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Operational research and critical systems thinking – an integrated perspective

Part 1: OR as applied systems thinking

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ABSTRACT: What does good operational research (OR) practice mean, and what can critical systems thinking (CST) do for it? This two-part essay proposes new answers to both questions. It reaches out to the wider community of OR professionals and explains from their perspective what CST is all about and why it matters for good practice. Part 1 first reviews the idea and history of systems thinking in OR, as a basis for properly situating CST within OR. It then offers a comparative, non-partisan account of the two strands of CST, critical systems heuristics (CSH) and total systems intervention (TSI), and identifies their combined potential in an ability to enhance the contextual sophistication of OR. The prevalent but inaccurate notion of the history of OR as a linear evolution from 'hard' to 'soft' and 'critical' systems thinking is replaced by an integrated perspective of OR as applied systems thinking.

Keywords: operational research / operations research (OR); history of OR; philosophy of OR; practice of OR; professional practice; professional education; professionalism; expertise; applied research; applied science; applied systems thinking; critical systems thinking; critical systems heuristics (CSH); problem structuring; research education; research practice, competence in practice; practical reason; practical reasoning; practical rationality

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Introduction

Operational Research (OR) is a rich, multifaceted, and remarkably successful profession. Operational researchers work for and with a great variety of clients. They are asked to intervene in a great variety of problem situations often characterized by high degrees of complexity and diversity. They bring to these situations strong analytical and consultancy skills. And finally, they rely on a sophisticated tool basket of quantitative and qualitative methods and have a solid educational and professional background. Although OR practitioners share many of these skills with other professionals engaged in industrial,

commercial, and governmental problem solving and planning – among them public policy analysts, management consultants, evaluation researchers, information systems designers, crisis managers and trustees – they have available some very *specialized* competencies in quantitative modelling and numerate analysis. These other professions also have their particular skills. What in the end distinguishes a profession is whether beyond specialized skills, practitioners also have a good portion of those more *generalist* skills on which depends the competent application of specialized skills in the first place, generalist skills such as situating problems properly in their contexts, understanding the needs of the parties involved, facilitating mutual understanding and conflict resolution, and so on. Good OR practice thus depends on a wealth of skills and services that its practitioners offer and which *together* make up OR's remarkable profile of competencies.

Rich practice, impoverished accounts

Against this rich profile of competencies that matter, the accounts one finds of OR practice in the literature often look impoverished. OR texts and journals often convey the impression that OR is a rather narrow discipline of quantitative modelling and numerate analysis, in which the many other skills that matter for successful problem solving and professional intervention hardly seem to play any role. The systems literature makes a partial exception in that it discusses the value of one particular generalist skill, systems thinking and its quest for a whole-systems perspective, for a proper understanding and handling of problem situations. But at the same time, systems-theoretical accounts of OR often draw on the same impoverished picture (not to say, caricature) of OR to argue their own case. Within the systems literature, the game repeats itself in that each school of systems thinking tends to give an overly narrow picture of the others, as if the reality of problem situations could ever be captured through a *merely* quantitative perspective (a caricature of **[/1229]** 'hard' systems thinking) or a *merely* subjectivist perspective (a caricature of 'soft' systems thinking), or even through a *merely* emancipatory perspective (a caricature of 'critical' systems thinking). Furthermore, as if to make things worse, 'classical' OR (a caricature of what OR was from the very beginning) is aligned with 'hard' systems thinking as if the very real successes of OR could be explained in this way (a caricature of the nature of professional practice, applied science and applied systems thinking). Based on such caricatures of OR as applied 'hard' systems thinking, one can then apparently introduce soft and critical systems thinking as *alternative* paradigms that will save OR theory and practice from their unenlightened state and make them evolve *away* from hard *towards* soft and critical systems thinking.

Rethinking the relation of OR and systems thinking

This is not how the present essay understands progress in OR and systems practice. It takes as its starting point the simple idea that professional practice is what professionals do in practice rather than what some theorists say it is. If this is so, one must doubt whether the rich universe of professional practice exercised in the names of operational research and applied systems thinking can be adequately captured and explained in terms of either hard or soft or critical systems thinking or any other particular theoretical paradigm. It would seem that the relationship of OR and systems thinking needs to be understood differently.

The position this paper takes is that both OR theory and OR practice have from the outset relied on an understanding of professional intervention, and of the role of systems thinking in it, that was considerably more sophisticated than the now prevalent caricatures of 'classical' OR and its supposed evolution from 'hard' to 'soft' and 'critical' systems thinking. It is advisable, then, to ground an adequate understanding of the ties between OR and CST in these three partial efforts:

i. a review of the original connection of *OR and systems thinking* with regard to their shared notion of competent practice;

ii. a systematic and non-partisan examination of the methodological potential of *critical systems thinking* as it can be found in its two main contemporary strands, critical systems heuristics (CSH) and total systems intervention (TSI) or creative holism (CH); and

iii. a clarification of the concept of *good OR practice* with a view to the challenges professionals face in practice.

Only on this triple basis can we hope to understand the relation between OR and CST in a way that is theoretically adequate *and* conducive to good practice. This, then, is what the present two-part essay proposes to do. It should be clear though that in pursuing this effort, the aim is not to assess or criticize what OR professionals do in practice and how well they do it. No claim is involved to do justice to the multifaceted efforts of those many skilled professionals who do their best in everyday practice to bring the skills and tools of OR to bear on the problems of the people and organizations they serve. Nor does the paper claim to give a history of OR that would come in any way close to doing justice to the field's rich history of ideas. The paper's only aim is to examine in a somewhat balanced and systematic manner what CST might contribute to OR's future profile.

OR and systems thinking in retrospect

Since the very beginning of operational research in efforts to improve military operations such as radar-supported aircraft interception shortly before and during World War II, one of the main ideas – apart from working in interdisciplinary teams – was to study operations 'as a whole', that is, to improve their overall *system performance* rather than to maximize the performance of each and every component activity. Expanding the approach to non-military applications in industrial production, business administration and civil government, the first internationally recognized textbook defined OR as 'the application of scientific methods, techniques, and tools to problems involving the operations of a system so as to provide those in control of the system with optimum solutions to the problem' (Churchman *et al*, 1957; pp 8f and 18; similar formulations were used by some other early and often-cited accounts of OR, eg by Beer, 1959, and Ackoff and Sasieni, 1968).

Two concepts of 'optimum solution'

It is to the credit of the wide-spread use and success of quantitative OR techniques that the notion of an 'optimum solution' today makes us think of mathematical optimization in the first place; but this is not how these pioneers understood the concept. Their notion of optimality was a systems-theoretical rather than a technical or mathematical notion. We might need to translate it today as the search for an *overall balance* between multiple, changing, conflicting, partly incommensurable and partly immeasurable or intangible objectives, as distinguished from a notion of optimality that aims at maximizing or minimizing the quantitative value of an objective function.

Some confusion about 'what OR is' has arisen in the past due to the fact that these two different notions of optimality have not been taken into proper account. As soon as we distinguish them, the dispute about whether the 'search for optimality' (eg Hillier and Liebermann, 1990, p 3) is constitutive of well-understood OR is redundant. **[/1230]** It is then clear that in a systemic sense it is still a guiding, though perhaps not constitutive, idea, while in a technical sense it is better replaced by the more general concept of a search for *overall preferred* solutions, whereby 'overall' refers to a considered problem context and a conforming combination and weighting of criteria for assessing its improvement, and 'preferred' refers to a ranking of trade-offs between considered solutions (all of which will ideally be 'efficient' or Pareto-optimal solutions). But of course, such a technical notion of 'overall preference' as it is used in multi-criteria decision-making techniques immediately bring up issues such as '*Whose preferences* matter for the ranking?' and '*What context*

matters for defining an overall perspective?' Just shifting from mathematical optimization to multi-criteria decision-making will not do, for the crucial issues reach beyond a mere question of technique. A systems-theoretical rather than just technical concept of 'overall preferred' solutions will remind us of these further-reaching issues.

The Churchman-Ackoff programme of research also is quite clear about another aspect of the early systems perspective of OR. 'Systems' were identified with organizational units and procedures (eg workflows in and between production units considered as man-machine systems) that were to be designed or redesigned systematically, with the aim of improving their functions 'relative to as large a portion of a total organization as is possible' (Churchman *et al*, 1957, p 6). The key issue was seen in the circumstance that due to the division of labour in organizations, each organizational unit tends to develop objectives of its own. It will, for example, try to minimize its operating cost rather than putting the organization's overall success first, over which it has no measure and control. With a view to securing overall success, well-defined and controllable unit objectives are essential, but even more essential is finding an adequate *balance* between unit objectives and overall objectives – an issue that Churchman and co-authors (1957, pp 4-6) referred to as *executive-type problems*, as it is the key responsibility of chief executives to deal with such issues. Systems, then, were organizational or otherwise interconnected problem situations that presented executive-type problems, and OR accordingly was 'the use of science in the study of executive-type problems' (1957, p 6).

