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Soft Systems Methodology: A Context Within a 50-Year Retrospective of OR/MS

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Soft systems methodology (SSM) has been used in the practice of operations research and management science (OR/MS) since the early 1970s. In the 1990s, it emerged as a viable academic discipline. Unfortunately, its proponents consider SSM and traditional systems thinking to be mutually exclusive. Despite the differences claimed by SSM proponents between the two, they have been complementary. An extensive sampling of the OR/MS literature over its entire lifetime demonstrates the richness with which the non-SSM literature has been addressing the very same issues as does SSM.

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> There is more to OR than mathematics and the experimental sciences; there is a working version of the concept of value, with all its human and practical overtones. Charles Hitch (1956, p. 426)

Had cavemen designed their carts with square wheels, then over time, wear and tear would have improved their invention. By analogy, or perhaps counterpoint, operations research (OR) was born having round wheels. Its spectacular successes in World War II attest to that (Blackett 1962, Morse 1986, Roche 2002). Over time, however, the academic establishment has reinvented the wheels into polygons if not perfect squares. Abbott (1988) and Corbett and Van Wassenhove (1993) claim that this change was caused by natural drift. If these respected authors are right, and much evidence shows that they are, according to Pierskalla (1987) and Reisman and Kirschnick (1994), then management scientists have redefined what is natural and forced that science to drift in their direction of choice. In natural science, such movements require the expenditure of otherwise usable resources. Any basic thermodynamics text will attest to that. In academia, such resources were plentiful in the 1970s, '80s, and '90s, especially in the United States.

In solving managerial problems, good systems thinking (ST) includes both soft systems methodology (SSM) and the time-honored but recently dubbed hard systems methodology (HSM). It has been so since the birth of OR and management science (MS). The need to invent soft systems thinking (SST) and SSM arose around 1972 (Checkland and Scholes 1999) because of inbreeding (Reisman 1995; Reisman and Kirschnick 1994, 1995), from which a new paradigm emerged within OR/MS graduate education and published research.

Saaty (2000, p. 9) reflected on this condition:

> I once asked a well-known OR/MS friend, who has written many books on the subject, to define OR/MS. He said, "In one sentence, it is more or less optimization subject to constraints." I said, "That is the problem solving part, how do you define the system in which the problems arise?" He said, "We do not know enough yet to do that."

We call this paradigm *neoclassical OR/MS*. A predisposition to these afflictions was recognized as far back as the mid 1950s. Koopman (1956) dubbed them *linearitis* and *maximitis*. However, even within the neoclassical OR/MS paradigm,

> [o]ver the past 40 years, OR/MS has changed significantly. Today, the emphasis is on becoming a

> specialist, not a generalist . . . a higher priority is placed on theoretical research than on applied research; issues of exactness and complexity stand in the way of providing answers to complex problems . . . today's graduates would not deign to cross the deterministic-probabilistic boundary (White 1991, p. 185).

With little doubt this neoclassical OR/MS justified the following statement:

> So we were lucky in our research programme that the failure of classic systems engineering in rich "management" problem situations, broadly defined, was dramatic enough to send us scurrying to examine the adequacy of the systems thinking upon which systems engineering was based (Checkland and Scholes 1999, p. A11).

However, not all OR/MS workers jumped on the bandwagon. Not all followed the emerging paradigm, and not all perceived classic ST to be failing. Contemporaneously with SSM being initiated into the curriculum at the University of Lancaster (UK), being diffused to other institutions, and becoming an academic discipline, some practitioners of the art of OR/MS did good SST without so calling it. Among them were academics on both sides of the North Atlantic. They were following practices established by the pioneers of OR/MS and some of their work found its way into the mainstream and into flagship journals. Their publications, however, were like drops in a bucket overflowing with papers based on the new OR/MS academic paradigm. In 1968, a senior colleague in what was then a major OR PhD granting department announced that applied OR dissertations should no longer be approved. Fortunately, he did not prevail. However, in the late 1980s, a department editor of *Operations Research* rejected a paper structuring barter and countertrade practices in terms of a taxonomy and in terms of models that was submitted by this paper's first author. The author pointed out that over 35 percent of world trade was based on some form of reciprocity, namely, countertrade. The figure is now higher. For example, consider Poland's multibillion dollar purchase of F-16 fighter planes (http: // www.polandembassy.org / News / Biuletyny_ news/p2003-04-18.htm). The editor argued, "Barter is negotiation; negotiation is game theory. If game theory is not used, it is not operations research." Neoclassical OR/MS prevailed, the paper was published in *Industrial Marketing Management*, and the OR/MS community missed a major opportunity to record and to do the missionary work Blumstein (1987) called for. Parenthetically, content analysis of all game theory (GT) articles published in *Operations Research*, *Management Science*, and *Interfaces* starting with Vol. 1, No. 1 of each, up to and including 1995, showed that the OR/MS literature on GT was overwhelmingly dominated by articles classified as pure theory, with no direct real-world underpinnings, incrementally extending what had already been published—neoclassical OR (Reisman et al. 2001).

