Creativity in OR/MS: From Technique to Epistemology

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We have to remember that what we observe is not nature in itself, but nature exposed to our method of questioning.–Werner Heisenberg, 1958, *Physics and Philosophy*

James R. Evans [1991, 1992, 1993a, 1993b] has made an interesting contribution with his articles on creativity in OR/MS practice. His main conclusion is that OR/MS practitioners ought to take creativity seriously if they want to be effective problem solvers, and he has suggested a number of techniques that would help them [Ackoff and Vergara 1981].

In a sense, creativity has always been part of the OR/MS tradition, albeit in an embryonic form. Since its early days, for example, OR/MS has been an interdisciplinary undertaking that encouraged bringing insights from different disciplines to bear on a particular problem [Churchman, Ackoff, and Arnoff 1957]. Similarly, as Evans has reminded us, OR/MS theory building involves elements of creativity, although this is less related to OR/MS practice per se and more to generating new ideas and novel insights, an activity characteristic of all scientific research (that is, Popper's [1980] "context of discovery").

Yet, despite the growing recognition that creativity in problem solving is both desirable and necessary, it is commonly acknowledged that to date creativity has not had the impact it ought to have had on OR/MS practice [Evans 1991, p. 13; Ackoff and Vergara 1981, p. 11]. Why? Why does so important a concept not have the place it deserves in the OR/MS literature? Evans [1991, p. 13] suggests that one reason for this is that "we (the OR/MS community) do not understand creativity." We have been so bewitched by our scientific ambitions (and achievements) that we

0092-2102/96/2602/0073$01.25
This paper was refereed.

PROFESSIONAL—COMMENTS ON

have neglected the artistic part of problem solving. In his papers Evans has tried to address this deficiency by suggesting "methods for becoming more creative, and ways to enhance problem-solving skills." Ackoff and Vergara display a similar concern with techniques for enhancing individuals' creativity, in their review of creativity in problem solving and planning. These researchers have focused on creativity as a feature of individual mental activity; hence they discuss a number of methods and techniques individual OR/MS practitioners can use to enhance their creativity [Rickards and de Cock 1994].

We address the question of the role of creativity in OR/MS practice from a different angle. We move the debate from seeing creativity as a contingent property of individuals to examining the epistemological basis for creative OR/MS practice. Although techniques for enhancing individuals' creativity are useful and have a place in OR/MS, it is also worth examining creativity in relation to the form a problem-solving inquiry takes. The question we wish to explore in this paper is this: What must problems be like, and what form should the process of inquiry into problems take, if creativity is to become an integral part of OR/MS practice?

Thinking, Acting, and Problem Solving

Several management scientists agree that the problems they tackle fall along a continuum. At one end are problems whose nature is independent of what participants think about them (these are hard or well-structured problems). At the other end of the continuum are problems whose nature depends on how participants construe them (these are soft or ill-structured problems) [Ackoff 1978; Checkland 1981; Flood and Jackson 1991; Rosenhead 1989; Schon 1994; Simon 1960]. Airline flight scheduling or maintenance problems, for example, tend to be hard problems, while such problems as labor turnover, poor motivation, or strategic change would be soft problems. Quality problems, re-engineering problems, and most management and policy-making problems in general fall between these two ideal types. Hard problems tend to be narrow, stable, operational, and technical. Soft problems tend to be broad, volatile, and ambiguous.

Because they exist independently of the language of the analyst or the participants, hard problems can be studied in a detached manner by OR/MS analysts, and their regularities can be uncovered and subsequently codified in the form of (largely) mathematical algorithms. The analysts can use the knowledge they obtain in an instrumental mode: varying the inputs into a mathematical formula, they can obtain different outputs. For those OR/MS analysts dealing with hard problems, creativity is helpful in the problem-solving process but, as Evans [1992, p. 89] admits, "not as important as good analytical and engineering reasoning." Creativity is thus not a necessary part of the process of inquiry into a hard problem, though analysts always welcome its flashes. As Schon [1994, p. 244] has put it: "there is little room for professional artistry, except as a matter of style grafted onto technical expertise." Even the hardest of problems, however, have their soft spots: no matter how technical problems are, they usually occur in a social context, and this means the analyst may not be able to handle them effectively through purely technical means.