Science applied to systems

In retrospect, the pioneers indeed started out with a remarkably modern concept of optimality. It was a systems-theoretical rather than mathematical concept. The main concern was that good problem solving should *avoid* any kind of optimization that would lose sight of a whole-system perspective – the very contrary of a narrowly technical concept of optimization as it is now often associated with 'classical' OR and with its supposedly underlying paradigm of 'hard' systems thinking. If any aspect of this early systems orientation looks a bit dated today and may justly be associated with hard systems thinking, it is its tendency to hypostatize the systems concept, that is, to use it as an ontological rather than epistemological device – systems were understood to be real-world entities rather than just ways to conceive of problem contexts, as in 'soft' systems thinking. However, this now usual distinction between 'hard' and 'soft' systems thinking did not exist at the time and in practice is never as sharp as the current OR and systems literature tends to depict it; for it is quite clear that all human

knowledge of and thought about the 'real' world refers to a *conceived* reality. All systems thinking therefore involves a degree of freedom as to how systems are delimited (for fuller discussion see Ulrich and Reynolds, 2010, p 251f). Whether one relies on a rather 'hard' or 'soft' employment of the systems concept makes little difference in this respect. The core idea is and remains that improvement is a function of the whole relevant system and hence, that it is essential to 'look at the total system' (Churchman *et al*, 1957, p 56). From the outset, this effort was understood to raise fundamental questions of inquiry and ethics (eg Churchman, 1961 and 1971; Ackoff and Emery, 1972; Ackoff, 1974; for overviews of some central themes of Churchman and Ackoff's systems thinking, cf Britton and McCallion, 1994; Ulrich, 2004).

There is a second aspect that looks partly dated: contemporary management and planning conceptions prefer decentralized modes of decision-making to centralized top-down planning as it might be seen to be presupposed in the pioneers' quest for a system-wide perspective. Inasmuch as this assumption was really built into the original conception of OR, it is clear that current conceptions of OR need to accept the *loss of a system-wide* perspective that, for instance, Daellenbach and Read (1998) have described well. Methodologically speaking though, the question of how a decentralized approach can ensure a satisfactory overall result without some overall planning remains relevant. 'Internal market' solutions as they are now increasingly used both in public and private sector management can to some extent replace system-wide planning and control tools, and OR can contribute to both approaches. The ongoing replacement in many countries of centralized governmental hospital services planning with decentralized management on the basis of so-called diagnosis-related groups (DRGs), a system of case classification and pricing that allows establishing internal markets for decentralized management as well as developing system-wide measures of performance and quality control for central management, provides an example. As this remarkable, international success story of OR illustrates – the DRG system was developed by the US American operational researcher Robert Fetter and collaborators at Yale University **[/1231]** (see Fetter *et al*, 1980 and 1986) – a clear conception of overall results and policies is still essential, and accordingly there is still a demand for 'system-wide' quantitative analysis, modelling, and control. As so often we are talking about a matter of changing emphasis rather than a genuine alternative.

In conclusion, the systems perspective of early OR reaches far beyond the now prevalent association of 'classical' OR with a narrowly positivistic and 'hard' understanding of systems thinking, and its tendency to equate 'systems' with organizational units does not necessarily

imply a focus on centralized top-down planning. Against such a distorted view, there is a need today to emphasize that OR was from the outset conceived as a framework of applied research that would *make a difference* to conventional applied science by situating problems carefully within the relevant whole systems or, as the OR and systems literature now prefers to put it, within their contexts. For the pioneers, this meant they had to envisage a model of applied science that did not exist at the time and which in many respects remains a challenge today – a holistic, interdisciplinary, and problem-oriented model of applied science that would be both philosophically well-grounded and practicable. It certainly helped that their notion of science was rooted in the American tradition of *philosophical pragmatism* rather than in the logical empiricism (or logical positivism) that was then *en vogue* in the scientific community, particularly in Europe. Ignoring these pragmatic rather than logical-positivist roots has often led to misunderstandings about the prominent role of the term 'science' in Churchman and Ackoff's conception of OR; *their* science was not the science most readers had in mind. One of the few observers who have noted this point is Boothroyd (1978, p 80); a summary account of the influence of pragmatism on Churchman's thinking can be found in Ulrich (2004, pp 1125-1127; for a basic introduction to pragmatism see Ormerod, 2006). With this *caveat,* Churchman and Ackoff's vision for OR was to promote an interdisciplinary and problem-oriented *science applied to systems.*

Emerging difficulties and new ideas

In the 1960s and 1970s it became increasingly apparent that a basic dilemma plagued the original conception of OR. Convincing as the idea of combining the tools of *applied science* and *applied systems thinking* was, no specifically 'systemic' methods were available to make sure that problems were adequately defined in the face of complex contexts and that it was clear what good (or 'preferred') 'overall' solutions meant. Yet these were precisely the kind of challenges that had led the pioneers to conceive of OR as an applied systems discipline rather than an applied science only. They amount to basically three issues that remain relevant today:

Applied science versus applied systems thinking

There was an unresolved *tension between the 'systems' and 'science' poles of OR;* that is, between the insight that had spurred the birth of OR in the first place – that the analytical tools of science were ill-suited for capturing the reality of systems – and the continuing quest

for scientific rigor that shaped the field's development, its practice, educational programs, and standards of excellence.

With hindsight, one might see OR's birth defect in the circumstance that it conceived of the 'systems' aspect of applied science in terms of its *subject* of research but not equally of its *method* of research. While aiming to develop an innovative, interdisciplinary and integrated kind of applied research and consultancy, the OR mainstream as it mirrors itself in the profession's educational programs and most respected journals (but not necessarily in good OR practice) largely continued to define its standards and procedures in terms of the very analytical and quantitative methods that the pioneers had found relevant but insufficient. There was a certain *methodological vacuum* regarding the exact nature of a 'systems approach' (Churchman, 1968).

Social versus technical complexity

A second difficulty consisted in the absence of a strong foundation of operational research practice (as distinguished from OR techniques) in social-scientific conceptions of professional intervention such as they became available in the 1960s and 70s. Conceptions such as 'planned social change' (Bennis *et al,* 1962), 'process consultation' (Schein, 1969), 'organization development' (French and Bell, 1973), and many others ('action research', 'group dynamics', 'sociology of knowledge' etc) come to mind. Epistemologically speaking, what mattered more than these specific approaches is the underlying *social turn* of the understanding of knowledge in the applied disciplines, an idea that at the time had not yet fully liberated itself from the naturalistic tendencies of 'behavioural science' but which nevertheless contained some of the seeds of the later language-analytical and discourse-theoretical revolution of contemporary philosophy (cf Ulrich, 1988, on the theoretical implications for systems thinking and practice). Practically speaking, the main implication is a *participatory reorientation* of the notion of good practice in applied science, applied systems thinking, and professional intervention in general (cf Ulrich, 2000, on the need for grounding an adequate notion of professional competence in participatory practices of civil society).

[/1232] There were some remarkable early exceptions within the field of OR/MS, among them Churchman and Schainblatt's (1965a, b; cf Müller-Merbach, 1988) framework of 'mutual understanding' and Boothroyd's (1978; cf Ormerod, 2010a) process-oriented framework of 'articulate intervention'. Apart from such individual efforts, however, the profession's mainstream of the 1960s and 1970s hardly took up the ground-breaking concept that informed these new research approaches, the concept of the *social construction of reality*

(Berger and Luckmann, 1966). It reaches far beyond the 'behavioural science', 'social psychology' and partly also 'social engineering' language of the epoch. Knowledge in it is no longer understood as a function of the 'real world' and proper theorizing about it *only*; it now also depends on what the parties involved *want* to be considered relevant – the *normative core* of what 'counts' as knowledge. Furthermore, it recognizes that when it comes to inquiry and intervention in organizational and societal problem situations, and indeed in human affairs in general, the *situational complexity* to be understood and mastered is of a social (intersubjective) as much as a technical (functional) nature. The implication is that an adequate understanding of such situations cannot be achieved without involving those concerned – the participatory idea.

Mathematical versus contextual sophistication

Some members of the OR community did recognize how ground-breaking the new ideas were, for OR and applied systems thinking no less than for other applied disciplines. In the US, Churchman and Ackoff began to develop new research and training programmes under the labels 'social systems design' (Churchman, 1970, 1971,) and 'social systems science' or S^3 (Ackoff, 1973, 1974, 1979b, 1981). In the UK, Checkland (1972, 1978, 1981) set out to develop a 'systems-based methodology' that might inform 'systems studies' properly speaking. The result was somewhat ambivalent: separate 'systems' communities formed in the US and the UK, whereas the OR mainstream remained largely unaffected. The OR community greeted the new ideas with interest – and carried on as before, without any sustained effort to review the field's foundations.

More attention was paid to the critique that Ackoff (1979a) eventually directed at the OR mainstream, after many years during which he and Churchman had admonished the profession to face the need for a 'systems approach' that would be more socially aware and participatory in orientation. As a result of the failure to develop such an approach, Ackoff argued,

> OR came to be identified with the use of mathematical models and algorithms rather than the ability to formulate management problems, solve them, and implement and maintain their solutions in turbulent environments. This obsession with techniques … reduced the usefulness of OR, a reduction that was well recognized by executives who pushed it further and further down in their organizations, to where such relatively simple problems arose as permitted the application of OR's *mathematically sophisticated* but *contextually naïve* techniques. (Ackoff, 1979a, p 94, italics added).