Systems Thinking

We define the word *system* as follows:

> A system is a set of resources—personnel, materials, facilities, and/or information—organized to perform designated functions, in order to achieve desired results (Reisman 1979, p. 2).

ST then is basically thinking systemically and paying attention to the dynamic, often nonlinear or stochastic processes of interaction among the resources and the environment within which the system operates.

SST provided an identity and some structure to an aspect of ST needed for solving managerial problems—the kind of stuff used by many practitioners and written about by many academics prior to and ever since Checkland's introducing SST and making it fashionable (1981). Though not an entirely original idea in classical ST, SST emphasizes identifying the correct problem at the initial stages of solving managerial problems by introducing a methodology. SSM's value lies in identifying the problem situation in an organized manner. Unfortunately, Checkland and Scholes (1999) imply that in managerial ST applications, SST is of a higher order than HST and a needed replacement for it.

> It was having to abandon the classic systems-engineering methodology which caused us to undertake the fundamental thinking in Chapters 2–4 of STSP (Checkland 1981). And it was this rethink which led ultimately to the distinction between "hard" and "soft" systems thinking (Checkland and Scholes 1999, p. A7).

Moreover, they unequivocally state:

> It is this shift of systemicity (or systemness) from the world to the process of inquiry into the world which

> is the crucial intellectual distinction between the two fundamental forms of systems thinking, "hard" and "soft" (Checkland and Scholes 1999, p. A10).

Thus, they introduced a dichotomy or a sense of incompatibility, if not mutual exclusivity, between SST and hard systems thinking (HST).

The dust has now settled. SST has been articulated, established, and validated. It has been legitimized in many different ways. For example, the *Journal of the Operational Research Society* named an SST publication as its 50th Anniversary Paper (Ranyard 2000). SST is a recognized school of thought in both the real world and academia. It is complementary to HST in solving managerial problems.

Classical Systems Thinking

Recognizing that systems abound in the real world, we suggest that they can be classified along a three-sided continuum (Figure 1). One extreme point (corner) of this figure is labeled: "large high-technology socioeconomic system performing a one-of-a-kind function." Clearly, this category can include any process of enquiry into the world, which suggests that when dealing with socioeconomic problems HST might always have included SST.

In discussing the various types of systems, we distinguished system types based on whether they are open or closed, adaptive or nonadaptive, man-made, or natural (Reisman 1979). In these three sets, the

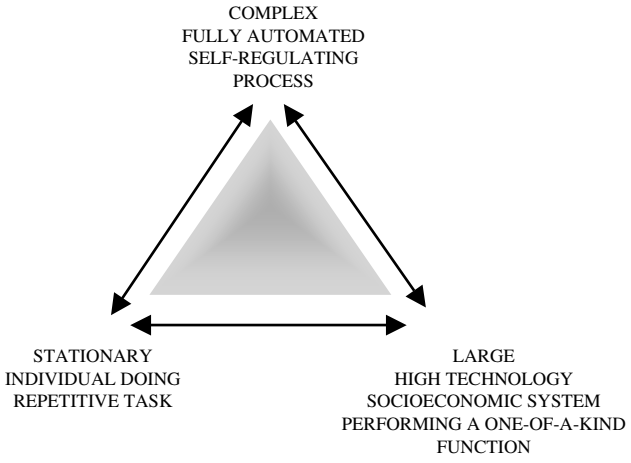

Figure 1: This figure defines a continuum bounded by three extreme types of systems.

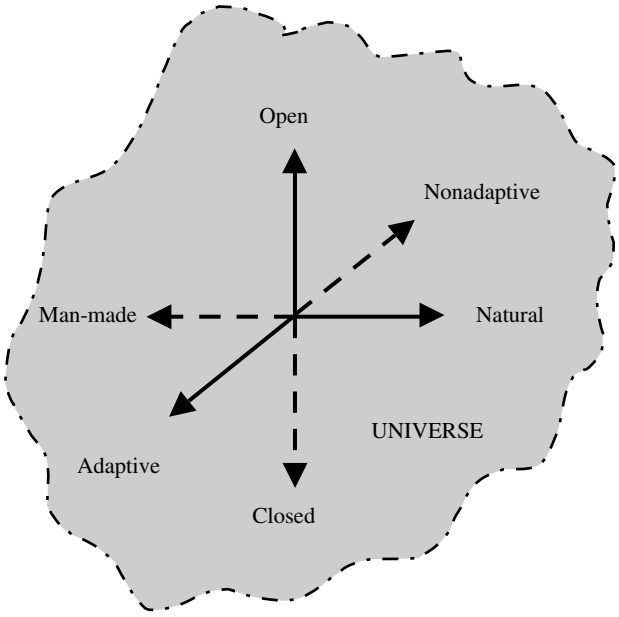

Figure 2: This figure shows the classical descriptors of system types embedded within the SST type of "universe" boundaries. However, the system attributes (normally treated as being dichotomous) are shown to be continuous.

attributes are dichotomous (either/or), but we can also consider them in terms of a continuum (Figure 2). Furthermore, man-made systems can include conceptual systems as well as procedural systems. Within the procedural-systems (such as legal procedures, flows of patients in a clinic, flows of paper work, and diagnostic algorithms) subcategory, one can include any process of enquiry into the world. The adaptive-systems category captures the ever-changing nature of some procedural systems. In discussing adaptive versus nonadaptive systems, Reisman (1979, p. 11) notes that "Adaptive systems react to the variations in their surroundings in a direction that is favorable to the goals of the system. Each change in the environment evokes a favorable response from the system and thus leads to a new system."