As we move towards the other end of the continuum, problems become softer and they tend to be dependent on how participants construe them. Participants have a dual role in problem situations: thinking and acting [March 1994]. Soros [1987 p. 33] describes the interplay of thinking and acting as follows:

> On the one hand, participants seek to understand the situation in which they participate; on the other hand, their understanding serves as the basis of decisions which influence the course of events. The two roles interfere with each other. Neither role is performed as well as it could be if it were performed separately. If the course of events were independent of the participants' decisions, the participants' understanding could equal that of the natural scientist; and if participants could base their decisions on knowledge, however provisional, the results of their actions would have a better chance of corresponding to their intentions.

When thinking and acting are so interwoven, events cannot be segregated from thoughts; participants' thoughts form part of the situation to which they relate. Problems, therefore, do not have an independently given nature but exhibit instead a malleable and protean texture: they are linguistically mediated events and processes that change when participants' interpretations change. As Taylor [1985 p. 34] observes: "The language is constitutive of the reality, is essential to its being the kind of reality it is." Problems at this end of the spectrum are what a community of participants says they are [Churchman 1971; Rorty 1991; Tsoukas forthcoming].

Soros [1987, p. 42–43] provides a succinct formulation of the interweaving of thinking and acting in problem situations. The connection between thinking and acting, he says, can be broken up into two functions. The *cognitive function* is the participants' effort to understand a particular situation; their perceptions depend on the situation. The *participating function* is the impact of participants' thinking on the situation; the situation is influenced by their perceptions. More formally, the two functions can be depicted as follows [Soros 1987, p. 42]:

cognitive function $y = f(x)$ and

participating function $x = \phi(y)$.

Thus,

$$y = f[\phi(y)] \quad \text{and } x = \phi[f(x)].$$

The independent variable of one function is the dependent variable of the other. How participants handle a problem (the participating function) depends on what they think about it (the cognitive function), and vice versa. The interplay between the participants' acting and thinking (what Soros [1987, p. 42] calls *reflexivity*) generates a never-ending process of change. Soft problems are potentially on the move—becoming different any time participants' interpretations of the situation change [Checkland 1981; Eden, Jones, and Sims 1983; Gharajedaghi and Ackoff 1994]. Thus in soft problem situations, novelty is always lurking around the corner. The result is that the stable regularities requisite for employing the scientific method reliably can be obtained only tentatively [Sayer 1984].

Since soft problems are constituted by the particular languages participants employ to describe them, it follows that the more languages participants use to describe a problem, the less given they will take a problem's nature to be. Creativity in such cases is not just a matter of individual style appended to technical expertise, but rather a constitutive part of the process of inquiry into a problem situation and of the action taken. By using different descriptions, that is, different images and different vocabularies, and by enlisting different points of view, participants can bring forth different aspects of a phenomenon and thus become more aware of the ambiguity, multidimensionality, and plasticity of the stuff they deal with [Bryant 1989; Flood and Jackson 1991; Senge 1990; Tsoukas 1994a, 1994b]. As Morgan [1986, 1989, 1993], whose pioneering work promotes an interpretive perspective in organization science, has aptly remarked: "Images, assumptions, and frames of reference can act as different lenses, allowing us to see what we otherwise cannot see. Or, to change the metaphor, they act like radar systems allowing us to pick up significant messages from a situation that would otherwise escape attention" [Morgan 1993, p. 5]. Checkland [1981], Flood and Jackson [1991], and Schon [1994] have also made similar comments.

Discussion

The two ideal types of problems, hard and soft, differ in the extent to which they are independent of the language of the analyst or participants or, to use Soros's terminology, the extent to which the cognitive function is independent from the participating function. In most problem situations OR/MS scientists encounter, the two functions intermingle to a greater or lesser extent. Some aspects of a problem may be independent of what participants think about it, while some other aspects depend crucially on participants' interpretations and understandings. Creativity, thus, is necessary in tackling such problems; to some extent, what the problem is depends on how participants perceive it. Interpretation cannot be eliminated from a social system [Tsoukas 1994a, forthcoming].

Consider the following example drawn from Vickers [1983, pp. 42–43]. Imagine, says Vickers, an inventory controller whose task, at first sight, appears quite straightforward: he replenishes supplies of raw materials by adjusting the rate of incoming materials to correspond to the rate at which they flow outwards. On second thought, however, an inventory controller does many more things:

> He must get good value for his money, yet keep good relations with his suppliers. He must be sensitive to changing nuances in the requirements of the users but only in so far as they can be contained within a practicable buying policy. He must try out new supplies and new suppliers without unduly disturbing uniformity of products and the good will of established contacts. . . . The buyer has to regulate relations not only between flows of material but also between people; nor can the one be reduced to the other [Vickers 1983, pp. 42–43].

