

Critical Systems Thinking

An Evolving Systemic Approach

Luis Arturo Pinzon-Salcedo^{a,@}

a: Engineering School, Universidad de los Andes, Bogotá, Colombia

@: lpinzon@uniandes.edu.co

Introduction

We begin this chapter by presenting a brief description of the development of critical systems thinking (CST) and its main characteristics. Its two main initial strands are presented, as well as an account of important contributions that surfaced in the last decades. Emphasis is made on the basic themes addressed by CST writers and practitioners. Critical systems practice is illustrated by describing a real-world application that has evolved successfully and reached millions of people. Lastly, we present some potential future developments of CST.

The Emergence of CST

Systems thinking development can be described by noting three waves [1,2]. The third is the one associated with CST.

The First Wave

This wave was popular in the 1950s and 1960s and proposed a systems approach as an alternative to reductionism. It is assumed that systems are integrated by real-world components, and models are conceived as representations of reality. Functionalist and structuralist paradigms prevailed in the first wave [1,3,4]. An agreement among the individuals of a system on a predetermined and unproblematic goal was assumed [5]. First wave approaches ignored the plethora of possible and even conflicting goals supported by the diverse individuals who were part of the system. Conflict, coercion and power in the social systems were ignored [1].

The Second Wave

Critique of the first wave [6,7] led to the appearance of the second wave. Subjectivism and intersubjectivism prevail in the second wave, as well as participative practices, the principles of interpretivism, and the modelling of the stakeholders' mental constructs aiming at intersubjective understanding [2]. The idea of considering multiple perspectives associated with numerous realities

became important. Second wave approaches had an interpretive character [8], and it became important to respect individuals' perspectives on the goals to be achieved. Consensus and accommodations [9] became important. Processes for discussing ends were developed [10], but the participative criterion used presupposed that all the stakeholders of the problematic situation are willing and are prepared to participate into a free discussion about potential changes to be implemented. However, participative, open, free and unconstrained debates in many social and organisational contexts are difficult. Under these circumstances the consensus or accommodation that emerges at the end of a debate may be highly affected by the 'constraints' that are imposed on the discussion. Critics of the soft systems approaches [1,8] claim that these approaches fail to do enough to remedy the effect of relationships characterised by inequalities of power and resources. In these contexts more radical and critical approaches are needed.

The Third Wave

By the end of the 1970s, the second wave attracted criticism that focused on two main concerns: its isolationist nature, as well as the shortcomings of its underpinning interpretive theory in social situations where inequalities of power prevailed [4,8,11]. This led to the appearance of two different strands of research associated with CST that became part of the third wave. While the first one emphasized power relations and emancipatory thinking [12], the other was more oriented towards pluralism and the conception of systems methodologies as complementary [5,13]. We will briefly examine these two CST threads.

The Power- and Emancipatory-oriented Strand

Concerns of critics related to shortcomings of the interpretive theory that supported the second wave of systems thinking led to the need for emancipatory theory and practice. Failing to understand the power structures can end up reinforcing the interests of the dominant groups of society or organisations.

To cope with the coercive and political elements of social reality, Ulrich [12] developed the first emancipatory methodology explicitly based on systems thinking [13]. This methodology became the first key significant cornerstone of the third systems thinking wave [2]. It aims at using a critical and systemic approach to examine the boundary judgements implicit in any plan. Any rational inquiry is expected to be critical in the sense that no participants' assumption should be accepted beyond question. It is expected to be systemic because interveners should establish boundaries within which critique takes place. The power-oriented strand took advantage of two main concepts: boundary critique and boundary judgements [2].

According to Ulrich [14], all recommendations for improvement rely on which 'facts' and 'values' are considered relevant and which ones are discarded. These constitute the so-called 'boundary judgements' as they determine the boundaries of the planning process, the limits of argumentation, what needs to be included in analyses, and whose ideas are considered legitimate [12]. Ulrich [15] replaces the "monological" concept of rationality by a "dialogical" one, based on a model of rational discourse that establishes the necessary conditions for building a "rational" consensus between the involved and the

affected. These are conditions in relation to the “rightness” of the normative content of a situation or design.