Other strongly argued critiques were to follow, by authors such as Dando and Bennett (1981) and Rosenhead and Thunhurst (1982), but none had a similar impact. Ackoff's critique caused strong reactions for two reasons. On the one hand, it articulated the profession's longstanding failure to develop adequate frameworks for good practice and thereby apparently touched a sensitive spot; on the other hand, there was its own outrageous failure to do justice to actual OR practice, which had always been so much more than just applying techniques. It is this 'much more' – the ways how professionals employ their tools – rather than the tools themselves which determine how contextually naive or sophisticated a profession's practice is. Ackoff's own practice demonstrated this, and so did the practice of many of his colleagues who successfully advised corporate managers and governmental authorities. They could hardly have been so successful had they relied mainly on 'contextually naïve techniques'.

Unfortunately, Ackoff's failure to do justice to the profession deflected attention away from the essential message. With the benefit of historical distance it stands out more clearly: ensuring a healthy *balance between technical and contextual sophistication* is vital to all professional practice. Technical sophistication requires specialized methods as OR uses them; but putting such technical sophistication to good use depends on generalist skills of recognizing and analyzing problem situations. That is, the value of technical sophistication depends on contextual sophistication. A concern for such balance should accordingly inform the development of the conceptual foundations and practical tools of OR as well as its educational programs and standards of good practice.

New definitions, old issues

OR is now often defined without explicit reference to the three guiding ideas that stood at its beginnings: applied science, systems thinking, and optimum (or preferred overall) solutions. For example, it is now defined as 'the discipline of applying advanced analytical methods to help make better decisions' (INFORMS, 2003). While OR is obviously still associated with a scientific attitude of objectivity and rigor and in this general sense remains an applied science, it is now more often seen as (abstract) technology (eg by Dando *et al*, 1977; **[/1233]** Boothroyd, 1978, pp 4-6, 15f; Rosenhead, 1986; Keys, 1989, 1995; Miser, 1991; and Ormerod, 1996a, b, 2010b). Clearly though, if OR is an applied *science (or technology) of the better*, it also involves knowing what is good, that is, issues of value judgement that reach beyond science and technology.

The art of putting problems well

A change of definition does not remove the key difficulty: How do we know a problem is well put? Problem solutions are rarely better than the underlying problem definitions. If the solution isn't adequate, chances are the problem definition wasn't either. Problem definitions in turn are rarely better than the underlying understanding of *problem contexts,* or in more traditional systems terminology, the system's environment. If a problem definition turns out to have been inadequate, chances are the context was not adequately considered. In a world of growing interconnectedness, complexity and diversity, understanding problem contexts well has become a crucial problem in itself. Churchman and Ackoff recognized the difficulty early on, but few recognized that they did:

> There is an old saying that a problem well put is half solved. This much is obvious. What is not so obvious, however, is how to put a problem well. (Churchman *et al,* 1957, p 67)

To Churchman and Ackoff, *putting problems well* meant to 'sweep in' all aspects of the environment that might be relevant for securing improvement, rather than allowing available methods, models and data to dictate problem definitions. Thus understood, good practice always involves some applied systems thinking, whether implicitly or explicitly. If methodological support is lacking, chances are the systems thinking involved will remain poorly defined and difficult to review.

It is thus clear why in its development since the 1970s, OR had to take the step from considering *systems as its subject* of research to also understanding *systems as a way of thinking.* The conceptual step involved was more fundamental than the shift from 'hard' to 'soft' systems thinking of which Checkland's (eg 1981, 1985) work immediately makes us think today; it consisted in recognizing that systems as a subject of study called for systems-based frameworks and methods to study them. Such tools for 'systems studies' (Checkland) were not available in OR until the 1970s, no more than in other applied disciplines.

The need for systems methodologies

There was therefore a need to develop the basic idea of systemic thinking just explained – that professionals should not allow their specific methods and data alone to define the problems they deal with – into methodological principles and tools that would inform (but not replace) the use of those specific tools. Generally speaking, the more specialized a discipline becomes, the more urgent the need for such complementary methodological support will tend to be. This explains why along with OR's development into an increasingly specialized mathematical discipline and, beyond it, an increasingly sophisticated profession, a new field

of study emerged that focused on developing *systems methodologies:* new frameworks and tools were required for dealing with problems which conventional tools of science are ill-suited to deal with, the context- and perspective-dependent aspects of systems.

The 1960s and 1970s first saw the rise of 'systems engineering' (originally developed at the Bell Laboratories, see Hall, 1962), 'systems analysis' (developed at RAND Corporation, see Quade and Boucher, 1968), 'system dynamics' (developed at MIT, see Forrester, 1961) and 'managerial cybernetics' (developed at Manchester University, see Beer, 1972); but these early systems methodologies still oriented themselves so strongly toward the quantitative methods of natural science and engineering that they remained ill-suited for dealing with 'socially constructed' complexity in the sense of Berger and Luckman (1966), as they could not handle conflicting contextual assumptions tied to multiple worldviews, values, and interests. A further conceptual step was required to strengthen the balance between mathematical and contextual sophistication.

The emergence of soft and critical systems thinking

From the 1970s it gradually became clear that if systems methodologies were to be able to deal systematically with issues related to people's differing world views, values, and interests, they would require some grounding in the 'interpretive' (hermeneutic) paradigm of the social sciences and the humanities, possibly also in additional traditions of thought such as critical social theory, language analysis, ethics, and philosophical pragmatism. In response to this challenge, the late 1970s and early 1980s saw the emergence of two fundamentally new approaches to systems thinking. Checkland's (1981) work in England on 'soft systems methodology' (SSM) produced a practical framework for *soft systems thinking*. Ulrich's (1980b, 1983) work in California and later in Switzerland and England on 'critical systems heuristics' (CSH) produced a practical framework for *critical systems thinking,* soon thereafter followed by work at Hull University in England on an overarching framework called 'total systems intervention' (Jackson and Keys, 1984; Flood and Jackson, 1991; more historical detail on the two strands of CST will be given later). To be sure, Churchman (1970, 1979a, 1979b), Ackoff (1974, 1979b, **[/1234]** 1981) and others had *prepared* the ground by calling for a systems-oriented, cross-disciplinary, and participatory philosophy of management science, without however managing to translate their insights into rigorously spelled-out methodologies. Similarly, Bryer (1979), Mingers (1980), Ulrich (1981b) and Jackson (1982, 1985) subsequently *called* for alternatives to the work of Churchman, Ackoff, Beer, and Checkland but could not yet propose suitable methodological proposals.

It was thus left to SSM and CSH to redefine systematically what 'systems thinking' means when it is informed by the hermeneutic and critical traditions of philosophy, respectively, and to translate these redefinitions of systems thinking – as an epistemology of appreciating and learning about human activity systems (Checkland) and an effort of practical reason aimed at securing reflective practice (Ulrich) – into well-defined methodological frameworks for professional intervention. In turn it was left to total systems intervention (TSI) to put these new approaches into perspective and to suggest one possible way to conceive of their complementarity. Since the latter issue comes up systematically only as a consequence of the previous proliferation of new systems methodologies, it is advisable first to focus on what was fundamentally new in the emerging 'soft' and 'critical' strands of systems thinking. Subsequently the two different notions of 'critical' systems thinking in CSH and TSI will be analyzed in a comparative way, before the issue of an integrative framework can then be examined systematically in Part 2.

Basically, by '*soft* systems thinking' (or 'interpretive' systems thinking) Checkland (1981, pp 149f; 1983, p 671f; 1985, p 760; 2000, p S15f) understood a systems approach that locates its systemic nature in the process of inquiry rather than in the real world, with a particular focus on processes of learning and problem exploration; whereas by a '*critical* systems approach' (or a 'critically-normative' approach) Ulrich (1983, pp 25, 34f, 177; 1987, p 278f; 1988, p 156f; 1993, p 587f) meant the systematic use of systems thinking in the service of reflective practice, with a particular focus on the normative core of all uses of applied science and applied systems thinking. While SSM was conceived as a direct response to the limitations of systems engineering or other 'hard' systems approaches in dealing with managerial and organizational problems, CSH aimed at renovating the contemporary concepts of applied science and professional intervention in general, regardless of what specific ('hard' or 'soft') methodologies researchers use.

Corresponding to these aims, SSM found its theoretical inspiration mainly in Geoffrey Vickers' (1965) *'appreciative' systems thinking,* along with Max Weber's (1949) *interpretive social science* and Kurt Lewin's (1946) concept of *action research,* all of which can be understood to combine elements of classical sociological functionalism (Emile Durkheim, Talcott Parsons) with aspects of hermeneutic (Wilhelm Dilthey) and phenomenological (Edmund Husserl, Alfred Schütz) philosophy. By contrast, CSH found its main theoretical roots in the European (Continental) and North-American traditions of *practical philosophy* (or philosophy of practice), which include Kantian *critical philosophy* and its contemporary renaissance in *critical social theory* (Max Horkheimer, Jürgen Habermas, Herbert Marcuse),

language analysis (John L Austin, John R Searle) and *discourse theory* (Karl-Otto Apel, Jürgen Habermas) on the one hand and American *philosophical pragmatism* (Charles S Peirce, William James, John Dewey, C West Churchman) on the other hand; major theoretical inspirations were Churchman (1971, 1979b), Habermas (1975, 1979), Kant (1781/1965), and Peirce (1878).

