Methodology Alternative

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alternative OR

The hard facts support the use of soft systems methodologies and problem structuring methods in tackling real-world situations

By Hans G. Daellenbach

In 1961, C. West Churchman, one of the pioneers of operations research, told a graduate class at the University of California-Berkeley that it was in our hands to put operations research to work for strategic, executive-type problems of major importance to firms, governmental agencies and society as a whole, rather than get bogged down in tactical production problems of relatively minor importance — the path he saw OR veering toward. If we did not do this, Churchman said, then other people would come along and do it, but they would not call it OR. His prediction came true in the early 1970s with the birth of soft systems methodologies and problem structuring methods (SSM/PSM).

What Churchman did not expect was that the SSM/PSM people would also partially reject his own philosophical approach to problem solving, although a number of them used his views as a starting point, incorporating and extending his philosophy of a dialectic debate. In fact, most of the new methods grew out of trying to apply the traditional OR, systems analysis or systems engineering paradigms to less well-structured situations.

Learning from their failures, SSM/PSM designers developed new approaches known as (the name of the principle proponent and the date of the major publication appear in parentheses): the strategic assumption surfacing and testing method (R. Mason and I. Mitroff, 1969/1981), the metagame analysis (N. Howard, 1971), the viable systems model (S. Beer, 1972), Checkland's soft systems methodology (P. Checkland, 1972), the social system science (R. Ackoff, 1974), strategic choice approach (J. Friend, 1978), robustness analysis (J. Rosenhead, 1980), the hypergame (P. Bennett, 1980), strategic option development and analysis (C. Eden, 1983), critical systems heuristics (W. Ulrich, 1983), and the meta-methodology total systems intervention (M. Jackson, 1991).

Except for Jackson's methodology, each of these new approaches was developed to cope with particular situations. Therefore, they may not necessarily be suitable for completely different situations. Together they have been applied to more than one thousand documented real-life applications involving strategic issues, resulting in actual implementation of results or provoking a significant shift in thinking while leading to other projects.

It behooves us to listen to what these results have to say about the role of OR and why these approaches claim greater relevance for today's complex world. Without apology, I will liberally borrow from J. Rosenhead's incisive introductory chapter to "Rational Analysis for a Problematic World" [1989].

The domain of 'hard' methodologies

The protagonists of SSM/PSM refer to OR/MS and similar approaches as hard methodologies. Their claim is that OR/MS methods are suitable only if:

- The problem has been clearly defined, implying that: the objectives of the decision maker are given a priori, and there exist criteria to ascertain when they have been achieved; the alternative courses of action are given, either as a list of options or a set of decision variables; the constraints on the decision choices are known; the input data needed are available, regardless of how massive the requirements; and objectives, alternatives and constraints remain constant throughout the solution process, except for straight-forward numerical changes, i.e., they are not affected by the solution process.
- The problem can be sufficiently well insulated from its wider system that forms its environment, i.e., it can be optimized on the basis of the inputs it receives from the wider system.
- The problem is relatively well-structured, even if it may be complex, meaning that: the relationships between the variables are tractable; they can be expressed in quantitative form; and the computational effort for de-

termining the optimal solution is economically feasible.

- Uncertainties, if they exist, relate only to the environment and can be captured by probability distributions.
- The problem is of a technical nature, largely devoid of human aspects.
- The problem is seen exclusively from the vantage point of the decision maker. Only his or her objectives are considered. If the solution derived by the method is accepted, implementation is assumed to follow. This implies a hierarchical chain of command where the decision maker has the power, means and willingness to enforce the decisions.
- The external analyst is capable of bringing all strands together and employ high-powered, complex techniques that often completely hide how the solution has been derived, i.e., accepting the solution is often an act of faith, rather than being based on a proper understanding of the solution derivation.

SSM/PSM advocates claim that, although many such problems exist, the majority of the real-life strategic problem situations in business, industry and government violate many, if not most, of these assumptions. The traditional OR paradigm cannot accommodate these important problems and is thus largely reduced to dealing with rather simple and less important tactical problems after the major decision has already been made.