In other words, even an apparently technical problem, such as inventory control, has an ineliminable social dimension that makes it more than just a technical problem [Woolsey 1972, 1973]. OR/MS analysts may be more or less creative in their modeling of inventory-control problems, and most pertinent OR/MS literature focuses upon techniques for enhancing the analysts' individual creativity. While this is certainly laudable, on its own, it is not sufficient. Only when analysts recognize the irreducible social dimension of their problem situations (and the multiplicity of interpretations this entails), the web of social relationships that underpin particular problems, and the consequent mixing of their (as well as their clients') cognitive and participating functions, will they be able to practice a different kind of OR/MS in which creativity is not a mere add-on, contingent feature of analysts but a constitutive part of their work. The more they approach their problems from different angles, eliciting the views of all those who are involved, the more creative they will be in their approaches. While creativity certainly comes from the analyst's ability to "modify self-imposed constraints" [Ackoff and Vergara 1981, p. 9] and to "discover new relationships" [Evans 1991, p. 13], it also comes from two crucial epistemological assumptions: (a) problems are inescapably open-ended, since they depend to some extent on how participants perceive them; and (b) the analyst's perspective is only one amongst others.

Although the need to bring different perspectives to bear on the same problem did not escape the attention of early OR/MS scientists, they emphasized interdisciplinarity more than multiperspectivism. The difference may appear merely semantic, but it isn't. Churchman, Ackoff, and Arnoff [1957, p. 10], for example, argue in favor of an interdisciplinary approach to problem solving, meaning that OR/MS scientists should borrow scientific models from any discipline that has tackled analogous problems in its own special field [Machol 1974]. For example, a chemical engineer examining an inventory control problem may conceive of it in terms of flow theory, or an electronics engineer may look at it as a servo-control system. As Churchman, Ackoff, and Arnoff [1957, p. 10] remark: "[an electronics engineer] has in effect translated the problem into one of servo theory and he knows how to solve such problems."

It was important for early OR/MS scientists to translate every problem into a single language, one provided by science.

What the problem is depends on how participants perceive it.

They assumed that even in those cases in which OR/MS has not developed its own language for solving a particular class of problems, another discipline may well have done so, and this is what really matters. Interdisciplinarity is useful because it increases the chances that a scientific model will eventually be found that will be appropriate to the problem at hand. The scientific perspective on a problem is, ultimately, the most authoritative one.

Although such an approach does not concede a monopoly of knowledge to a particular discipline, it does concede near monopoly to science. OR/MS scientists are assumed to behave more or less like natural scientists: they stand outside the system they study and attempt to codify the regularities they are interested in in a (largely) mathematical language. The cognitive and the participating functions are thought to be separate.

However, the two functions are rarely separate in OR/MS practice. The kind of multiperspectivism we argue for places analysts on the same footing with the participants of problem situations. Analysts have no unique access to the nature of a problem, nor does the problem have a given, predefined nature. Instead, analysts must make their technical expertise available where needed; they must try to find out how participants perceive problems and facilitate the process of debate to bring different interpretations forward. In this way, they build creativity into the process of inquiry—they design the process to elicit different points of view, to challenge accepted assumptions, and to reveal hitherto unacknowledged features of a problem situation.

Checkland's [1981] "soft systems methodology" and Ackoff's [1981] "idealized design" of a system are good illustrations of OR/MS methodologies that are explicitly based on an understanding of the process of inquiry into problem situations like that we have outlined. Woolsey [1972, 1973, 1989] also bases his interventions on premises similar to those we discuss. In our view, Ackoff, Checkland, and Woolsey are not just three individuals who happened to be creative in their OR/MS practice, but rather three individuals who practice a creative form of OR/MS, a form whose basic epistemological premise is that most of the problems OR/MS analysts encounter are, partly at least, socially constructed.

References

Ackoff, R. L. 1978, *The Art of Problem Solving,* John Wiley and Sons, New York.

Ackoff, R. L. 1981, *Creating the Corporate Future,* John Wiley and Sons, New York.

Ackoff, R. L. and Vergara, E. 1981, "Creativity in problem solving and planning: A review," *European Journal of Operational Research,* Vol. 7, No. 1, pp. 1–13.

Bryant, J. 1989, *Problem Management,* John Wiley and Sons, New York.

Checkland, P. 1981, *Systems Thinking, Systems Practice,* John Wiley and Sons, New York.