A core issue: 'problem structuring'

Despite such differences of perspective, soft and critical systems thinking share a common interest in Churchman's question of 'how to put a problem well', as a basis for understanding what competent professional intervention means. For example, it means that expert-driven problem definition, with its emphasis on analysis and objectivity, needs to be complemented with, and embedded in, a pluralistic, participation-driven, methodologically well-defined process of *unfolding* problems within their larger contexts and from multiple perspectives. There will often be no single, definitive definition of 'the problem', as there are usually *options* for defining relevant contexts and perspectives – the 'soft' nature of problems. These options should be made transparent not only to the professionals and decision-makers involved but to all the parties concerned, and all should be in a position to voice their concerns. Likewise, the methods professionals use to analyze a problem situation and evaluate possible solutions need to be sufficiently clear to everyone concerned to permit critical discussion of their inherent assumptions and findings. Finally, problem definitions and solutions are also to be considered 'soft' in the sense that in the interest of learning, contextual assumptions should be kept open to modification and challenge, as there is no natural stopping point for declaring the process of problem structuring to be completed.

In view of this evolving understanding of good professional practice, the traditional focus on 'problem solving' came increasingly to be recognized as insufficient. There was a call for *systematic* problem structuring, defined as 'the process by which the initially presented set of conditions is translated into a set of problems, issues and questions sufficiently well defined to allow specific research action' (Woolley and Pidd, 1981, p 197; cf Pidd and Woolley, 1980). Problem-solving methods had to be complemented by *problem-structuring methods* (PSMs), **[/1235]** a term used by Rosenhead (1989) to describe the paradigmatic shift that would allow OR and systems thinking to cope with situations of complexity, uncertainty, and conflict.

It makes sense to understand both soft and critical systems methodologies as problem-structuring approaches, but a number of misunderstandings should be avoided. Soft and

critical systems thinking aim to support participatory processes of problem solving and decision-making *based on* systematic problem structuring, rather than limiting themselves to problem structuring. PSMs, on the other hand, are now usually identified with a number of *soft OR methods* that pursue more limited objectives. With the exception of SSM, which is usually included among the PSMs, they are not based in systems thinking, social theory and philosophy. Soft *systems* thinking comes into play coincidentally rather than systematically, while *critical* systems thinking remains altogether foreign to this 'soft' concept of problem structuring. There is no intention to help develop the philosophical foundations of professional practice as rational intervention in human affairs. There is no clear distinction between methodologies (i.e., frameworks for research practice that seek to develop such foundations) and mere methods (i.e., techniques that may offer themselves for use within various frameworks but do not articulate their related assumptions). And finally, it is unclear why problem structuring should be associated with a particular 'soft' paradigm of research only, and thus with the rather marginal part of OR called 'soft OR', rather than being considered a constitutive element of all methodologies, whether hard, soft, or critical. Its essence consists in its heuristic, open-ended, questioning mood rather than in adherence to any particular methodological paradigm. Suffice it to refer to Polya's (1945) work on *mathematical heuristics*, which exemplifies a 'hard' (analytical rather than hermeneutic) conception of problem structuring, and to *critical systems heuristics*, whose grounding in practical philosophy reaches beyond the hermeneutic tradition. Understanding problem structuring exclusively in 'soft' terms is neither necessary nor conducive to developing our understanding of professional competence.

OR and systems thinking today

Important as the conceptual step from 'problem solving' to 'problem structuring' is, it does not go far enough. It lacks a philosophical basis and practical tools for dealing with the normative core of 'good' professional practice. It thus risks boiling down once again to instrumentally oriented 'problem solving' – a managerialist notion of good practice – *without* a clear conception of what it means 'to put problems well' and to deal reflectively with claims to rationality, competence, and improvement. To counter this risk, critical systems thinking (CST) takes the idea of problem structuring two important steps beyond soft systems thinking.

Two key issues of critical systems thinking

The first and fundamental step consists in recognizing that all problem structuring has value implications, in the practical sense that it may do more or less justice to the different views and needs of people. There is no way round it, professional problem structuring entails choices as to what are the relevant 'facts' (observations) and 'values' (concerns) to be considered. What *should* in a specific situation constitute the basis of knowledge and values for doing a competent and rational job? There is thus a need to support professionals and decision-makers in handling this normative core of practice carefully. The challenge, in short, is dealing critically with the *normative content and consequences* of professional findings and conclusions.

The second step consists in recognizing that real-world complexity takes different forms and there is consequently not one best way to understand and handle it. Conversely, different intervention approaches and methods rely on different notions of social and technical complexity and accordingly have different strengths and weaknesses. There is thus a need to support professionals and decision-makers in selecting and deploying intervention approaches carefully. The challenge, in short, is dealing critically with the *theoretical content and limitations* of professional methods and tools.

Both issues shape the way we understand and situate *problems within their contexts,* which is what we mean by analyzing *'problem situations'* rather than 'problems'. By defining relevant 'facts' and 'values', professionals effectively define what context matters for assessing improvement. By choosing methodologies, professionals effectively define what kind of complexity matters for dealing successfully with the context. The common core issue, then, is what we might call sources of *contextual selectivity.* As we learned from reviewing the early systems orientation of OR, good use of its technical sophistication depends on its contextual sophistication. Dealing carefully with both sources of contextual selectivity is therefore imperative. Yet they place rather different demands on good practice. The selectivity of methodologies regarding the nature of problem contexts can be identified theoretically once and for all, whereas the selectivity of professional findings and conclusions needs to be identified anew in each specific problem situation and therefore is basically a responsibility of practice itself.

This circumstance explains why two different strands of critical systems thinking have developed, 'critical systems heuristics' (CSH) and 'total systems intervention' (TSI). The core idea they share is that systems thinking is useful for handling contextual selectivity. The

following definition of CST **[/1236]** appears to be sufficiently general to comprise the two strands yet sufficiently specific to be useful:

> **Definition:** *Critical systems thinking* (CST) is an application of systems thinking that aims to support good practice in OR and other applied disciplines with special regard to *contextual selectivity,* that is, assumptions that shape the perception of problem situations. The main sources of selectivity are seen (i) in the *normative content* of professional findings and conclusions and (ii) in the *theoretical content* of professional methodologies and methods. The normative content in question resides in the 'facts' and 'values' considered relevant for understanding and improving problem situations; the theoretical content, in the kinds of social and technical complexity that chosen methodologies and methods can handle. Good practice regarding these two sources of selectivity raises different methodological issues and has accordingly brought forth two different strands of CST, (i) critical systems heuristics (CSH) and (ii) total systems intervention (TSI). Their shared concern, and thus the basic aim of CST in general, is to support *reflective practice* in handling contextual selectivity.

While this definition emphasizes the shared methodological intent and potential of the two strands of CST, it does not ignore or blur their differences. In view of these differences, the two strands of CST will now be introduced separately but following a strictly parallel structure and using the same criteria of description and assessment.

Facing the normative core of professional practice: CSH

OR practice, like all professional practice, entails *validity claims* (eg to relying on accurate facts, considering relevant issues, being unbiased and fostering improvement) that have practical consequences but which it cannot fully justify. Reliance on systems methodologies does not remove the difficulty, for no methodology can fully justify the answers to such inevitable questions as 'Whose problem is to be solved in the first place?' and 'For whom should improvement be achieved and for whom not?' What is possible, however, is a conscious and careful handling of this normative core of all professional intervention.

CSH emerged from a research programme on this issue initiated by W Ulrich in early cooperation with CW Churchman at the University of California, Berkeley, in 1976. The ideas that led to CSH can be traced in a few initial publications of the years 1975-81 in German language, along with a number of English publications by Churchman (1979b, cf Ulrich, 1981c), Churchman and Ulrich (1980), and Ulrich (1977, 1980a, b, 1981a, b). The main text is Ulrich (1983). Useful for reviewing more recent developments are Ulrich (2000,

2003, 2006 and 2007) and Ulrich and Reynolds (2010); a brief history of ideas can be found in Ulrich (2001, pp 12-15).

CST as understood in CSH

Critical systems thinking as understood in CSH begins with the idea that holistic thinking – the quest for comprehensiveness – is a meaningful *effort* but not a meaningful *claim*. Doing full and equal justice to the views and values of all the people concerned is and remains an ideal. We should not expect OR professionals to achieve ideals but only, to deal critically with the fact that they never do. Consequently CSH aims to assist professionals, decision-makers and stakeholders in appreciating the inevitable *selectivity* of the facts (observations) and values (concerns) on which depend all claims to good practice.

In practical contexts of action, selectivity tends to translate into *partiality*, that is, different parties will be affected differently. CSH consequently also aims to help professionals and citizens in analyzing these consequences, how different they may look if assumptions about relevant observations and concerns are modified. Good practice cannot avoid selectivity and partiality, but it can try to make the sources of selectivity transparent to all the parties concerned and to give them an opportunity to articulate their critique. It can try to examine the partiality of consequences systematically, so that decisions can be taken in full awareness of their implications for the different parties concerned. Critical systems thinking, thus understood, promotes reflective practice with respect to this normative core of professional intervention; the central idea is to support a participative process of unfolding the unavoidable selectivity and resulting partiality of professional findings and conclusions.

The methodological approach of CSH

Although systems thinking is no remedy for selectivity, it holds a key to handling it critically. Systems thinking compels us to pay attention to the systems boundaries that delimit any system of interest. We can thus understand systems thinking as a tool for reflecting about the *boundaries of concern* that we presuppose whenever we conceive of some problem situation in systems terms. Systems thinking then becomes a *source of critique* – of questioning boundary assumptions and the ways they condition validity claims – rather than, as it is more usually understood, a source of justification, that is, a way of buttressing validity claims by more comprehensive considerations of fact and value.