Many OR/MS texts and scientific, hard-core OR journals help confirm this impression with their emphasis on the mathematics of OR. Textbooks typically devote six to 10 pages to the OR paradigm and then devote the remaining 98 percent of the text to techniques and examples of the use of techniques. The major portion of scientific OR literature is devoted to the mathematics of OR, with little concern for the practical relevance or the practical use of the techniques and algorithms presented.

Practical problem solving — the original tenet of OR — now receives little more than lip service. Even if the authors talk of applications, they only mean the "potential for" applications. They give us toy examples. Few of the new techniques and algorithms will ever see a practical implementation to a real-life project. As a result, most practicing operations researchers largely ignore this portion of the literature. Their approach to problem solving is much more comprehensive, flexible and realistic.

There are some notable exceptions to, and efforts to counterbalance, the emphasis of the mathematics of OR. *JORS*, the official journal of the United Kingdom's Operational Research Society, and *Interfaces*, jointly published by ORSA and TIMS, have regularly run accounts of real-life applications since the late 1970s. Each year, one issue of *Interfaces* is devoted to the six finalists of the annual Franz Edelman award for management science achievement. The award recognizes outstanding examples of professional, implemented OR practice. Since 1986, *Operations Research*, the flagship journal of ORSA, includes one or two accounts of implemented applications of OR work in each issue. However, the majority of these applications deal with tactical problems. In my opinion, this is far too little in relation to the flood of papers on the mathematics of OR.

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The real world of strategic decision making

The protagonists of SSM/PSM perceive the real world of strategic decision making quite differently. In the real world:

- The problem is not known a priori. What is presented, or what may trigger an investigation, is a problematic situation. It is often vague and only partially specified. It involves various stakeholders: the problem owner(s) (the person who controls the means), the problem user(s) (the person who will use the results), the problem customer(s) (the victim or beneficiary of the results), and the problem analyst. It usually consists of a number of interrelated and interdependent issues. In fact, one of the initial tasks in any project is to choose the issue or subset of interrelated issues to be tackled first. Consider:

1. Each stakeholder has her or his own Weltanschauung, i.e., way of viewing and interpreting the problem situation based on her or his background, experience, training and values. This implies that each stakeholder has her or his own perspectives and priorities. There is usually no a priori consensus. At the inception, most stakeholders are not fully aware of their own world view, let alone the views of other stakeholders. Consequently, objectives are not known a priori, but emerge only during the process of selecting a relevant issue and studying it (the solution process). Furthermore, since a person's world view is not something fixed for all times but is affected by experience and interaction with other people, the perspectives and priorities (the objectives) change during the solution process.
2. From this, it follows that the stakeholder will want to pursue multiple conflicting objectives, but the preference structure over the objectives still needs to be externalized. Again, the preference structure may be subject to change as part of the solution process.
3. The "means" available are only partially known a priori. New means may emerge as part of the solution process. Means are not just subject to technical constraints, but also to cultural feasibility. The latter may again change as world views change during the solution process.
4. There will be data gaps. The data may not be available, or not in the form required, e.g., average rather than marginal costs, or not relevant to the new system contemplated. There may not be sufficient time, resources and willingness on the part of the stakeholders

to get them or disclose them. Therefore, decisions may need to be made in the absence of all desirable data for a proper rational choice, as required by many high-powered OR techniques.

• Since problem situations consist of interdependent issues, a particular issue cannot easily be isolated and "optimized" independently. There are feedback loops with other issues. Hence, the concept of optimization becomes somewhat questionable.

• Because the problem is not known a priori and consists of interdependent issues, strategic problem situations are complex in the sense that they are ill-defined, involve people and aspects that do not necessarily lend themselves to be quantified, and are subject to various types of uncertainties. This contrasts with the purely technical and computational complexity that can be handled by OR techniques. Strategic problems are dynamic.