During the time Ulrich’s ideas on boundary judgements were proposed, it was common for conceptions and models of systems to not question the assumed boundaries; instead, they were assumed as part of reality. Ulrich [12] claims that designers should make their boundary judgements transparent to themselves and others.

Ulrich’s [15] Critical Heuristics of Social Systems Design provides a specific heuristic support option for the praxis of practical reason. Critical heuristics proposed twelve boundary questions to reflect on boundary judgements of systems design, and thereby examine its normative content and challenge other stakeholders’ arguments used to justify or question the concealed boundary judgements. Each question addresses a basic boundary concept such as ‘client’ or ‘witness’. Ulrich [16] further recommends asking each question from different perspectives in ‘ought’ and ‘is’ modes. Ethical options and conflicts need to be debated critically.

The Pluralism-Oriented Strand

During the 1980’s a strand of systems thinking emerged in the United Kingdom. Its advocates argued that although new methods of inquiry for dealing with social systems had recently been developed in the “soft” systems tradition, they were only appropriate for one class of social systems. For other social systems, they considered a more radical and critical approach was needed.

This strand has involved several approaches. However, the length of the present chapter prevents us from presenting a full discussion of all of them, which is why we will mention just a few. The first important approach in this strand was the Systems of Systems Methodologies.

The System of Systems Methodologies

In 1983 Jackson and Keys initiated a research programme to understand the relationship between diverse systemic methodologies, and to study the effectiveness of specific approaches in diverse problem contexts [17]. This programme became the second key cornerstone of the third systems thinking wave. Its main theoretical tool was the system of systems methodologies (SOSM).

Jackson and Keys [5] argue that problem contexts can be classified depending on the nature of the decision maker(s) and the system(s) in which the problem resides.

Depending on the nature of the system(s) Jackson and Keys [5] differentiated between simple and complex systems[5]. *Mechanical* problem contexts are those that include simple systems, while *systemic* problem context are those that include complex systems.

Problem contexts were classified as *unitary* or *pluralist* depending on the decision makers. A group of decision makers is considered unitary if all of them agree on a shared set of goals, and pluralist if they dissent on the goals to be reached.

Accordingly, problem contexts can be classified as *mechanical-unitary*, *systemic-unitary*, *mechanical-pluralist* and *systemic-pluralist*. Figure 1 represents the “ideal-type” grid of problem contexts that resulted from this classification.

		PARTICIPANTS		
		UNITARY	PLURALIST	COERCIVE
S Y S T E M S	S I M P L E	Simple Unitary	Simple Pluralist	Simple Coercive
	C O M P L E X	Complex Unitary	Complex Pluralist	Complex Coercive

Figure 1- The “ideal-type” grid of the SOSM (taken from Jackson, 2000, p. 359).

Jackson and Keys [5] added that each systems approach is suited to solve problems only in one of these kinds of problem contexts. Figure 2 shows some methodologies related to the “ideal-type” grid shown in Figure 1.

		PARTICIPANTS		
		UNITARY	PLURALIST	COERCIVE
S Y S T E M S	S I M P L E	Hard	Soft systems thinking	Emancipatory systems thinking
	C O M P L E X	Organisations as systems Organisational cybernetics		

Figure 2 – Preliminary classification of systems methodologies depending on their characteristics (taken from Jackson, 2000, p. 361).

Jackson and Keys [5] proposal had a set of interesting aspects:

- It presented the systemic problem-solving methodologies as complementary.
- It enabled potential users of systems approaches to better evaluate their assumptions, strengths and weaknesses.
- Since different types of problem contexts exist in the real world, systems thinkers need to learn different methodologies to cope with problems in different contexts, as well as developing new methodologies for the different types of problem contexts.