CSH achieves this by systematically identifying and questioning the ‘boundary judgements’ that delimit the ‘reference systems’ for professional findings and conclusions.

Boundary judgements determine for a number of basic boundary issues and related 'boundary categories' what is to be considered and what is to be left out when **[/1237]** it comes to defining relevant observations (judgements of fact) and concerns (judgements of value). A *reference system* is the set of boundary judgements that together define the context of application to which a specific claim or proposal refers and for which it is valid.

Boundary judgements are the perfect device for questioning the relevance and quality of reference systems; for unlike what one might assume at first, they define not just the *scope* of the context considered but equally its *content*, for example, how carefully we collect and formulate relevant observations and how well we argue related conjectures. This is so because any aspects of a problem situation that we fail to consider properly, say, because we argue incoherently or anticipate consequences incorrectly or fail to do justice to the concerns of others, have in fact been excluded from the relevant knowledge and value basis. Even if we do recognize some aspects as relevant and agree with others they should be considered but then fail to take them properly into account, due to lacking knowledge, to an error of judgement or some communicative misunderstanding, or because those in control of the situation decide to suppress their discussion, we have in fact (deliberately or not) excluded those aspects from our reference system. Thus the *argumentative quality* of a validity claim or related discussion very well reflects itself in boundary judgements (see Ulrich, 2005, p 3).

The main device to promote such argumentative quality is *critical systems discourse*, a dialogical form of boundary critique. *Boundary critique* is a systematic process of unfolding the normative core (selectivity) of the boundary judgements that underpin any specific validity claims, so as to understand what they may mean for the parties concerned (partiality). A second basic aim is to show that there are always options for defining boundary judgements, and to allow the participants to see how different any specific claim may look in the light of such options. In cooperative settings where the parties are prepared to try and agree on their boundary judgements, these can then be modified accordingly. In controversial settings this may not be possible; boundary critique then gains a new meaning and consists in employing boundary judgements for critical purposes *against* those who are not prepared to disclose and question them or who even try to impose them on the basis of authority and power rather than argumentation. Boundary critique thus becomes a discursive process of challenging validity claims that take their built-in selectivity for granted.

In short, CSH understands itself as both a philosophical foundation and a practical framework for *value clarification and critique.* Note that 'value clarification' applies to 'facts' as well as to 'values'; for what we take to be the knowledge basis of professional

interventions (eg relevant data, judgements of fact, personal views, anticipated outcomes, etc) – has no less normative implications than what we take to be its value basis (eg relevant concerns, notions of improvement, sources of legitimacy, ethical standards, etc).

The methodological core principle of CSH

CSH understands the issue of selectivity as a systems-theoretical expression of the unsolved core problem of practical philosophy, the *problem of practical reason:* How can we justify the normative content of practice or, if we cannot, what does it mean to act rationally? Since there is no complete or objective solution, CSH reformulates the problem as the question of how we can at least achieve a 'critical solution' in the sense of value clarification and critique, so that decisions can be taken in well-informed and morally conscious ways. Methodologically speaking, the question translates into the task of supporting *systematic processes of boundary critique.* The strategy of CSH for dealing with the problem of practical reason thus consists in what it calls the *critical turn* of our notion of rational practice – practice is rational to the extent it is aware of its inbuilt selectivity and partiality and qualifies its claims accordingly. This is how CSH aims to support the quest for rational practice despite its unavoidable selectivity and partiality.

Accordingly, CSH's methodological core principle is the *principle of boundary critique:* what a claim means and how valid it is depends on its reference system, that is, the boundary judgements that inform its view of relevant fact and values and thus its empirical and normative selectivity. To appreciate and qualify the adequacy of professional findings and conclusions it is consequently indispensable to examine the underpinning boundary judgements.

To this end, CSH proposes twelve generic boundary categories (see **Figure 1**). They stand for four crucial sources of selectivity built into all practice: its sources of motivation, of power, of knowledge and of legitimation. Each boundary category translates into two boundary questions, one asking what is the case ('is' mapping) and the other what should be the case ('ought' mapping). This **[/1238]** yields a *checklist of boundary questions* that explicitly define the precise intent of each boundary category (see Ulrich, 1987, 1996, 2000; Ulrich and Reynolds, 2010). They can be used, first, to identify boundary judgements systematically; second, to examine claims in the light of alternative boundary judgements; and third, as mentioned before, to challenge claims that rely on boundary judgements they take for granted.

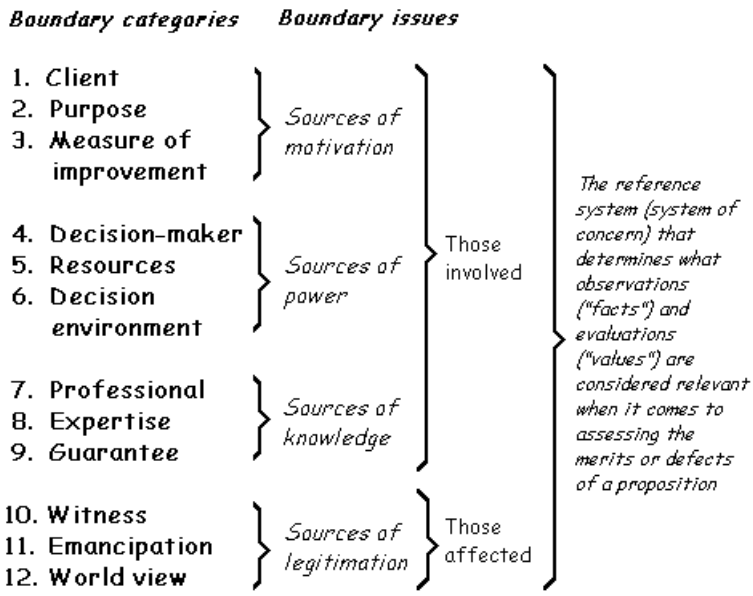

Figure 1 Boundary categories of critical systems heuristics
(Source: adapted from Ulrich, 1983, p 258)

The last-mentioned application leads to an argumentative employment of boundary judgements known as 'polemical' or 'emancipatory' boundary critique. It creates an improved *symmetry of critical competence* among the parties concerned whatever special knowledge or expertise they may have concerning the problem at issue. It constitutes an important methodological backing of the earlier-explained critical turn of the quest for rational practice. As a practicable model of cogent argumentation about normative issues (see Ulrich, 1983, pp 301-310; 1993, pp 599-605; and 2000, pp 257-260), it may be understood to pragmatize Habermas' (1979, 1984, 1990) theoretical model of rational practical discourse. The latter's ideal nature has confined his well-known 'discourse ethics' to remaining a much-discussed theory rather than a practicable model of moral discourse, so there is indeed a pressing need for pragmatization.

In sum, CSH can be defined as a methodological framework for boundary critique aimed at supporting a critical solution to the unsolved problem of practical reason. Despite its emancipatory implications – the aspect for which it is best known – CSH should not be misunderstood and used as an emancipatory systems approach *only*. The principle of boundary critique is vital for all rational practice, whatever importance is attached to emancipatory issues. Accordingly CSH does not aim to be a self-contained systems methodology but is better understood as a reflective framework that makes sense whatever specific methodology is used.

Practical implementation: the main procedure of CSH

Boundary critique is best implemented as an iterative process of reflecting on, and discussing, the implications of alternative boundary judgements. When we change some boundary judgement, the reference system of which it is constitutive will change, too; consequently, all other boundary judgements may need being reconsidered and adapted. CSH captures this idea and its methodological consequences with the image of an 'eternal triangle' of boundary judgements, value judgements, and judgements of fact, an idea that will be taken up in Part 2. Given that iterative processes are not easy to teach and to learn, it may help those new to boundary critique more at this stage to suggest a standard sequence for unfolding the boundary categories and questions of CSH (see **Figure 2**).