That these systems operate within their environments is captured by their delineation as open or closed systems. Reisman (1979, p. 11) states that "in discussing social systems it is necessary to be very precise in defining terms such as openness or closedness—'No man is an island . . .' An open system is therefore one that exchanges materials, personnel, information, money, and so on with its surroundings."

The process of enquiry itself fits neatly into the classical definitions of systems. So HST and SST are not mutually exclusive; they are complementary. In good ST, both are used at different stages of solving managerial problems (Figure 2).

Claimed Differences Between HST and SST

Checkland and Scholes (1999, p. 277) discuss the difference between HST and SST as follows: "…'the system' is no longer some part of the world which is to be engineered or optimized, 'the system' is the process of enquiry itself." They go on to say that the word "system" is no longer applied to the world; it is instead applied to the process of our dealing with the world (p. A10).

Moreover, Checkland (1981, p. 190) writes that the SSM starts with "an urge to bring about improvement in a social system in which there is felt to be an ill-defined problem situation." Hard system methodology starts with "an urge to solve a relatively well-defined problem which the analyst may, to a large extent, take as given, once a client requiring help is identified."

Checkland implies that in classical ST managerial problems are taken as given. If Checkland bases his argument on what he has seen dominating the OR/MS flagship journals, he has a point. Reisman and Kirschnick (1994) used content analysis to show that articles appearing in *Operations Research*, *Management Science*, and *Interfaces* were predominantly what we call neoclassical OR in their 1992 volume-year and much more so when compared to 1962 for the first of the two journals and for 1972, the launch year of *Interfaces*. More recently Gattoufi et al. (2004) and Reisman et al. (1997a, b) showed that the same neoclassical OR paradigm dominated the literature of several OR/MS subdisciplines over their lifetimes.

Compatibility or Nonexclusivity of HST and SST

The process of enquiry itself, SST's main issue, fits neatly into the classical definitions of systems. It is a procedural, adaptive, and open system. Also, in its extreme form, it is a large high-technology socioeconomic system performing a one of a kind function. Moreover, adaptive (HST) systems react to the variations in their surroundings in a direction that is favorable to the goals of the system. Each change in the environment evokes a favorable response from the system and thus leads to a new system. The complexity subject—the main issue of SSM—comes into play in this discussion. Human existence in a system makes the system open and dynamic. Consequently, the system reacts and changes during the inquiry, creating difficulties for the system analyst. Some compare the situation to shooting at a moving target. SST is most needed in the early stages of addressing management issues, while HST is often necessary in the latter stages of problem solving.

In discussing a general model for analyzing production and operations systems analysis, Reisman and Buffa (1964, p. 65) wrote:

> The model recognizes the dynamic aspects of enterprise behavior. . . . This model is intended for use by the operations research practitioner who sees simulation primarily as a useful device for the analysis and synthesis of man/machine/process systems, . . . and particularly the management scientist with a socioeconomic and psychological orientation who sees simulation primarily as a new tool for research into problems of human behavior in organizations.

However,

> It is important to realize that an initial statement of needs can, after some preliminary analysis, turn into a considerably different statement of needs. A clearly stated technical description of a need can suddenly transform itself into one that is entirely different. The situation has not changed, the long-range goals may still be the same, but as the problem solver understands the situation better, he or she comes to realize that a more general and more appropriate need is in order (Reisman 1979, p. 237).

So, statements about SST to the contrary notwithstanding, some classical systems workers do not assume the problem to be as it was given or presented to them. Thus, we can say that the two approaches are compatible. They are not mutually exclusive. We believe that in good ST both are used at different stages of the process of solving managerial problems and have been since the founding of OR/MS.

The OR/MS Literature Dealing with Stakeholders

In their seminal OR textbook published in 1957 through its 10th printing a decade later, Churchman et al. discuss the stakeholder issue as follows:

> Both the consumer's and the researcher's problem must be formulated. The research consumer is the person (or group) who controls the operations under study.... In formulating the consumer's problem an analysis must be made of the system under his control, his objectives, and alternative courses of action. Others affected by the decisions under study [stakeholders] must be identified and their pertinent objectives and courses of action must also be uncovered (1957, p. 13).
>
> Most organized systems involve the following components: controllers, agents who carry out policies, instruments and materials used in so doing, outsiders who are affected by the organization's activity, and the social environment in which these components operate (1957, p. 109).
>
> Once the participants in the problem other than the decision maker have been identified, their relevant interests should also be determined (1957, p. 110).
>
> In effect, then, limitations on possible solutions emanate from the interests of these other parties (1957, p. 111).