It is worth noticing that Jackson and Keys [5] intentionally left out a problem context they identified as *coercive* contexts. These contexts involve structural conflicts and contradictions between opposing economic and political interests. In a coercive context any cohesion or ‘agreement’ might be the result of the exercise of power of some groups over others. By the time Jackson and Keys [5] conceived their proposal, they were not aware of any systemic methodology suited for coercive contexts. However, Ulrich’s [12] emancipatory systems approach had recently been published.

Although the SOSM embraced pluralism, it was limited because the use of diverse methodologies during a single intervention was not contemplated, and neither was a distinction between methodologies, methods, techniques, and tools that allowed for the use of parts of them during an intervention where other methodologies or elements of them were used.

CST Basic Themes

Some other strands have been developed within CST. Due to the brevity of this document, we will only share some of the most important ones so readers can explore some of them: Total Systems Intervention (TSI) version one [13], TSI version two [18], the Creative Design of Methods [2,19–22], PANDA (participatory appraisal of needs and the development of action) [23], and “discordant pluralism” [24,25].

As a result of the diversity in CST literature there are several interpretations of what it is and what its main themes are. Despite the differences, three main themes or “commitments” can be noticed in the CST landscape: critical awareness, improvement and pluralism [4].

Critical Awareness

“Critical awareness” involves exploring the theoretical underpinnings, weaknesses and strengths of systems methodologies, as well as the applicability of systemic methods, tools, methods, and techniques that contribute to the different methodologies [1,8]. It also comprises “social awareness” of the societal and organisational climate, and constraints that may affect a systemic intervention [4], including the effects that power at the micro-level has on the construction of knowledge [4,26].

Improvement

It involves emancipation and the promotion of human wellbeing, and raises issues on both knowledge and ethics [16]. On the one hand, improvement requires us to evaluate the alternative use of our resources, and

requires knowledge of the situation at hand and of the available options. On the other, improvement entails choices between the interests and values of different stakeholders. These choices may encompass conflicts—including conflicts between moral requirements. Any conception of improvement raises ethical problems. Some alternatives for improvement may favour particular moral requirements, which may be devalued in favour of other moral requirements when another option for improvement is embraced.

Pluralism

Jackson and Keys [5] argue in favour of the use of pluralism in all stages of an intervention. CST promoted theoretical and methodological pluralism in systems thinking. Before the emergence of CST, the combination of methods was done based on an “imperialist rationale” where one epistemological position is embraced and other systems thinking approaches are used, but only insofar as they seem useful and increase the strength of the favoured epistemological position [4]. On the contrary, CST favours a type of pluralism that respects the different characteristics and strengths of the diverse systems thinking approaches, promotes their development, and recommends how they can be used in different problem contexts. For further reading, Mingers and Brocklesby [27] discuss different types of pluralism.

Contemporary CST thinkers aspire toward a type of pluralism that promotes flexibility in the selection and use of a large diversity of methodologies, methods, and techniques in any intervention. This selection depends on the purposes of the intervention and the characteristics of the problem context, and can implicate—in a theoretically informed way—parts of the methodologies according to rationales of paradigms different from the ones under which the methodologies were originally conceived [28,29].

The Creative Design of Methods

Midgley’s [21] creative design of methods (CDM) is the CST approach that was used during the practical application presented in this chapter.

This approach takes advantage of methods from other methodologies. Midgley [2] argues that most situations are perceived as sufficiently complex to justify the use of a variety of methods, going as far as to design new methods. Consequently, it is better to think in terms of designing methods rather than using pre-existing methodologies. The problematic situation that an intervener wants to tackle is understood by using a set of interrelated questions that address the purposes of the intervention. Each purpose might be addressed by way of a method, a complete method, or a set of methods. The purposes are addressed by a *synergy* of methods.

Midgley [19,20] claims that it is impossible for any pluralistic approach to be meta-paradigmatic because it must make assumptions that are incommensurate with assumptions made by the paradigms that support other methods and methodologies. Since paradigmatic thinking could not be transcended, Midgley argues in favour of mixing methods and not methodologies. Methods disengaged from their initial methodological principles are understood from the perspective of a pluralist methodology and can be used in innovative ways.