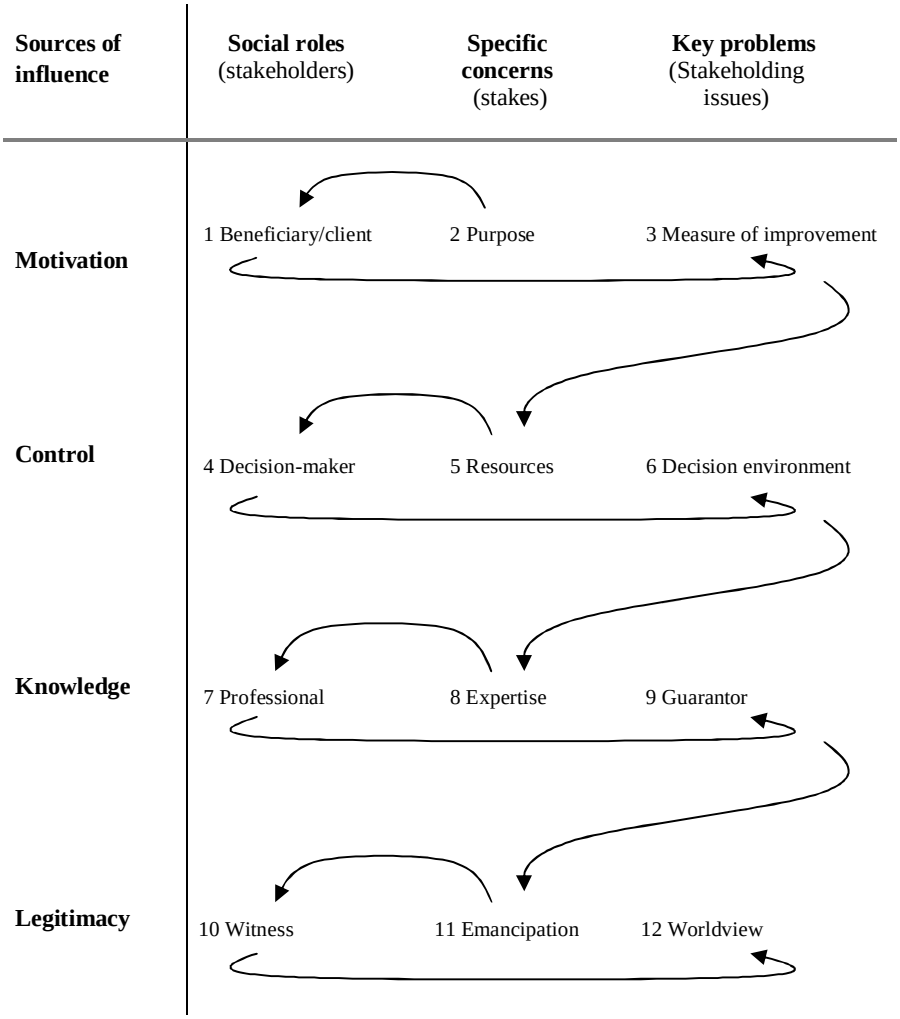

Figure 2 A standard sequence of boundary critique
(Source: adapted from Ulrich and Reynolds, 2010, p 259, and Reynolds, 2007, p 106)

Recent development

In an effort to strengthen its applicability and relevance to good professional practice, the on-going development of CSH currently aims to tie its central concept of boundary critique closer to a pragmatic framework of critical and responsible argumentation called 'critical pragmatism' (Ulrich, 2006, 2007). Some aspects of this current effort will be taken up in Part 2 and therefore need not be discussed here.

Ensuring informed methodology choice: TSI/CH

Good professional practice depends on the proper choice and use of intervention methodologies and conforming methods. Applied systems thinking can support professionals in adapting their methodologies and methods to the organizational or societal problem context*s* in question. Good systems practice will take advantage of the availability of different systems methodologies that, because they are informed by different methodological paradigms, can do justice to different kinds of contexts; it is in this sense multi-paradigmatic.

TSI emerged from a research programme on this issue initiated by MC Jackson in cooperation with P Keys at the University of Hull in 1983 and subsequently continued with RL Flood till the early 1990s. The ideas that led to **[/1239]** TSI can be traced in Jackson and Keys (1984, 1987), Keys (1987), and Jackson (1982, 1985, 1987a, b, 1990, 1991); the main text is Flood and Jackson (1991). Useful for reviewing more recent developments are Jackson (1997, 1999, 2000, 2003, 2006a, b); a brief history of ideas from TSI's perspective can be found in Jackson (2000, p357f). Jackson (2003, 2006b) meanwhile refers to his development of TSI as 'creative holism' (subsequently: CH, not to be confused with CSH) or 'critical systems practice'; I will not adopt the latter label, for I have used it throughout my writings (eg Ulrich, 1996, p 45f; 2003, p325) to refer to reflective practice of systems methodologies in general.

Both TSI and CH (subsequently: TSI/CH) assume that the nature of problem contexts can usefully be captured in terms of alternative *sociological paradigms* for describing the social reality in question (see Burrell and Morgan, 1979) along with various organizational 'images' or *systems metaphors* of organizational theory (see Morgan, 1986). Systems methodologies, depending on the kinds of problem contexts for which they have been developed, may themselves be characterized in such terms, and their strengths and weaknesses can thus be better understood. It thus becomes possible to *match* contexts and methodologies in a

systematic way, so as to support professionals in choosing the methodologies and conforming methods best suited to deal with a situation. As Jackson recalls:

> To explore and develop this idea, Paul Keys and I, during 1983/84, initiated a research program, at the University of Hull, aimed theoretically at explaining the relationships between different systems-based methodologies and practically at discovering the efficacy of particular approaches in various problem contexts. (Jackson, 2000, p 357f; similarly 2010, p 134).

CST as understood in TSI/CH

Critical systems thinking as understood in TSI/CH begins with the idea that applied systems thinking – the attempt to understand entire problem contexts in systems terms – is meaningful to the extent we are aware of the sociological paradigms and organizational metaphors that inform it. By relying on different paradigms and metaphors, different systems methodologies make different theoretical assumptions about the nature of problem contexts. Applied systems thinking accordingly depends for its justification and rationality on *paradigmatic fit* between systems methodologies and problem context.

In OR and other forms of applied research, the requirement of paradigmatic fit translates into a need for informing the selection and use of methodologies and conforming methods by *paradigm analysis* as well as, where relevant, *metaphor analysis.* TSI/CH consequently puts the critical focus on the *theoretical* underpinnings of alternative research paradigms rather than, as does CSH, on the normative core of professional practice. Critical systems thinking, thus understood, promotes reflective practice with respect to these theoretical underpinnings; the central idea is to support a theoretically informed process of matching methodologies with problem contexts.

The methodological approach of TSI/CH

The main theoretical device of TSI/CH is a *contingency approach* to methodology choice, based on a paradigmatic and to a lesser degree also a metaphorical analysis of the three major traditions of systems thinking thus far – hard, soft, and critical systems thinking. The idea is that there is no such thing as a best systems methodology and underpinning tradition of systems thinking; rather, situational aspects of the problem context at hand determine what tradition of systems thinking is best suited as a source of methodological guidance and specific methods or tools of intervention. A second idea is that such an approach promises to resolve the ‘OR in crisis’ debate of the 1970s and 1980s, as it offers a way to see ‘hard’ and

'soft' OR approaches as appropriate for dealing with different problem contexts rather than competing for the same ones.

Contingency frameworks are also called *contingency theories*, as they involve theoretical generalizations about the crucial aspects of the application domain to which the framework is to be applied. This theoretical device is often used in the social sciences (eg in management and organization theories) when a variety of approaches is required to handle a given class of problems, as the proper approach is dependent ('contingent') on the situation or, more precisely, on a range of changing situations.

Applied to contexts of professional intervention, using a contingency approach implies that it is possible empirically to identify some independent (contextual) variables that regularly, for reasons that can be explained theoretically, may be expected to condition the outcome of interventions. Subject to this condition, a contingency approach can be called a contingency *theory* and can be assumed to explain and *justify* the selection of situation-specific intervention approaches. It follows that the crucial question for a contingency approach is whether it can identify and validate a small number of empirical dimensions (ideally only two) in terms of which both intervention contexts and intervention approaches can be classified in a relevant and reliable way.

In short, TSI/CH understands itself as a *contingency theory* for methodology reflection and selection that bases its classification of intervention situations and approaches on the two main tools of paradigm analysis and metaphor analysis.

The methodological core principle of TSI/CH

TSI/CH understands the issue of selectivity as a question of the (social-) theoretical assumptions that inform the 'matching' of intervention approaches and problem **[/1240]** contexts: How can we ensure 'paradigmatic fit' of systems methodologies and situations? Methodologically speaking, the question translates into the task of developing and validating a classification of systems methodologies that can be mapped onto a corresponding classification or problem contexts. This is what TSI/CH calls a *system of systems methodologies* (SOSM). It says that systems methodologies and conforming methods are well chosen if their underlying systems metaphor (machine, organism, etc.) and/or paradigm (functionalist, interpretive, etc.) match with the kind of complexity or 'complications' (Jackson and Keys, 1984, p 474) that a problem context entails. The 'complications' in question are captured in terms of two dimensions, the 'systems dimension' and the 'participants' dimension, which in the terms of the present paper stand for the two

interdependent core issues of *complexity* (the number, interconnectedness and dynamic nature of the aspects to be considered) and *diversity* (the number, divergence and importance of multiple perspectives). **Table 1** summarizes the extended SOSM of 1991.

Table 1 The extended system of systems methodologies (SOSM)
(Source: adapted from Flood and Jackson, 1991, p 42; Jackson, 1991, pp 29 and 31; 2000, p 359)

Systems dimension of contexts (increasing complexity)	*Participants dimension of contexts (increasing diversity of values)*		
	Unitary (paradigm: functional) **HARD SYSTEMS THINKING**	*Pluralist (paradigm: interpretive)* **SOFT SYSTEMS THINKING**	*Coercive (paradigm: emancipatory)* **EMANCIPATORY SYSTEMS THINKING**
Simple	*Simple-unitary problem contexts* *(systems metaphor: machine)* • Operational research (OR) • Systems engineering (SE) • Systems analysis (SA)	*Simple-pluralist problem contexts* *(systems metaphors: culture, coalition)* • Systems approach (Churchman) • Strategic assumption surfacing and testing (SAST)	*Simple-coercive problem contexts* *(systems metaphor: prison)* • Critical systems heuristics (CSH)
Complex	*Complex-unitary problem contexts* *(systems metaphors: organism, brain)* • Organizational cybernetics/ viable systems diagnosis (VSD) • Socio-technical systems thinking	*Complex-pluralist problem contexts* *(systems metaphors: culture, coalition)* • Interactive planning (Ackoff) • Soft systems methodology (SSM)	*Complex-coercive problem contexts* *(systems metaphor: prison)* • ?