That stakeholders are those people who have a vested interest in the problem situation and its solution; that they have, in one way or another, some leverage and influence on the development and use of a model; that the success or failure of a model depends very much on the attitude and behavior of stakeholders; that the stakeholders are the model's clients; that it is important for model builders to identify the stakeholders before the model is developed; and that the identification of stakeholders as a process itself generates some highly pertinent information about the perceptions and values of clients regarding the problem situation are facts that have been raised in the OR/MS literature throughout time.

Mason and Mitroff (1981, p. 43) reinforced the issue in saying that identifying stakeholders is an easy way of discovering the prevalent assumptions about a problem situation, for while it could be difficult to "see" assumptions, most people can rather easily generate a set of stakeholders that bears on their perspective. From the stakeholders, it is but a short step to assumptions. "Stakeholders are all those claimants inside and outside the firm who have a vested interest in the problem and its solution." "Identifying the stakeholders seems to be a prerequisite for developing models that have acceptable levels of conceptual and operational validity, which may lead to successful model implementation" (Oral and Kettani 1993, p. 216).

The developers of SST apparently recognized the need to involve stakeholders:

> ...SSM [is] most powerful when used by participants in a problem situation, the study was carried out by three managers...with some methodological help provided by outsiders (Checkland and Scholes 1999, p. 277).
>
> This was a highlighted study carried out by a team consisting of two insiders (civil servants) and three outsiders (Checkland and Scholes 1999, p. 278).

So, despite statements about HST to the contrary, classical systems work emphasizes involving stakeholders. HSM and SSM are compatible in regard to stakeholder issues. As far back as the 17th century, in saying, "Esse est percipi" (Existence means being perceived), the Irish philosopher George Berkeley (2001) questioned whether things exist as such or only through our (individually different) perceptions.

The OR/MS Literature on Implementation and Model Validation

Related to the isssues of involving stakeholders are issues of implementating recommendations resulting from an OR/MS study, as Mantel et al. (1975, p. 221) attest:

> From the project's inception, the team regarded itself as an extension of the JCF (Jewish Community Federation) rather than as a separate entity. Ongoing involvement of Federation leadership was provided through establishment of an ad hoc Federation committee composed of lay leaders with extensive business experience and charged with overall project direction. The presence of this overseer committee and the inclusion of the JCF professionals on the research team ensured that implementation of results would receive continual attention.

Clearly soft systems thinkers did not originate the practice of involving stakeholders in projects nor do

we claim that Mantel et al. did. The practice goes back to the founding fathers of OR/MS.

Irrespective of whether ST is called hard or soft, in solving managerial problems, one should not lose sight of the fact that real-world studies are not worth much unless they are successfully implemented and achieve the desired outcomes. Practioners should structure and conduct systems studies to maximize the probability of successful implementation. They must ensure that the methods they use and the results they obtain can be implemented by planning for implementation, designing the task force, establishing relationships with users, and evaluating results critically. The common element underlying these strategies is communication. Success requires enlightened users and sponsors who own the study. The resulting climate of confidence will favor successful implementation.

Oral and Kettani (1993) considered the modeling and validation process in OR from several different perspectives, among them the model user's perspective and the model formulator's perspective. They also compiled a bibliography of publications concerning the issues underlying SST, which we expanded (Table 1).

> A look at the history of model validation in operations research indicates that validity has been interpreted in different ways depending on the epoch and on the context. During the early years of operations research, the concept of model validity included, usually only implicitly, ideas like usefulness, usability, representativeness and cost considerations, albeit their relative importance varied. For the pioneers of operations research, such scientists as Blackett, Waddington, Morse, Kimball, and Koopman, the issues of usefulness, usability and cost were naturally resolved through an effective and sound modeler-user interface (Landry et al. 1983, p. 207).

Moreover, Reisman (1979, p. 261) wrote that the subject of implementation of systems has been of great concern to the many professions that do systems analysis. The concern is due to the fact that too many completed systems studies have never been implemented. The question being raised is why? Clearly, no one answer is universally applicable. Research into the matter is in its infancy. However, based on years of reflection on systems studies performed in organizations, some directives have emerged on what