CDM promotes dealing critically with boundary judgements, i.e. being critical towards phenomena in the external world and being self-critical [12]. The notion of boundary critique was introduced by Ulrich [14] and Midgley et al. [30], and it draws upon ideas developed by Churchman [6]. He argued that what is considered an improvement depends on the boundary of analysis used. For him, boundaries are not 'given' in the real world, but are rather personal or social constructs that define *what* knowledge is taken as pertinent, and *who* is a legitimate decision maker. Boundaries are associated with values because different values may affect the construction of boundaries that affect the knowledge regarded as relevant [12]. But drawing boundaries restricts the ethical viewpoint taken and the definition of said boundaries of improvement is an ethical issue [2].

Midgley and other systems thinkers have argued that when different actors (individuals or groups) have dissimilar ethics, conflict can arise between them as they make diverse boundary judgments on the same issue [2,31,32]. When an actor prefers an ethical perspective, he or she values some particular elements that might be included within a 'primary boundary' (see Figure 3). This boundary also determines what and who is excluded. Awareness of what is excluded discloses a 'secondary boundary'. Marginal elements that may receive a 'sacred' or 'profane' status (or are 'valued' or 'devalued', respectively) are situated between these two boundaries. If marginal elements are 'valued', the secondary boundary is strengthened and its associated ethic receives priority. Otherwise, these elements remain in a marginal area and are regarded as 'profane'. Concurrently, the actor may ignore other elements for not considering them pertinent (those elements will remain outside the secondary boundary and are part of a wider system or context) (see Figure 3). Theoretical critique of systems boundaries entails the explicit formulation of the secondary boundary and the execution of informed and reflexive choices between boundaries [31].

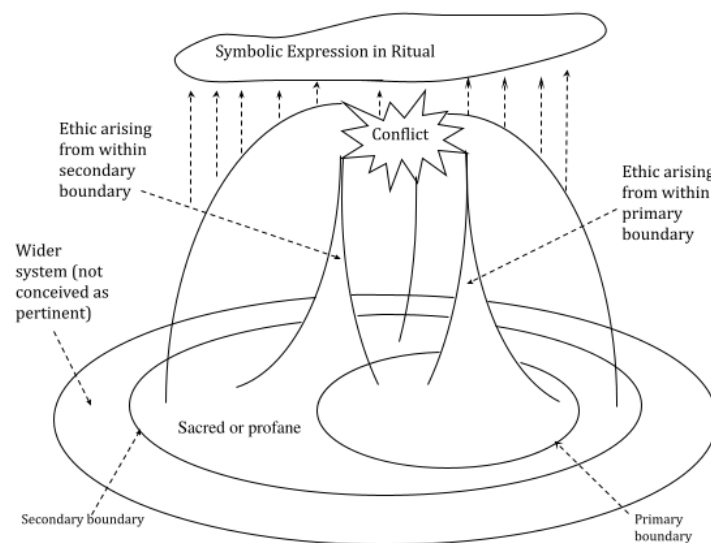


Figure 3. Marginalisation, conflict and ethics (taken from Midgley, 1992, p.12).

Figure 3 shows how conflicting ethics arise from the primary and the secondary boundaries. If these ethics enter into conflict, rituals can express the dynamics that emerges. The reader can explore further topics and developments of theory of marginalisation in several writings [2,30,33].