Churchman, C. W. 1971, *The Design of Inquiring Systems,* Basic Books, New York.

Churchman, C. W.; Ackoff, R. L.; and Arnoff, E. L. 1957, *Introduction to Operations Research,* John Wiley and Sons, New York.

Eden, C.; Jones, S.; and Sims, D. 1983, *Messing About in Problems,* Pergamon Press, Oxford.

Evans, J. R. 1991, "Creativity in OR/MS: Creative thinking, a basis for OR/MS problem solving," *Interfaces,* Vol. 21, No. 5, pp. 12–15.

Evans, J. R. 1992, "Creativity in OR/MS: Improving problem solving through creative thinking," *Interfaces,* Vol. 22, No. 2, pp. 87–91.

Evans, J. R. 1993a, "Creativity in OR/MS: The multiple dimensions of creativity," *Interfaces,* Vol. 23, No. 2, pp. 80–83.

Evans, J. R. 1993b, "Creativity in OR/MS: Overcoming barriers to creativity," *Interfaces,* Vol. 23, No. 6, pp. 101–106.

Flood, R. L. and Jackson, M. C. 1991, *Creative Problem Solving,* John Wiley and Sons, New York.

Gharajedaghi, J. and Ackoff, R. 1994, "Mechanisms, organisms, and social systems," in *New Thinking in Organizational Behaviour,* ed. H. Tsoukas, Butterworth/Heinemann, Oxford, pp. 25–39.

Machol, R. E. 1974, "Principles of operations research: The screwdriver syndrome," *Interfaces,* Vol. 4, No. 3, pp. 26–27.

March, J. 1994, "How we talk and how we act: Administrative theory and administrative life," in *New Thinking in Organizational Behaviour,* ed. H. Tsoukas, Butterworth/Heinemann, Oxford, pp. 53–69.

Morgan, G. 1986, *Images of Organization,* Sage, Newbury Park, California.

Morgan, G. 1989, *Creative Organization Theory,* Sage, Newbury Park, California.

Morgan, G. 1993, *Imaginization,* Sage, Newbury Park, California.

Popper, K. 1980, *The Logic of Scientific Discovery,* fourth edition, Hutchinson, London, England.

Rickards, T. and de Cock, C. 1994, "Creativity in OR/MS: Training for creativity—Findings in a European context," *Interfaces,* Vol. 24, No. 6, pp. 59–65.

Rorty, R. 1991, *Objectivism, Relativism, and Truth,* Cambridge University Press, Cam-

bridge, England.
Rosenhead, J. 1989, *Rational Analysis for a Problematic World*, John Wiley and Sons, Chichester, England.
Sayer, A. 1984, *Method in Social Science*, Hutchinson, London, England.
Schon, D. 1994, "Teaching artistry through reflection-in-action," in *New Thinking in Organizational Behaviour*, ed. H. Tsoukas, Butterworth/Heinemann, Oxford, pp. 235–249.
Senge, P. 1990, *The Fifth Discipline*, Doubleday Currency, New York.
Simon, H. A. 1960, *The New Science of Management*, Harper and Row, New York.
Soros, G. 1987, *The Alchemy of Finance*, John Wiley and Sons, New York.
Taylor, C. 1985, *Philosophy and the Human Sciences: Philosophical Papers*, Vol. 2, Cambridge University Press, Cambridge, England.
Tsoukas, H. 1994a, "Introduction: From social engineering to reflective action in organizational behaviour," in *New Thinking in Organizational Behaviour*, ed. H. Tsoukas, Butterworth/Heinemann, Oxford, England, pp. 1–22.
Tsoukas, H. 1994b, "Refining common sense: Types of knowledge in management studies," *Journal of Management Studies*, Vol. 31, No. 6, pp. 761–780.
Tsoukas, H. forthcoming, "The word and the world: A critique of representationalism in management research," *International Journal of Public Administration*.
Vickers, G. 1983, *The Art of Judgment*, Harper and Row, London.
Woolsey, R. E. D. 1972, "A candle to St. Jude, or four real-world applications of integer programming," *Interfaces*, Vol. 2, No. 2, pp. 20–27.
Woolsey, R. E. D. 1973, "A novena to St. Jude, or four edifying case studies in mathematical programming," *Interfaces*, Vol. 4, No. 1, pp. 32–39.
Woolsey, R. E. D. 1989, "The fifth column: Sales psychology of MS/MIS systems: Why some work, why some win," *Interfaces*, Vol. 19, No. 2, pp. 29–33.