• There are at least three types of uncertainties and ambiguities:

1. Environmental uncertainties, only some of which may possibly lend themselves to partial specification by probability distributions. However, most strategic decisions involve completely new and unique futures. Therefore, past data are usually of little relevance and use.
2. Ambiguities about objectives which are due to conflicting perspectives and only partially externalized world views of the various stakeholders. Hopefully, the solution process will shed more light on these aspects. But it would be wishful thinking to expect that world views of the various stakeholders will ever be fully externalized and a full consensus between the various stakeholders reached.
3. Ambiguities about the cultural, social and political feasibility of means. These may not be apparent a priori, but only become known as part of the solution process.

Coupled with this are the biases most individuals fall victim to when attempting to make statements about data subject to uncertainties and ambiguities, and the effect of framing on their answers [see the seminal papers by A. Tversky and D. Kahneman, 1974 and 1981].

• People are active participants in the solution process. They are not passive subjects to be studied; their involvement does not end once the data extracted from their minds has been fed into the solution technique. Hence the problem situation is dynamic, not static. It involves cultural, social and political aspects with all the emotional and political complications of real people.

• Strategic decision situations usually involve groups of people with different perceptions, priorities and agendas, not just a single decision maker. Even if a hierarchical structure of command exists, implementation of the solution still requires the active acceptance and cooperation of almost all stakeholders to become effective, not just the top decision maker. However, for most issues in the public arena (health, justice or the environment) there is no hierarchical chain of command, but a confrontation of various highly educated groups with a vested interest, such as the medical staff, nurses and the administrators in a hospital. The solution process must be able to cope with such multitude and diversity.

• All stakeholders respond best if the method used is genuinely participative and transparent to them, and if they contribute to the construction of the solution actively, i.e., if they own the solution. The role of the analyst, if there is one present, becomes more one of a facilitator than problem solver.

The OR paradigm assumes away most of these aspects. The problem is taken as already neatly defined and ready for mathematical modeling. The critical and difficult problem-shaping aspects that any analyst would have to deal with are absent from the paradigm.

The only OR model that tries to deal with the human aspects of conflict is game theory. As J. Rosenhead [1989, p. 8] states, " ... the classical theory can handle only a thin caricature of the richness of real situations. Practitioners have made virtually no explicit use of game theory, leaving it as the preserve of academics of an unusual abstract disposition."

Main features of SSM/PSM

The protagonists of SSM/PSM claim their approaches can handle the real world of strategic decision making more successfully than OR for the following reasons:

• Their approaches do not deal with problems, but with problematic situations that consist of various interrelated issues and involve multiple stakeholders, all bringing in their own personal world views, perspectives, priorities and agendas of which they are only partially aware. R. L. Ackoff refers to these as "messes."

• Cutting through the maze of interrelated issues is a critical part of these approaches. A major effort goes into this aspect. For the ultimate results or solution to be of any value and use, this aspect has to be done right.

• They are truly participative, involving all or most stakeholders at various stages of the solution process. There are specific aids for facilitating dialogue between the various stakeholders.

• They first look at "what" or strategic questions, rather than "how" or tactical questions, i.e., "What is the nature of the issue?" or "What changes are systematically desirable and culturally feasible?" Only when a sufficient consensus has been reached on such aspects do they address, "How are these changes best brought about?"

• They accept that the problem chosen is an intellectual construct. A different group of people would perceive the problem differently, and so might the same group in a different context. But if the problem is an intellectual construct, so must be the system(s) built to solve it. The problem definition and the corresponding system(s) are thus subjective. There is no implication that this particular system exists in the real world or should exist in this form.

• They are not optimizing, but satisficing approaches to problem solving, although they aim to devise solutions that are effective in terms of the goals, and efficient in terms of the means. Many do not attempt any rigorous quantification, although this is not excluded if it leads to greater insight and consensus into the various perspectives, and into the technically and culturally feasible solution space. Many also use highly effective graphical aids

to bring out the structure of the issues considered and the relationships between various aspects. This does not, however, imply that these approaches are not rigorous in terms of their systems thinking and the use of systems concepts.