A Practical Application

This section presents a practical CST application in which a multimethodology was used by diverse communities and researchers to create a peace programme that operates in more than 460 schools. Using a multimethodology gave us the required flexibility to tackle a large variety of evolving situations in very complex contexts. Midgley's [20] creative design of methods guided the intervention, contributing to mixing methods and tools from a wide spectrum and including several problem structuring methods (such as critical systems heuristics or CSH, soft systems methodology or SSM, and interactive planning), boundary critique, analytical techniques, negotiation and alternative dispute resolution methods. We differentiated methods from methodologies—while a method is a set of techniques conceived to reach a particular goal, a methodology is regarded as a theory or research practice underpinned by clear philosophical principles [22]. The peace programme was initially designed in 2003 taking advantage of methodological and theoretical pluralism, carrying out a continuous critique of the ontological and epistemological bases of the diverse systems approaches used, as well of the stakeholders' ideas that emerged during the intervention. The peace programme, called the Hermes Programme, is an initiative of the Bogota Chamber of Commerce, directed at the construction of peace in Colombia, and created at a time when this country was affected by an internal war. The methodology that was designed specifically for this intervention included methods selected on the basis of interveners' critical understanding of the problematic context, the research questions asked [31], and the way the methods addressed the needs, wants, moral concerns and feelings of those involved in the situation. Methods were interpreted through the overarching methodology. Moreover, this methodology also incorporated new methods designed for this intervention drawing upon relevant theories. For the sake of brevity, it is impossible to describe the whole intervention in detail, but more details can be found in Pinzon-Salcedo and Torres-Cuello's paper [2,30,33].

To initiate the intervention we mixed elements from CSH, SSM, interactive planning and the conflict management field. A broad range of methods was selected to overcome the limitations each approach has. For instance, CSH's lack of attention to managing complexity was addressed by using methodologies such as interactive planning and SSM. A first workshop was organised with a group of stakeholders to collectively and broadly discuss who should participate in the design of the programme and what knowledge should be considered. Boundary critique as well as methods developed drawing-upon the peace and conflict resolution literature were used for this workshop. The results were employed to plan a second workshop.

Critical awareness was particularly important for the second workshop. We examined the societal and organisational climate that surrounded our intervention and the potential effects of power on the construction of knowledge. We strived to be self-reflective on the presuppositions flowing into our judgements, while making our ontological and epistemological assumptions transparent to all stakeholders. We planned to design a peace education programme for Bogota, a city where hundreds of thousands of displaced people were living as a result of the internal conflict. We considered that multimethodology and the participation of a wide range of stakeholders were essential in finding a path towards improvement that was ethically reasonable. We used CSH during the second workshop to discuss twelve boundary issues associated with the programme's sources of motivation, control, knowledge and

legitimation. They helped us in identifying several elements like the purposes and clients. For instance, CSH was useful in critically examining the purposes of the peace programme we wanted to develop. We chose to design a programme for the development of conflict resolution skills among young people of the marginalised areas of the city, which aimed at empowering them and improving their interparty recognition. The objectives of the programme were seen as complementary elements of an emancipatory approach to building peace. Aiming at interparty recognition is seen as emancipatory because it promotes the ability to go beyond oneself and one's boundaries, while approaching other people's perspectives in a way that can transform and liberate the self. By the end of the second workshop we mixed methods from Ackoff's idealised design methodology, Checkland's SSM and statistics to design the whole programme. For instance, this included a first version of the main subsystems of the programme (see Figure 4).