1953. Hermann, C. C., J. F. Magee	1981. Gass, S. I., L. S. Joel
1954. Edie, L. C.	1981. Mason, R. O., I. I. Mitroff
1954. McCloskey, J. F., F. N. Trefethen, eds.	1981. Richels, R.
1955. Brigham, G.	1981. Woolley, R. N., M. Pidd
1955. Kelly, G. A.	1982. Palding, E., A. G. Lackett
1956. Kahn, H., J. Mann	1983. Gass, S. I.
1956. Koopman, B. O.	1983. Landry, M. et al.
1957. Churchman, C. W. et al.	1983. Malouin, J.-L., M. Landry
1957. Kahn, H., J. Mann	1983. Schon, D. A.
1958. Roy, H. J. H.	1984. Beer, S.
1958. Toulmin, S.	1984. Eden, C., S. Jones
1961. Churchman, C. W.	1984. Jackson, M. C., P. Keys
1961. Forrester, J. W.	1984. Muller-Merbach, H.
1962. Blackett, P. M. S.	1984. Tidman, K. R.
1963. Ackoff, R. L., P. Rivett	1984. Yewlett, C. J. L.
1963. Johnston, R. A. et al.	1985. Barlas, Y.
1964. Quade, E. S.	1985. Sauter, V.
1965. Churchman, C. W., A. H. Schainblatt	1986. Morse, P. M.
1965. Levin, R. I. et al.	1986. Murphy, F. H.
1967. Naylor, T. H., J. M. Finger	1987. Ackoff, R. L.
1967. Stringer J.	1987. Blumstein, A.
1968. Churchman, C. W.	1987. Finlay, P. N., J. M. Wilson
1968. Glans, T. B. et al.	1988. Abbott, A.
1969. Forrester, J. W.	1988. Eden, C.
1969. Pounds, W. F.	1988. Smith, G. F.
1970. Blair, L. H. et al.	1989. Barlas, Y.
1971. Forrester, J. W.	1989. Rosenhead, J. V.
1971. Ravetz, L. R.	1989. Smith, G. F.
1971. Van Horn, R. L	1990. Banville, C.
1971. Churchman, C. W.	1990. Barlas, Y., S. Carpenter
1972. Meadows, D. L. et al.	1990. Brunsson, N.
1973. Ackoff, R. L.	1990. Vennix, J. A. M. et al.
1973. Forrester, J. W.	1991. Miser, H. J.
1974. Meadows, D. L. et al.	1992. Assad, A. A. et al.
1975. Lilien, G. L.	1992. Reisman, A.
1976. Lilien, G. L., A. G. Rao	1993. Corbett, C. J., L. N. Van Wassenhove
1977. Ackoff, R. L.	1993. Dery, R. et al.
1977. Gass, S. I.	1993. Mitchell, G.
1979. Ackoff, R. L.	1993. Oral, M., O. Kettani
1979. Coyle, R. G.	1993. Smith, I. H.
1979. Stainton, R. S.	1994. Cornoford, T. et al.
1980. Forrester, J. W.	1994. Forrester, J. W.
1980. Gass, S. I.	1994. Tacket, A., L. White
1980. Majone, G.	1995. Miser, H. J.
1980. Mintzberg, H.	1996. Fortuin, L. et al.
1980. Nissen, D.	1996. Landry, M. et al.
1980. Pidd, M., R. N. Woolley	1996. Ormerod, R. S.
1980. Randers, J.	1997. Davies, M. et al.

Table 1: These publications are representative of those that concern the philosophic or theoretic notions underlying SST. We culled these from the literature for each year beginning in 1953, reflecting the launch of OR's literature, and running through 1997, to allow two years for preparation and publication of Checkland and Scholes (1999). We deemed the items in this sample to have had the highest and widest visibility to OR/MS academics and practitioners worldwide. We give complete information in the reference section.

should, and should not be done, in systems analysis practice.

Classical systems work emphasizes effective and sound modeler-user interfaces. HST and SST are not mutually exclusive. They are compatible in regard to model-validation issues. In their famous article "The researcher and the manager: A dialectic of implementation," Churchman and Schainblatt (1965) discussed both modeler-user interfaces and validation.

Relevance of the *Systems Dynamics* Literature

The founder of *systems dynamics*, Jay W. Forrester (1994, p. 1) commented as follows:

> Systems dynamics, systems thinking and soft operations research (soft OR) all aspire to understanding and improvement of systems. In all, the first step interprets the real world into a description used in the following stages. In systems dynamics, description leads to equations of a model, simulation to understand dynamic behavior, evaluation of alternative policies, education and choice of a better policy and implementation. Case studies, systems thinking and soft OR usually lack the discipline of explicit model creation and simulation and so rely on subjective use of unreliable intuition for evaluating the complex structures that emerge from the initial description of the real system. Nevertheless, systems thinking and soft OR, with emphasis on eliciting information from real-world participants, should contribute useful insights to systems dynamics. Conversely, the model creation and simulation stages of systems dynamics should contribute rigor and clarity to systems thinking and soft OR.

So, despite statements about SST, the systems dynamics approach is compatible with SST.

The Complementarity of HST and SST

Given the prevailing state of SST and neoclassical OR/MS, we need both SSM and HSM to solve the right problem in the right way (Figure 3). In dealing with managerial (real-world) issues, practitioners need to apply both soft and hard ST at different stages of the project.