- They allow the problem situation, in all its complexity, and the means to evolve as part of the solution process, i.e., the problem situation remains dynamic.
- Most see their underlying philosophy as learning systems, rather than problem-solving systems. Their aim is to help the participants gain greater insight into their own personal world view and perspectives, the world views and perspectives of the other stakeholders, and the culturally and technically feasible solutions space. Experience has shown that this will induce a critical review of their own world view, allowing it to evolve as part of the solution process. This, in turn, will affect the feasible solution space and help bring about a greater degree of shared consensus. When a "solution" emerges, it is almost obvious and entirely owned by all stakeholders involved. The underlying theoretical basis for this is H. Simon's [1958, pp. 47-52] model of adaptive human behavior. It postulates that the level of satisfaction, the intensity of search for new solutions, the expected reward and the level of aspiration form a feedback loop of interdependent, continuously changing variables during the search process.
- They usually have a number of different working modes in their solution process. The process switches between them in a truly iterative and flexible, not algorithmic, fashion. A mode of working is abandoned when either sufficient or insufficient progress has been made. This is based on the recognition that the marginal return of further progress of a given mode falls off rapidly as more time is devoted to it, as well as the fact that unblocking may have to occur at another mode first. Most methods have specific tools or techniques for working in a given mode. For many, there exist interactive computer programs to facilitate working in that mode or to help gain better insight/oversight of complex interrelationships and connections.
- For most, the point at which the process is terminated and a decision or resolution is reached is arbitrary, i.e., there is no definite terminating stage. But work is abandoned when the stakeholders feel satisfied with the level of insight and consensus reached, and the "solution" becomes obvious.
- The analyst's role changes from problem solver to facilitator and moderator, with the technical subject expertise remaining in the hands of the stakeholders.

Decisions may need to be made in the absence of all desirable data for a proper rational choice, as required by many high-powered OR techniques.

If you are interested in reading more about SSM/PSMs, the text by J. Rosenhead [1989] is an excellent starting point. It covers six SSM/PSMs, including Colin Eden's cognitive mapping for strategic option development and analysis (SODA); Peter Checkland's soft systems methodology; and the strategic choice approach, jointly developed by John Friend, Allen Hickling and others. Each approach is first discussed and explained in general terms, followed by an account of a real-life application with most of its intricacies.

Some conclusions

This discussion of SSM/PSM notwithstanding, there is a genuine role out there in the real world for operations research. OR has contributed to solving a large number of important practical problems, albeit mainly of a tactical nature. At the same time, there is no denying that OR's success rate for the more ambitious strategic problems has been rather poor. Even the impact of the big energy models of the 1970s and early '80s, into which enormous efforts were poured by various highly prestigious OR groups, proved to be disappointingly small. Few of the budding corporate and governmental OR groups of the 1960s and early '70s have survived. These should have been the groups involved in strategic decision making, but most of their efforts went into tactical problem solving. It is rather telling that most of these groups were dissolved, with many of their members assigned to line management where they wound up dealing with the same tactical decisions.

This could be interpreted as a sign that OR has really penetrated the operational level of many firms. But it also means that firms see the realm of OR as dealing with a variety of production, logistics and scheduling problems down at the tactical level. If this was our aim, we have succeeded. I doubt, however, that most of us who got into OR in the late 1950s or '60s saw this as our goal. We had much higher ambitions and hopes.

On the other hand, some of the better known SSM/PSM have an admirable track record in solving real-life strategic problems that should be the envy of the OR community. Checkland's soft systems methodology [1981] alone has seen around 1,000 genuine applications. These approaches have found widespread acceptance among people who were not part of the original inner circle that developed them in the first place.

One can question why OR research and its literature seem to largely ignore the realities of the real world of decision situations, even of a tactical nature (not to speak of strategic situations), and continue to devote an ever larger portion of its efforts to the mathematics of OR rather than to practical problem solving. I have my own pet theory: The academic establishment demands that its young members publish in rigorous journals in order to climb the academic ladder. It is much easier to publish highly mathematical papers than relevant, real-life applications. As a result, the gulf between academic research and real life gets wider and wider.