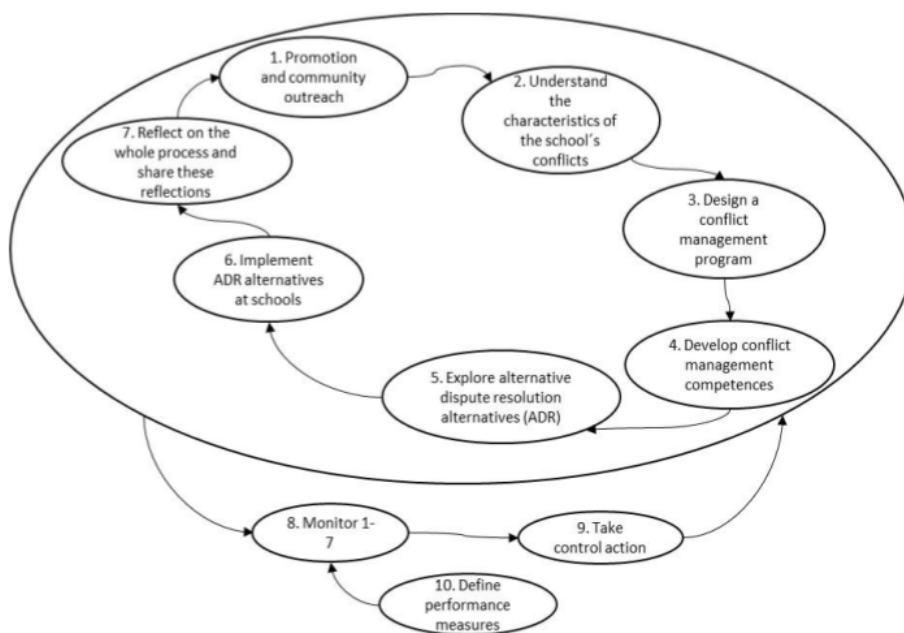


Figure 4. Initial conceptual model of the Hermes Programme (taken from Pinzon-Salcedo and Torres-Cuello, 2018, p. 951).

The multimethodology developed for Hermes Programme has evolved drawing upon more methods and paradigms during the more than 15 years that the programme has been expanded to cover more communities and more regions in the country. The first version of the Hermes Programme was implemented in 2004. Several studies have shown the transformative effects of the programme and its capacity in achieving its objectives, improving prevention and effective management of conflicts, as well as creating a culture of peace that has transformed social practices, norms, regulations, and structures thereby strengthening the effects of the programme [2,30,33]. Several independent studies [34] have shown that the programme has a “ripple effect” whereby its positive effects spread to wider circles of society reducing the levels of violence across the communities involved. By 2009, UNICEF claimed that the programme had “impacted more than 220,000 people” ([35], p. 3). Since then CST has continued contributing to the expansion of this programme, that now includes more components that broaden the impact of this programme beyond the school boundaries, reaching millions of people. Boundary critique

has always been important in this process, opening new opportunities to enhance the impact of the programme.

Because the programme operates in more than 460 schools, it needs to be adapted to many specific contexts. For instance, while one community may be located in a rural and marginalised area of the country, another lies in a violent area of a big city. Conceptions of improvement change between local contexts, and the best that can be achieved is “local” rather than “universal” improvement [29,36].

This research endeavour shows a practical application where deliberately reflecting on the three main CST themes (critical awareness, improvement, and pluralism) were particularly important for the effectiveness and impact of the whole intervention. Mixing methods allowed us to achieve satisfactory solutions to the limitations of some of these methods.

Conclusion and Future Potential Developments

CST began with two key cornerstones to transform the systems approach contributing to the creation of a third way of systems thinking. The growth of CST has been quite dynamic, with rapid changes, largely due to the critical spirit of CST thinkers. They have incessantly explored the underpinnings, weakness and strengths of their ideas and methodologies, and have been open to the criticisms that have originated outside their discipline. CST evolved around ideas such as critical awareness, methodological pluralism, complementarism, improvement and emancipation. However, the future of CST will provide more surprises and developments.

The next are but a few examples of potential developments:

- Improvement of our understanding on how to deploy several systems approaches together in order to gain synergies so that desired emergent properties arise when methods of these approaches are mixed. In particular, we need to learn more about mixing problem structuring methods and when and how to use up-front boundary judgements, because the dangers of failing to do so might be considerable (dangers in both the realms of instrumental and practical reason).
- Using CST to enrich a wide variety of disciplines while simultaneously learning from them. Recent examples of this type of endeavours can be found in the fields of water management [37,38] and evaluation [39], but taking advantage of CST ideas in other areas is necessary.
- Building bridges between the different conceptions of CST, and developing new CST approaches [40].
- Developing new answers to the three challenges of the development of methodological pluralism identified by Mingers and Brocklesby [27], and in particular to cultural and psychological challenges because this can contribute to the expansion of CST and of systems thinking in general. This involves addressing the difficulties that people can have in becoming multi-methodology literate, as well as the cultural constraints people may experience to embrace a multi-methodology approach [41].
- Advancing pluralism not only in the modes of representation that can be employed in practice, but also in the facilitation process [23].