Admittedly oblivious to stirrings that created SST on the eastern side of the Atlantic, Reisman (1979) addressed these issues in terms of the different mentalities needed during the early stages and the later stages. In the earlier stages, the practitioners need a

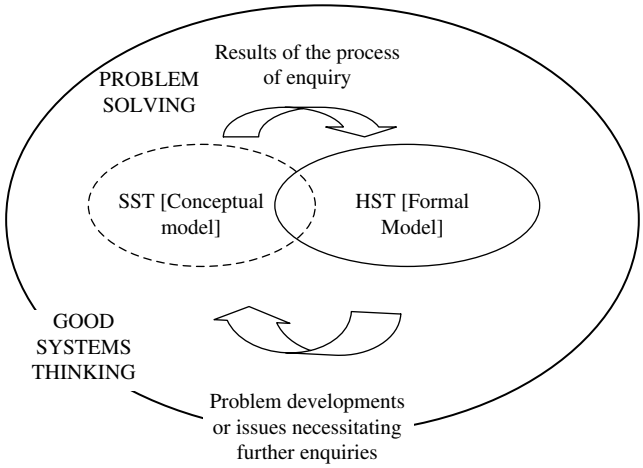

Figure 3: In this depiction of good systems thinking, we show that iterations between SST and HST are an integral part of the process of solving managerial problems.

generalist mentality to properly abstract the essence from a typically noisy and dynamic environment. Hence, practitioners need SSM and a broad perspective. In the later stages of the project, which are more technical and operational, they require a more concrete and technical mentality. Hence, they need HSM skills. This does not mean that early project stages require SST exclusively and that the subsequent stages require nothing but HSM. Soft problem situations may occur late in a project's hard situations, early in a project's life. "Unfortunately, in admission and graduation decisions faculty appear to make a Type I error . . . failing a student [applicant] who should pass an exam" (White 1991, p. 189) and be admitted. Hence, we select based on proven intelligence. This tends to systematically select out the mentality needed in the early stages of structuring real-world problems. "In recruiting graduate students, we are not particularly concerned about the long-term implications . . . of our selection" (White 1991, p. 189). Recently, Saaty (2000, pp. 9–10) addressed the same issue: "To analyze problems in detail, we need intelligence. But we need creativity to synthesize and create structure to obtain higher level abstraction[s] of problems." However, even within the neoclassical OR/MS paradigm, "Over the past 40 years, OR/MS has changed significantly. Today, the emphasis is on becoming a specialist, not a generalist. . . . today's graduates would not deign to cross the

deterministic-probabilistic boundary" (White 1991, p. 185). Even the solutions to the most complex management problems have distinct phases; recognizing needs, stating the problem, formulating the value model, synthesizing alternatives, analyzing and testing, evaluating and decision making. These phases are part of an iterative process of problem solving (Reisman 1979, p. 234).

It is difficult, in fact nonsensical, to separate HST and SST, because in most studies practitioners must address both issues throughout the project's life cycle. For instance, classical systems analysis calls for fairly thorough documentation of the system (a systems description) prior to any analysis or attempted redesign. An organization can use a description of the system in compact and operationally meaningful terms to understand, to teach, to redesign, to improve, to optimize and to control the system or any of its units. Systems analysis is often used as an end in itself. The results of systems analysis can answer the question, Who does what, where, when, why and how?

SSM addresses those issues when asking the following questions:

(1) What is the real problem?

(2) What goals or objectives are to be achieved given the conflicting perceptions about the problem situation?

(3) What are the constraints?

(4) Who are the players, the stakeholders?

(5) Who are the beneficiaries?

(6) Who are the regulators?

(7) What part of the world is involved? or What is the system?

(8) How does this system perform its functions?

(9) What are the system's subsystems?

(10) What are or what should be the criteria for evaluating system performance?

To address complex managerial problems in the real world, practitioners must answer each of these 10 questions. Correct answers are not easily found. The practitioner follows a process like that of a good physician diagnosing and treating a sick patient for the first time. The physician must listen to the patient, record the symptoms, collect relevant family and patient histories, study the patient's chart or medical record, do a physical examination, and order laboratory and other tests prior to making a diagnosis and deciding on a treatment plan. In systems applications to solving managerial problems, the practitioner follows an analogous process to create a systems description (Reisman et al. 1972, pp. 8–31).

All of the stakeholders' initial responses should be questioned. Based on his experience dating back to World War II, Hugh Miser, one of the grand old men of OR/MS, recognized this issue by saying: "When an OR worker is called on to help with a problem, it is common experience for the client to describe the problem in terms that later turn out to be incorrect, or to state expectations that later turn out to be mistaken" (Wagner et al. 1989, p. 669). This is especially so with question 10. History is replete with examples of good organizations being sent into downward spirals or self-destruct modes by decision makers using wrong, though not obviously so, criteria to evaluate performance (Reisman et al. 1972, pp. 32–37). Many corporate executives with great academic credentials are facing long jail sentences because of board-approved performance-based compensation packages, and Wall Street's preoccupation with short-term performance. At least one wag has said, "Be careful what you measure because what you measure is what you will get." OR/MS practitioners recognized this problem way back (Koopman 1956).

The strength of SST lies in getting a good handle on a description of the system. Whether the description is expressed in terms that are compact and operationally meaningful and that an organization can use to understand, to teach, to redesign, to improve or optimize and to control the system or any of its units depends on the skills of the SST professionals. Classical systems analysis relying on effective use of text, graphics, and mathematical or conceptual models teaches such skills.

Eliciting the needed information from decision makers is not a trivial matter. Practitioners must take a systems view at all times while defining the system to be studied. Hence, the virtue of SST. Again, "the structuring which derives from consciously enacting the system of enquiry enables apparently disparate studies to be examined as a group through the epistemology which SSM provides" (Checkland and Scholes 1999, p. 277). This notion was the basis of every study we list in the appendix.