Viewed in this way, the established academic operations research community can be said to be its own worst enemy. Is it pushing itself into a state of irrelevancy? (A. Reisman's presentation at the TIMS 1994 Anchorage meeting reached that conclusion.) This tendency is particularly strong in the United States, but less so in the United Kingdom. It has always been the reality in the former Eastern block countries, where it was safer to deal with the mathematics of OR than tackle real-life problems. Unfortunately, there are now signs that this search for purity is creeping into the academic circles of continental Europe and some Asian countries, such as China, Korea, Japan and India. The major effect of these efforts is to help aspiring academics achieve the status of full professor.

I realize that these statements will not make me popular with parts of the OR community. But I see this eagerness for developing ever more sophisticated and esoteric algorithms as nothing more than a sort of mathematical masturbation. On the other hand, I have nothing against people doing this, even enjoying it, as long as they do not call it operations research.

There will be many of you who, like Robert Machol, a former president of ORSA, will allege that allowing social (or other human personality) considerations to enter into the analysis is simply an attempt to hide behind the obfuscation provided by sociological jargon, and thus excuse improper OR practice [1980]. Such arguments arise out of a mistaken belief that OR practice is objective, similar to experimental practice in the natural sciences. All OR practitioners bring along their own world view of which they are largely unaware, unless they make a serious effort to externalize it. And this, of course, will affect how the problem is tackled. As C. W. Churchman stated on a number of occasions, the moment we start tinkering with a system we become part of it. In addition, data are not free of interpretation bias and questions of validity, nor are the ways of obtaining them and the sources always credible [see Tversky and Kahneman, 1974 and 1981].

Furthermore, few, if any, OR projects are open to the type of validation or refutation by repetition, as is possible in the natural sciences. The situations OR people deal with are dynamic; a project cannot be repeated under the same or even similar conditions. Hence, OR practice involves a large dose of subjectivity. On the other hand, most OR practice is rather sloppy in terms of how it uses the systems approach on which it claims to be based. The approach is usually systematic rather than systemic. Some of the SSM/PSM approaches are more rigorous in this respect.

Mathematical rigor, however, is but one aspect to consider. Most OR practitioners will tell you they would rather use a non-rigorous approach that comes up with usable, useful results in a given time-frame and within the resources available than have recourse to a flawless, rigorous specification with highly restrictive assumptions that has a high risk of only producing results of questionable usefulness, often long after the original problem has lost its relevance. R. Ackoff [1960] used the famous analogy: "We must avoid operations of which it can be said that the surgery was successful but the patient died."

In the final analysis, the proof is in the eating. So far, SSM/PSM have fared surprisingly well and are gaining acceptance by a wide community of executives of powerful national and international corporations as well as governmental agencies.

The aim of this article is to provoke some introspection into where OR is going, particularly for those of us in academia. Do we want to continue on our current path of claiming to be a science and devote the majority of our efforts into developing the mathematics of OR, or do we want to return to the original spirit of dealing with real-life problem solving? How we answer this question will greatly affect what we teach as OR and how we teach it.

I, along with a number of other colleagues, opt for embracing the spirit of SSM/PSM, and using these methods to effectively tease out the important problems. We may even find new applications to which we can apply our awesome arsenal of OR techniques with success. But even tactical problems are better approached as problem situations in order to put them into the right perspective and systemic context [H. Daellenbach, 1994].

I would like to give the last word to Donald Schon [1987]: "In the swampy lowland, messy, confusing problems defy technical solutions. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, however great their technical interest may be, while in the swamp lie the problems of greatest human concern. The practitioner must choose. Shall he remain on the high ground where he can solve relatively unimportant problems according to prevailing standards of rigor, or shall he descend to the swamp of important problems and non-rigorous inquiry?"

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