An earlier, four-celled version of the SOSM (Jackson and Keys, 1984) distinguished 'hard' and 'soft' methodologies only. Although it is frequently cited as the origin of the TSI strand of CST, it actually did not yet introduce the notion of 'critical' systems thinking and offered no place to CSH. When CSH became known to the authors after publishing their 1984 work, integrating its notion of a 'critical systems approach' was not easy and took some time. First hints at the planned extension of the SOSM appeared in some articles of the late 1980s (eg Jackson, 1987a, b, 1990), but the extended SOSM was presented only in 1991 (Flood and Jackson, 1991; Jackson, 1991).

With a view to the integrated perspective at which the current paper aims, the difficulties in question are worth explaining. We have seen that CSH aims to support the use of all methodologies and methods, whether they are based on a hard or soft or non-systemic paradigm – CSH's way of being multi-paradigmatic. We have also seen that CSH does not aim to be employed as a self-contained methodology. Moreover, its understanding of reflective practice aims at the 'other', practical-normative, dimension of reason – the unsolved problem of practical reason – of which the SOSM with its focus on theoretical paradigms has no grasp. For CSH, justification of practice is a matter of practice itself, as no reference to theory (much less to paradigm choice) can justify its normative core; accordingly it aims at

'critical heuristics of social practice' rather than 'critical theory of society' or any other kind of social theory (including contingency theory). All these aims cut across the different problem-solving contexts and paradigms considered in the SOSM. The SOSM, by contrast, assumes that any methodology can be assigned to a specific type of problem context; that doing so is a matter of theory (paradigm analysis) rather than of practice itself; and that any methodology thus classified is then to be employed as a 'dominant' (if not stand-alone) approach whenever its inbuilt paradigm matches the requirements of the context.

The only way CSH could apparently be adjusted to the logic of the SOSM was by narrowing its notion of critical systems thinking down to a *merely* 'emancipatory' purpose, as distinguished from the overall 'critical' purpose of the SOSM. This was achieved by associating it with a 'prison' metaphor that supposedly made it adequate for 'coercive' problem **[/1241]** contexts only. CSH could thus be integrated into the SOSM, but at the expense of treating it as a self-contained methodology that seemingly was to be chosen (or not) as an *alternative* to soft and hard systems methodologies. As a result, its concern for the normative core of *all* practice moved out of sight (for critical discussion and alternatives, see Ulrich, 2003).

In British OR, CSH was henceforth understood mainly through the lens of the SOSM, and 'critical systems thinking' became widely identified with TSI. Consequently, CST was now almost the same as the SOSM – an extended contingency framework for methodology choice that also offered itself as a framework for discussing the evolution of OR (eg Jackson, 2006a). Both uses attracted much interest and the mentioned difficulties of the extended SOSM did not hamper its success in helping to raise awareness in the profession that there are options for conceiving of good professional practice. The discussion that the SOSM was able to generate in turn has helped to make CSH more known, so that its core principle of boundary critique is increasingly being recognized as an important, independent source of critical thought on practice. These diverse successes of the SOSM certainly have contributed to the comparatively high level of methodological awareness and discussion that distinguishes the OR profession, which in turn has allowed it to bring forth soft and critical systems ideas that are now radiating into many other fields.

It is another question whether the SOSM's specific assignment of systems methodologies to problem contexts is theoretically well-founded and effectively conducive to good (ie, sufficiently reflective) practice. Suffice it to say that some doubts have arisen in the debate as to whether its theoretical basis (ie, in essence, its two dimensions for mapping problem contexts) is strong enough to warrant such 'pigeon-holing' of systems methodologies or even

a claim to offering the only valid view of their nature and complementarity. Other methodologies (including CSH) might just as well assign a limited rather than overarching role to the SOSM and to the TSI framework built around it, thus 'pigeon-holing' TSI/CH within *their* frameworks of good OR practice. In any case, the integrated perspective at which the present effort aims renders such mutual 'pigeon-holing' rather pointless and we therefore need not discuss the issue in any detail. The multi-paradigm and multi-methodology orientation of TSI/CH is meaningful for reflective practice without any presumption of defining the only adequate classification and use of systems methodologies.

Practical implementation: the main procedure of TSI/CH

To support methodology choice in practice, the SOSM still needed to be embedded in a methodology properly speaking, that is, a framework that would guide practitioners in asking relevant questions and proceeding systematically. This is what 'total systems intervention' (TSI), a name adopted in 1991, is all about. It stands for the practical procedure of methodology choice and implementation that Flood and Jackson (1991; also Jackson, 1991) proposed on the basis of the SOSM as a 'meta-methodology' for critical systems practice. The procedure may be employed in a linear or iterative way. To its original three phases labelled 'creativity', 'choice', and 'implementation', Jackson's (2003, 2006b) revision of TSI as 'creative holism' (CH) has more recently added a fourth phase, 'Reflection' (see **Table 2**).

The *creativity* phase is to encourage consideration of what alternative systems paradigms and root metaphors might mean for thinking about a problem context at hand, so that a 'dominant' metaphor can be identified and it becomes clear whether preference should be given to a hard (mainly functionalist), soft (mainly interpretive) or critical (mainly emancipatory) orientation. In the *choice* and **[/1242]** *implementation* phases, a conforming particular systems methodology can then be chosen based on the SOSM and used to implement specific change proposals. In the *reflection* phase, finally, outcomes of TSI/CH guided intervention are to be reflected so that methodological learning can take place.

The new reflection phase brings Jackson's 'critical holism' (CH) a bit closer to CSH's focus on reflective practice. It widens the focus from theoretical justification *ex ante* to on-going reflection *based on* practice and taking place *in practice.* Not unlike the 'critical reflection mode' that Flood (1995, p 227f) previously added to TSI, CH's 'reflection' phase aims to evaluate, 'after the event' (Jackson, 2003, p 289), how TSI/CH has been used in specific interventions, with a view to improving TSI/CH itself. Although the underlying notions of learning and rationality may still not be 'practical' in the philosophical sense in

which CSH understands the term – in the sense of recognizing practical reason as a genuine and indispensable dimension of rational practice – the reflection phase nevertheless promises new chances for cooperation between TSI/CH and CSH. For example, given that it is not entirely clear how exactly the TSI/CH framework should be employed to evaluate its own application, CSH might be able to support CH's reflection phase; the latter would then be properly employed for reflective ends across systems paradigms and frameworks, addressing the practical-normative no less than the theoretical-instrumental dimensions of reason.

Table 2 The meta-methodology of TSI/CH: standard phases of methodology choice and use (Source: adapted from Flood and Jackson, 1991, p 54; Jackson, 1991, p 276; 2000, p 372; and 2006b, p 654)

Phase	***Activity/aim***
(1) CREATIVITY	
Task	To identify major aims and issues of the problem context
Tools	Use of different metaphors and paradigms to gain different perspectives
Outcome	Appreciation of dominant and dependent metaphors/paradigms and related issues
(2) CHOICE	
Task	To choose appropriate systems methodologies and methods
Tools	Use of SOSM to reveal strengths and weaknesses of methodologies and methods
Outcome	Choice of dominant and dependent systems methodologies and methods
(3) IMPLEMENTATION	
Task	To arrive and implement specific positive change proposals
Tools	Systems methodologies and methods used properly according to the logic of TSI/CH
Outcome	Relevant change according to the concerns of the different paradigms
(4) REFLECTION	
Task	To evaluate the intervention and ensure methodological learning
Tools	Understanding of the concerns of different paradigms regarding good practice
Outcome	Methodological progress

Recent development

Another recent development brings CH considerably closer to sharing its understanding of CST and of reflective practice with CSH: it has now abandoned TSI's claim to 'meta-paradigmatic' status in favour of multi-paradigmatic 'critique *between* the paradigms' (Jackson, 2010, p 136). This is also more consistent with a concern for pluralism as CSH understands it, in the words of Churchman (1968, p 231): 'The systems approach begins when first you see the world through the eyes of another.'

Consequently CH also no longer insists on choosing a single 'dominant' methodological paradigm, which in practice meant that there was virtually no room for CSH ever to guide an

intervention (Flood, 1995, describes nine cases employing TSI of which only one was based on CSH). Following considerable discussion about the value of methodological 'complementarism' or 'pluralism' (eg Jackson, 1999), 'mixing methods' (eg Midgley, 1997) and 'multi-methodology' (eg Mingers and Gill, 1997), a free combination or 'mixing' of methodologies or *parts* of methodologies and conforming methods is now encouraged. This again brings TSI/CH a bit closer to CSH, which is premised on the idea that essential for the quality of professional practice 'is not which type of method(s) we use but rather what validity claims we associate with the methods we use and how critically we deal with these claims' (cf Ulrich, 2003, p 337f). This modification also makes CH more flexible to use and thus brings it closer to the needs of practice. It can now be said to help practitioners 'harness the various systems methodologies, methods and models' by being 'multi-paradigm, multi-methodology and multi-method in orientation' (Jackson, 2006b, 248 and 253; 2010, p 136). This makes it a less pressing issue whether TSI/CH can really claim to be a contingency *theory,* that is, whether its classification of methodologies and problem contexts is social-theoretically well-founded and practically adequate.

