL Press: London.
- Greenberger M, Crenson MA and Crissey BL (1976). *Models in the Policy Process*. Russell Sage: New York.
- Harvey D (1989). *The Condition of Postmodernity*. Blackwell: Oxford.
- Horlick-Jones T *et al* (2001). Decision support for organisational risk management by problem structuring. *Health Risk Soc* **3**: 141–165.
- Jackson MC (1995). Beyond the fads: systems thinking for managers. *Systems Res* **12**: 25–42.
- Kaufman SA (1995). Escaping the Red Queen effect. *The McKinsey Quart* **1**: 119–129.
- Kirby M (2003). *Operational Research in War and Peace: The British Experience from the 1930's to 1970*. Imperial College Press: London.
- Midgley G and Ochoa-Arias AE (eds) (2004). *Community Operational Research: OR and Systems Thinking for Community Development*. Kluwer Academic: New York.
- Mingers J and Rosenhead J (2004). Problem structuring methods in action. *Eur J Opl Res* **152**: 530–554.
- Pratt J, Gordon P and Plamping D (1999). *Working Whole Systems: Putting Theory into Practice in Organisations*. Kings Fund: London.
- Rosenhead J (1982). Why does management need management science? In Troncale L (ed). *A General Survey of Systems Methodologies*, Vol. 2, Society for General Systems Research, Louisville, KY, pp 834–839.
- Rosenhead J (1989). Operational Research at the crossroads: Cecil Gordon and the development of post-war OR. *J Opl Res Soc* **40**: 3–28.
- Rosenhead J and Mingers J (2001). *Rational Analysis for a Problematic World Revisited: Problem Structuring Methods for Complexity, Uncertainty and Conflict*. Wiley: Chichester.
- Rosenhead J and Thunhurst C (1982). A materialist analysis of operational research. *J Opl Res Soc* **33**: 111–122.
- Schon DA (1987). *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*. Jossey-Bass: San Francisco.
- Stacey RD (1992). *Managing the Unknowable: Strategic Boundaries Between Order and Chaos in Organizations*. Jossey-Bass: San Francisco.
- Stowell F (ed) (1995). *Information System Provision: the Contribution of Soft Systems Methodology*. McGraw Hill: London.
- Taylor FW (1947). *Scientific Management*. Harper and Brothers: New York (comprising Shop Management (1903), The Principles of Scientific Management (1911), and Testimony Before The Special House Committee (1912)).

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