Further, practitioners should involve all of those concerned with the system in discussing proposed changes.

> By this way an element of action research enters into the process. This makes it more likely that any solutions will be both technically sound and culturally acceptable. This process of consultation and involvement also introduces an element of iteration, whereby changes evolve in a number of steps and with the consensus of all of those involved. The iteration also allows a gradual coming together of all people involved (Kirk 1995, p. 14).

Without any quarrel, "the structuring which derives from consciously enacting the system of enquiry enables apparently disparate studies to be examined as a group through the epistemology which SSM provides" (Checkland and Scholes 1999, p. 277).

Literature Linking Hard and Soft Systems

A multimethodology (MM) literature was spawned as the dichotomy between SSM and HSM became accepted. The most visible articles in this emerging discipline were those of Jackson and Keys (1984), Jackson (1989, 1993, 1997), Mingers (1992), Mingers and Gill (1997), and Muller-Merbach (1994). In addition, the critical systems thinking (CST) literature was created by Mingers (1992), as well as another literature linking SSM with HSM (Brocklesby and Mingers 1998, Jackson 1997, Ulrich 2003). In these publications, the authors stress the need to be critically aware of shortcomings in both SSM and HSM. In the late 1980s and early 1990s, they stressed new integrative systems perspectives and methodological pluralism. After critical examination of the pros and cons of the different systems approaches, they selected the most appropriate. According to the MM and CST proponents, doing this allows one to address a wider range of issues than is possible with a single approach. Consequently, CST advocates not only probe the complementarity of SST and HST, but also aim to indicate which systems approach is suitable for solving what kind of a problem. They offer guidance in selecting a particular systems approach, hard or soft, as system improvement evolves from problem structuring to problem solving.

Classical OR/MS Literature Involving Both HST and SST

Any serious attempt at studying SST and SSM, especially in juxtaposition to hard systems, must include the extensive literature on model validation (Oral and Kettani 1993) and legitimization (Landry et al. 1996, 1983) that goes back to World War II (Blackett 1962). Nor can anyone making such an attempt overlook the rich literature dealing with implementation of study results, structuring the study task force, and considering all stakeholders. According to Churchman et al. (1957, p. 9), "The effectiveness of such interdisciplinary teams in tackling the type of problem characterized as the subject matter of OR is not accidental." "The early literature on operations research repeatedly mentioned the interdisciplinary nature of OR teams" (Wagner et al. 1989, p. 667). Interestingly that sentence is followed by, "The reduction in the emphasis on the interdisciplinary nature of OR has coincided with a reduction in the perception of the usefulness of OR." Both of these reductions coincided with the emergence of neoclassical OR/MS and institutional loss of memory. So, assuming the SSM/HSM dichotomy as fact, in his forward-looking article "Beyond methodology choice . . . ," Ulrich (2003) states, "Contrary to present conceptions of methodological pluralism or 'complementarism,' boundary critique must not be subordinated to methodology choice, for it is constitutive of all critical inquiry and practice. These considerations lead to a reconsideration of CST and to a new view of reflective professional practice in general, as critically systemic discourse." The pioneering OR/MS generation would find this statement coming in 2003 somewhat amusing. They practiced it and they wrote about it. And so did some members of the next generation (Table 1).

Over the entire lifespan of OR/MS, various writers have paid a great amount of attention to the issues that proponents of SST claim to have uniquely addressed. Other authors applied skills gained from the rich experience of such OR/MS pioneers as Blackett, Kimball, Koopman, Morse, and Waddington, who "naturally resolved through an effective and sound modeler-user interface" (Landry et al. 1983, p. 207) the kind of issues that SST claims as its own. In a book that "includes a 30-year retrospective [on SST],"

Checkland and Sholes (1999) recognize only two publications from the large body of relevant literature (Table 1), Blackett's (1962) and Schon's (1983).

Although the process of enquiry was the crux issue these seasoned OR/MS workers discussed, Checkland and Scholes (1999) hardly acknowledges them. On the other hand, in reviewing Checkland's 30-year retrospective of SST (Checkland and Scholes 1999), we found a strange set of anomalies. Nowhere in the book could we find any mention of the noble efforts professional societies, such as ORSA and EURO, have made on both sides of the North Atlantic in attempting to correct the wrongs SST proponents claim to have corrected. Efforts toward this end are exemplified by a comment on a major self-study, "First where humans participate in operations that are studied by OR, OR will have to deal realistically with human behavior. This is just a particular instance of the formulation issue . . . discussed," Wagner et al. (1989, p. 667). Such efforts included annual competitions for the best real-world application of OR/MS; the sections of journals and the sessions at each annual meeting dedicated to OR/MS practice and to teaching OR/MS; the "Ombudsman" columns in *Operations Research*; the many non-SST articles addressing the very issues SST proponents claimed were causing SST to replace HST; the many articles based on serious research on research, reaching similar conclusions. And nowhere in the book could we find testimonials to people who never wavered from the original paradigm of OR/MS as many of the newcomers did. Many such testimonials can be found elsewhere, for example:

> Over his 50+ year career William Wager Cooper has been totally unaffected by the very significant "natural drift" away from the "swamps of relevance" and from "missionary work" toward "introversion," "loss of relevance," "devolution," and "mechanical optimization," which took place during that same timeframe among the OR/MS academic establishment in the United States. History has borne out that W. W. Cooper was correct in keeping his course firmly rooted in the very "swamps of relevance" while significantly and meaningfully extending and expanding the theoretical basis of OR and of MS, giving other professions a sought after tool and thus enabling the kind of "missionary work" that Blumstein called for (Reisman et al. forthcoming, p. 16).