- Developing what Flood [18] called the “ergonomics of reflection”. This field has not evolved enough yet, but can draw upon new developments in neuroscience as well as ancient knowledge from all over the world.
- Exploring the practice and implications of new forms of critical reflexivity that remain largely unexplored by CST such as those discussed in Foucault’s later writings or those associated with Japanese traditional arts (like *kyudo* or the way of the bow).
- Contributing to the development of new methodologies that address the shortcomings of current systemic methodologies.
- Leading the development of a fourth wave of systems thinking, that surpasses the achievements of the previous three waves.

New developments of CST will surface in the future. However, being self-reflective demands from CST thinkers to be critical to all theoretical propositions (ontological or epistemological) and methodological approaches, examining their inevitable limitations.

References

1. Jackson MC. Systems Methodology for the Management Sciences. Contemporary Systems Thinking. 1991. doi:10.1007/978-1-4899-2632-6
2. Midgley G. Systemic Intervention: Philosophy, Methodology, and Practice. Springer, Boston, MA; 2000. doi:10.1007/978-1-4615-4201-8
3. Lilienfeld R. The Rise of Systems Theory: An Ideological Analysis. Technology and Culture. 1978. p. 538. doi:10.2307/3103192
4. Jackson MC. Systems Approaches to Management. Springer Science & Business Media; 2000. Available: <https://play.google.com/store/books/details?id=xwwGCAAAQBAJ>
5. Jackson MC, Keys P. Towards a System of Systems Methodologies. J Oper Res Soc. 1984;35: 473–486. doi:10.1057/jors.1984.101
6. Churchman CW. Operations Research as a Profession. Management Science. 1970. p. B–37. doi:10.1287/mnsc.17.2.b37
7. Ackoff RL. Resurrecting the Future of Operational Research. The Journal of the Operational Research Society. 1979. p. 189. doi:10.2307/3009600
8. Jackson M. The Nature of “Soft” Systems Thinking: The Work of Churchman, Ackoff and Checkland. J Appl Syst Anal. 1982;9: 17–39.
9. Checkland P, Winter M. Process and content: two ways of using SSM. J Oper Res Soc. 2006;57: 1435–1441. doi:10.1057/palgrave.jors.2602118
10. Checkland P. Systems Thinking, Systems Practice. 1981.
11. Flood RL, Jackson MC. Overview. In: Flood RL, Jackson MC, editors. Critical Systems Thinking: Directed Readings. John Wiley & Sons; 1991.
12. Ulrich W. Critical heuristics of social planning: A new approach to practical philosophy. 1983.
13. Flood R, Jackson M. Critical Systems Thinking: Directed Readings. Wiley; 1991.
14. Ulrich W. Critical Systems Thinking for Citizens: A Research Proposal. University of Hull, Centre for System Studies; 1996. Available: <https://play.google.com/store/books/details?id=6MDeAQAACAAJ>
15. Ulrich W. Critical Heuristics of Social Systems Design. Operational Research and the Social Sciences. 1987. pp. 79–87. doi:10.1007/978-1-4613-0789-1_9
16. Ulrich W. A primer for critical systems heuristics for action researchers. Hull: Centre for Systems Studies.; 1996.
17. Jackson MC. Which Systems Methodology When?: Initial Results From A Research Programme. Systems Prospects. 1989. pp. 235–241. doi:10.1007/978-1-4613-0845-4_38
18. Flood RL. Solving Problem Solving: A Potent Force for Effective Management. Wiley; 1995.