These developments suggest that the two strands of CST might still find ways to live with one another, or at least to encourage practitioners to combine whatever tools of critical reflection and discourse they find relevant in both strands, so as to enhance their professional competence and practice. After all, that is the core idea of critical systems thinking.

A summary comparison of CSH and TSI/CH

To facilitate an overview of the discussed aspects of CST, **Table 3** summarizes the accounts of CSH and TSI/CH in a way that should facilitate comparison. In addition, **Table 4** summarizes a few additional aspects that reach beyond the present discussion, concerning the evaluation, mutual perception, and possible developments of the two strands of CST.

Table 3 CSH and TSI compared: discussed aspects
(Source: adapted from Ulrich, 2012)

Aspect	***CSH***	***TSI/CH***
Core idea	Professional practice involves *validity claims* that cannot be justified theoretically but at least can be handled openly and critically by practice itself	Professional practice involves *methodological choices* that can be justified theoretically by analyzing underpinning research paradigms and systems metaphors
Basic aim	*Reflective practice* with respect to the normative and empirical content of professional findings & conclusions	*Reflective practice* with respect to the theoretical content of (systems) methodologies and methods
Critical focus	*Analysis of reference systems:* surfacing the boundary judgements constitutive of the facts and values considered relevant, and analyzing how they condition different perceptions of practical claims (eg problem definitions, proper ends and means, proposals for action or evaluation standards)	*Paradigm analysis:* surfacing the theoretical paradigms and metaphors underpinning alternative methodologies and analyzing how they condition different perceptions of the nature of problem contexts and suitable methodologies (eg functionalist, interpretive, emancipatory or post-modern perspectives)
Basic approach	*Critical systems discourse:* a discursive framework for value clarification and critique	*Contingency theory:* a contingency framework for methodology choice and use
Methodological core principle	*Boundary critique:* unfolding the selectivity of reference systems	*Informed methodology choice:* matching systems methodologies with problem contexts
Main critical device	*Checklist of boundary questions:* a definition of boundary categories for 'is' and 'ought' mapping (i.e., descriptive and normative analysis) of reference systems	*System of systems methodologies* (SOSM): a classification of problem contexts and conforming systems methodologies
Implementation	A discursive *process of unfolding selectivity:* a standard sequence of boundary critique	A holistic *meta-methodology of methodology choice and use:* standard phases of context and methodology matching

Table 4 CSH and TSI compared: some further, evaluative aspects

Aspect	***CSH***	***TSI/CH***
Major achievement	*Critical holism*, or the 'critical turn' of applied systems thinking: from a holistic to a critically-normative understanding of the systems idea – systems thinking as a form of critique	*Creative holism*, or the 'multi-methodological' turn of applied systems thinking: from mono- to multi-paradigmatic systems practice – systems thinking as a form of multi-methodology, multi-method, and multi-paradigm practice
Mutual perception and critique	CSH about TSI/CH: 'TSI/CH may not be a particularly good example of CST, as it achieves little in the way of supporting systematic value clarification and critique with respect to the contextual assumptions and consequences that all professional practice implies, whatever methodologies and methods it may rely on. Reflective practice cannot be replaced by, or reduced to, a theoretical critique of methodology choice based mainly on paradigm analysis' 'Boundary critique is more fundamental than paradigm analysis, for our boundaries of concern tend to determine how we see paradigms' 'TSI pigeon-holes CSH by reducing its use to coercive problem contexts, against its broader aim of supporting reflective practice in all kinds of problem contexts (ie regardless of the methodologies and paradigms employed)'	TSI/CH about CSH: 'CSH may not be a particularly good example of CST, as it achieves little in the way of supporting systematic paradigm analysis and critique with respect to the contextual assumptions that all methodology choice implies, whatever views and values the people concerned may have. Theoretical critique of methodology choice cannot be replaced by, or reduced to, reflective practice based mainly on boundary critique' 'Paradigm analysis is more fundamental than boundary critique, for our paradigms tend to determine how we see boundaries' 'CSH pigeon-holes TSI by reducing its use to theoretically informed methodology choice and mixing, against its broader aim of supporting reflective practice in all (ie, not only theoretical) respects'
Some strengths (+), difficulties (-), and future challenges (?)	(+) Provides a basis for dealing with the practical-normative as well as the theoretical-instrumental dimension of rational practice (+) Translates the problem of holism into a framework for reflective professional practice (+) Supports reflective practice of other methodologies and methods rather than claiming to be a self-contained methodology (+) Encourages a dialogical and practical-normative, rather than merely expert-driven and theoretically based, notion of professional competence (-) Theoretical grounding in practical philosophy demands some interest in basic philosophical reasoning (-) Practice requires discursive skills (-) Didactic aspect to be developed: How can ordinary professionals, decision-makers, and citizens acquire the new critical competence that boundary critique promises? (?) Can the vision of a 'critically-heuristic training for citizens' be realized?	(+) Provides a basis for debate about the historical development of OR and applied systems thinking (+) Provides a framework for multi-methodology, multi-method, multi-paradigm professional practice (+) Supports the theoretical understanding of other methodologies rather than being a methodology itself (+) Encourages paradigmatic and methodological awareness and openness as aspects of professional competence (-) Theoretical grounding in sociological paradigms demands some interest in social theory (-) Practice requires mastery of a multitude of systems methodologies and methods (-) Didactic aspect to be developed: How can practitioners themselves, rather than just pre-defined contingency theory, be put in charge of methodology selection? (?) Can the missing normative dimension of rational practice be brought in?

Summary and conclusions for Part 1

What has critical systems thinking (CST) to contribute to good OR practice, and how can its two main strands, critical systems heuristics (CSH) and total systems intervention (TSI), work together in a mutually supportive way? The present two-part essay seeks to give new answers to these questions. This first part prepares the ground by correcting several misconceptions that have hampered their discussion in the past, and allows the following conclusions:

1. Counter to what is usually assumed, OR's early understanding of good practice started out with a systems-theoretical concept of optimality that reached far beyond the concept of mathematical optimization with which 'classical' OR is now often associated and which has led to its characterization as 'hard' systems thinking.
2. Due to the fact that to this day, no coherent overall account of CST is available that would do justice to both its strands, its potential for contributing to good OR practice is now usually underestimated, as it is either ignored or else identified with only one of the two strands. Since the prevalent perception, particularly in Britain, tends to identify CST mainly with TSI's **[/1243]** focus on theoretically informed methodology choice and mixing, its underpinning notion of reflective (or 'critical') practice appears to be mainly a matter of social theorizing remote from practice, whereas the genuinely practical dimension and normative core of rational practice have moved out of sight.
3. As a consequence of the two previous points, the development of OR has come to be seen as a seemingly linear evolution from 'hard' (classical OR) to 'soft' (SSM) and 'critical' (CST) approaches. Such a perspective is not conducive to promoting good OR practice, nor does it justice to its actual richness.
4. Finally, as a consequence of all three previous points, the discussion about CST has remained largely an insider discussion. Accounts of its two strands, critical systems heuristics (CSH) and total systems intervention (TSI), have remained mainly partisan accounts and their mutual relationship has not become clear; accordingly unclear and marginal has their contribution to OR practice remained.

In response to these observations, a view of OR as applied systems thinking emerges that sees systems thinking as constitutive for good OR practice in general, rather than only for certain recent developments and/or marginal applications (such as 'soft OR', 'community OR' or 'critical management science'). An essential element of this new view is reflective practice. Another essential element, related to it, is the quest for increasing OR's sophistication with regard to context analysis. Just as OR's early concept of optimality (or 'optimal solution') included the idea of mathematical optimization but went beyond it, a contemporary concept of good OR practice might once again try to strike a balance between

the demands of technical and contextual sophistication; for the practical value of OR's technical sophistication depends on its contextual sophistication.

In such a recovered view of OR as applied systems thinking, CST has a basic role to play: it responds to the deficits of practicability that the original quest for overall 'whole-systems' rationality entailed, by shifting the focus from the original, hopeless attempt of avoiding contextual selectivity to its transparent and systematic handling. Therein resides the basic idea and value of 'critical' systems thinking: it can support reflective practice with special regard to contextual selectivity, across all strands of systems thinking and contexts of professional intervention. **[/1244]**

It is clear, then, that CST should be seen as an integrated part of OR methodology, rather than as a (final?) stage of its evolution. It also follows that CST is not well understood and practiced as a self-contained systems paradigm and/or methodology. Furthermore, what holds true for CST as a whole also holds true for its two strands: they need to be situated systematically within an integrated framework of reflective practice rather than seen as self-contained methodologies. Accordingly important it is to work towards a coherent account of the ways in which *together* they can support reflective practice.

With these objectives in mind, the present first part of this essay, for the first time in the history of CST, has undertaken a comparative, non-partisan account of the key ideas of its two strands. As a result, not only their different notions of reflective practice have become clearer but also their shared characteristics: there emerges a shared potential of the two strands of CST to enhance OR's **[/1245]** contextual sophistication in a mutually supportive way, and thereby to contribute to *OR as reflective practice of applied systems thinking.* In an effort to tap this potential, the second part will take the idea of an 'integrated' conception of OR and critical systems thinking one crucial step further, by embedding it in a new conception of good professional practice as argumentative practice and by situating the role of both strands of CST within it.

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