Incidentally, Mitchell's (1993) book inspired a very lively discussion of OR/MS analysts' approaches to real-world problems by Keys (2000, pp. 229–232), Miser (2000, pp. 225–228), Mitchell (2000, p. 235), and Smith (2000, pp. 233–234).

Conclusion

James G. Roche (2002, p. 25), in his *Omega Rho* Distinguished Lecture, articulated the problem most recently:

> The original ops [operations] researchers understood that to be effective, they needed teams of mathematicians, historians, military theorists, psychologists, and economists among others. They understood the natural complexity of war, to include second-order effects. War is not just a mechanical or scientific act. In practice, it is an art and science that operates in a foggy sea of strategy, politics, and luck . . . . Somewhere along the lines, this was lost as a fundamental concept of military operations analysis.

Because it was also lost on the majority of the OR/MS academic community, it is fair to allow for the claimed differences between SST and ST or HST. Even so, we must recognize that the two, while different, are mutually supportive.

SSM plays the greater role in identifying, defining, and solving the right problem, and HSM plays the greater role in solving that problem the right way. Moreover, SST is crucial to enhancing the probability that the host or client organization will implement the study results. A plethora of evidence suggests that SSM's founding fathers cannot claim exclusivity in this crucial arena nor can they claim inventors' rights. OR/MS has always been concerned with the very same issues. Successful practitioners of OR/MS have addressed them at all times and practiced the concepts at all times. To be sure, "much of what was published in the flagship OR/MS journals and much of what was being taught and researched at many universities, including some of the very best" (Pierskalla 1987) created the need for some reaction, hence, SSM. Unfortunately, the rhetoric in its seminal texts has misled or confused many newcomers to OR/MS and perplexed some of us old-timers.

Epilogue

In a December 3, 2004 search of http://www.informs.org/Biblio/topics.html for INFORMS-approved key words for this paper, I found that the word *system* or

systems never appeared as a primary designation in the 18-page single-spaced document unless preceded by a modifier, as in education systems but not as in general systems theory. I did not find such phrases as systems approach, systems analysis, systems design, or systems philosophy either. This online list of key words has evolved over at least the last three decades. Is this an oversight or yet another symptom of what we called neoclassical OR and an institutional loss of memory? What would C. West Churchman say about this if he were still with us?

Appendix

Listed below are articles in archival journals and chapters in books, starting in 1969, and describing studies performed by the authors using the underlying concept of SST to obtain results that were implemented.

Blum, A., B. V. Dean, R. A. Koleski, S. J. Mantel Jr., A. Reisman, R. Ronis, J. Rubenstein, A. L. Service, M. Jaffee, R. Reich, H. Reiger. 1973. A measurement model for planning and budgeting for the Jewish Community Federation of Cleveland. A. Reisman, M. L. Kiley, eds. *Health Care Delivery Planning.* Gordon and Breach Science Publishers, New York, London, and Paris.

Dean, B. V., A. Reisman, P. Darukhanavala. 1973. Are you looking for a new plant location? *Automation* **2**(11) 48–52.

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Duran, L., A. Reisman. 1983. Design of alternative provider team configurations: Experience in both developed and developing countries. *Book of Readings, Education of Operational Research and System Analysis in Health Services Administration Programs*. Serie Desarrollo de Recoursos Humanos No. 50, Pan American Health Organization, Washington DC, 205–228.

Duran, L., A. Reisman, J. Becerra, C. Regis. 1984. Manpower needs forecasts for the health services of the United States of Mexico. *Boletin de la OSP* (May), Pan American Health Organization, Washington, DC, 387–395.

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Mantel, S. J., Jr., A. Service, A. Reisman, R. A. Koleski, A. Blum, B. V. Dean, R. Reich, M. Jaffee, H. Rieger, R. Ronis, J. Rubinstein. 1975. A social service measurement model. *Oper. Res.* **23**(2) 218–240.

Mesarovic, M. D., A. Reisman. 1972. *Systems Approach and the City.* North-Holland, Amsterdam, The Netherlands.

Morito, S., A. Reisman, H. Emmons, J. Rivaud. 1977. On designing and implementing a dental practice management game. *Proc. 1977 Winter Simulation Conf.* National Bureau of Standards, Washington, DC, 440–447.

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Science. American Elsevier Publishing, Amsterdam, The Netherlands, 291–310.

Reisman, A., N. Eisenberg, A. Beckman. 1969. The application of operations research to community planning. *J. Jewish Communal Service* **46**(1) 70–92.

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