Available: <https://play.google.com/store/books/details?id=kxq7AAAAIAAJ>

19. Midgley G. Midgley G (1989). Critical Systems: The Theory and Practice of Partitioning Methodologies. In, Proceedings of the 33rd Annual Meeting of the International Society for the Systems Sciences, held in Edinburgh, Scotland, on 2-7 July 1989. 1989.
20. Midgley G. Creative Methodology Design. *Systemist*. 1990;12: 108–113.
21. Midgley G. Developing the methodology of TSI: From the oblique use of methods to creative design. *Systems Practice*. 1997. pp. 305–319. doi:10.1007/bf02557900
22. Midgley G. Dealing with coercion: Critical Systems Heuristics and beyond. *Systems Practice*. 1997. pp. 37–57. doi:10.1007/bf02557850
23. Taket A, White L. Partnership and Participation: Decision-making in the Multiagency Setting. Wiley; 2000. Available: <https://play.google.com/store/books/details?id=NISBQgAACAAJ>
24. Gregory WJ. Critical systems thinking and pluralism : a new constellation. doctoral, City University London. 1992.
25. Gregory WJ. Discordant pluralism: A new strategy for critical systems thinking. *Systems practice*. 1996;9: 605–625.
26. Flood RL, Romm NRA. Enhancing the process of methodology choice in total systems intervention (TSI) and improving chances of tackling coercion. *Systems Practice*. 1995. pp. 377–408. doi:10.1007/bf02253393
27. Mingers J, Brocklesby J. Multimethodology: Towards a framework for mixing methodologies. *Omega*. 1996;25: 489–509. doi:10.1016/S0305-0483(97)00018-2
28. Midgley G. Critical Systems And The Problem Of Pluralism. *Cybern Syst*. 1989;20: 219–231. doi:10.1080/01969728908902205
29. Flood R, Romm N. Critical Systems Thinking: Current Research and Practice. Springer Science & Business Media; 1996.
30. Midgley G, Munlo I, Brown M. The theory and practice of boundary critique: developing housing services for older people. *J Oper Res Soc*. 1998;49: 467–478. doi:10.1057/palgrave.jors.2600531
31. Midgley G. The Sacred and Profane in Critical Systems Thinking. *Systems Thinking in Europe*. 1992. pp. 397–405. doi:10.1007/978-1-4615-3748-9_55
32. Midgley G, Pinzón L. The implications of boundary critique for conflict prevention. *J Oper Res Soc*. 2011;62: 1543–1554.
33. Pinzon-Salcedo LA, Torres-Cuello MA. Community Operational Research: Developing a systemic peace education programme involving urban and rural communities in Colombia. *European Journal of Operational Research*. 2018. pp. 946–959. doi:10.1016/j.ejor.2017.11.040
34. Orozco-Prieto FE. Evaluación del programa para la gestión del conflicto escolar (Hermes) de la Cámara de Comercio de Bogotá. UNIANDES. 2009.
35. UNICEF. The Hermes Programme for Conflict Management at School. 2009.

36. Jackson MC. Beyond the fads: Systems thinking for managers. *Systems Research*. 1995. pp. 25–42. doi:10.1002/sres.3850120106
37. Foote JL, Gregor JE, Hepi MC, Baker VE, Houston DJ, Midgley G. Systemic problem structuring applied to community involvement in water conservation. *Journal of the Operational Research Society*. 2007. pp. 645–654. doi:10.1057/palgrave.jors.2602248
38. Simbolon J. Critical Systems Thinking Review on Decentralized Drinking Water Management in Nauli City, Indonesia. *Systems Research and Behavioral Science*. 2017. pp. 643–653. doi:10.1002/sres.2490
39. Torres-Cuello MA, Pinzon-Salcedo L, Midgley G. Developing a Systemic Program Evaluation Methodology: A Critical Systems Perspective. Uniandes; 2018.
40. Ormerod RJ. Critical rationalism for practice and its relationship to critical systems thinking: Critical rationalism for practice. *Syst Res Behav Sci*. 2016;33: 4–23. doi:10.1002/sres.2326
41. Brocklesby J. From Single to Multi-Paradigm Systems Research. *Systems for Sustainability*. 1995. pp. 421–425. doi:10.1007/978-1-4899-0265-8_68