UNIVERSITY OF HULL

COLLABORATIVE LEARNING AND COORDINATION ACROSS AGENCY BOUNDARIES TO TACKLE WICKED PROBLEMS

being a thesis submitted in fulfilment of the

requirements for the degree of

Doctor of

Systems Science

in the University of Hull

by

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September 2022

Dedication

I dedicate this thesis to my beloved husband, Thomas, who has been the loving and sturdy rock where I can always find strength whenever I venture out into new territory and challenge myself.

To my mother, Eva Coler Thompson (1933-2014), for her loving support, encouragement, and constant belief that I could do anything I set my mind to. Although she died early in the PhD process, her belief in me helped immensely throughout it.

To my father, Forest Thompson, who admits he doesn't know much about what I do but is damn proud of me.

To Christine, my bright, big-hearted, and sometimes irreverent daughter, who is always proud of her mom and has made me laugh at times when I was quite frustrated or dispirited.

To my dear friend and mentor, Dr. Sheila Ronis, who has been my inspiration, my introduction into Systems Science, and who has selflessly shared her network of remarkable friends and colleagues. These colleagues have, in turn, further enriched my understanding of government and the need for interagency collaboration.

Acknowledgements

I am immensely grateful for the immeasurable support provided by so many people who have made this amazing and rewarding journey possible. I cannot acknowledge all who have been there for me, but the following are especially appreciated:

- Professor Gerald Midgley, my doctoral first supervisor; a scholar who has imparted such knowledge, a practitioner who has inspired my purpose, and a friend who has supported, pushed, and encouraged me every step of the way.

- Professor Angela Espinosa, my second supervisor; a bright, warm, and passionate systems scientist, whose enthusiasm for making real, lasting systemic improvements has sparked my own desire to make positive changes to our world.

- The University of Hull, which gave me an enriching academic home, especially Ellen, Louie, Wendy, and Margaret.

- Friends and colleagues from the Argonne National Laboratory; especially Dr. Todd Combs for championing me, Dr. Michael North for his wisdom and friendship, Dr. Ignacio Martinez-Moyano for his willingness to collaborate, and Kathy Lee Simunich for her never-ending encouragement.

- Friends and colleagues at the National Defense University; especially Dr. Michael Miklausic, who helped to organize the first workshop for this study, and Dr. Linton Wells, for his amazing grasp of system thinking and its importance in addressing wicked problems that affect security.

Publications and Conferences

Sydelko, Pamela, Midgley, Gerald, and Espinosa, Angela (2017). *A systemic integration approach to designing interagency responses to wicked problems.* 61st Annual Meeting of the International Society for the Systems Sciences: From Science to Systemic Solutions - Systems Thinking for Everyone, ISSS 2017, Vienna, Austria, 9-14 July 2017.

Sydelko, P., Midgley, G., & Espinosa, A. (2021). Designing interagency responses to wicked problems: Creating a common, cross-agency understanding. *European Journal of Operational Research*, *294*(1), 250–263.

Sydelko, P., Midgley, G., & Espinosa, A. (2022). Designing Interagency Responses to Wicked Problems: A Viable System Model Board Game. *European Journal of Operational Research* (under review).

Abstract

Conventional approaches to government are confounded by issues that cross agency, stakeholder, jurisdictional, and geopolitical boundaries. These open-ended and highly interdependent issues are often characterized in the literature as 'wicked problems. Typically, policies and budgets are developed to align with organizational boundaries, making it difficult to bring the appropriate talent, knowledge and assets into an interagency approach to tackle the interdependencies of whatever wicked problem is at hand. Many governments have recognized the need for interagency coordination in the face of highly complex problems; and in response, there has been advocacy for improved approaches to increase collaboration and synchronized interagency working. However, without appreciating that the perspectives and values of the various government agencies and other stakeholders can vary widely, and often can be in conflict, interagency endeavors often start out to solve very different perceived problems. Furthermore, interagency constructs are frequently organized through periodic meetings and loose agreements. They do not develop concrete strategic and operational plans for how an integrated approach will be organized and implemented.

The research described in this thesis was conducted to develop and evaluate a Systemic Intervention (boundary-exploring and multi-method) approach to designing interagency responses to wicked problems. This multi-method approach attempts to address many of the challenges to interagency design found in the literature. The Systemic Intervention approach was trialled on the wicked problem of international organized drug trafficking and its interface with local gangs in Chicago, USA. This wicked problem illustrates extreme complexity and the need for a cross-cutting design that cut across agencies, jurisdictions, and geographical boundaries.

The research was conducted in two phases: (1) the creation of a common understanding of a wicked problem among multiple agencies using Boundary Critique and a new participatory Problem Structuring Method (PSM) called 'Systemic Perspective Mapping'; and (2) the design of an interagency meta-organization using the Viable System Model (VSM), introduced to participants through a novel board game layout, so drug crime could be addressed at multiple scales.

The research findings indicate that the combined use of Boundary Critique and Systemic Perspective Mapping was able to generate enough of a common understanding to provide a foundation for the design of an interagency organization. Also, the VSM Board Game effectively enabled multiple agency representatives to intimately interact with their representation of the

wicked problem and with each other in order to clearly delineate new agency responsibilities, communication mechanisms and channels, adaptive operations management, and an anticipatory function – all tailored to address the wicked problem they had structured as a group.

The methodological approach developed in this research shows significant promise for transfer and adaptation to help tackle the design of interagency organizations for other wicked problems.

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Chapter 1: Introduction

Wicked problems are open-ended, highly interdependent issues that cross agency, stakeholder, jurisdictional, and geopolitical boundaries (Rittel & Webber, 1973). They often affect the well-being of many people (sometimes in a life-or-death manner), as well as other sentient beings and ecosystems. Wicked problems present some of the most important challenges of our time. Examples include (but are certainly not limited to) climate change (Lazarus, 2008; Levin, Cashore, Bernstein, & Auld, 2009, 2012; Moser, Jeffress, Williams & Boesch, 2012), pandemics (Connolly, 2015; Cankurtaran & Beverland, 2020; Moon, 2020), health care for aging populations (Westbrook, Braithwaite, Georgiou, Ampt, Creswick, et al., 2007; Braithwaite, Runciman & Merry, 2009), and energy security (Chester, 2010; Sydelko, Ronis & Guzowski, 2014; North, Murphy, Sydelko, Martinez-Moyano, Sallach et al., 2015; Ison, Collins & Wallis, 2015).

Likewise, attempts to *solve* wicked problems can (positively or negatively) affect lives, and often in unforeseen ways when the problems morph unexpectedly (Australian Public Service Commission, 2007; Camillus, 2008; Farrell & Hooker, 2013; Friend & Hickling, 2013). However, deciding not to address them because of their complexity is still making an active choice, as failure to intervene frequently results in the expansion of impacts into new environments, new populations, and ultimately future generations (Meadows, Meadows, Randers, & Behrens, 1972; Camillus, 2008; Lazarus; 2008; Levin et al., 2012)

Wicked problems confound conventional approaches to government because policies and budgets tend to be aligned within organizational boundaries and not across them (Head, 2008). Government bodies most often take a traditional linear and reductionist (overly simplistic) approach to attempt to solve wicked problems: breaking them down into parts and solving each of these parts independently within silos, erroneously hoping that all these independent solutions will aggregate into a solution to the whole thing (Fuerth & Faber, 2012).

Despite these difficulties, various approaches have been devised in the U.S. (as well as in other countries) to achieve coordination or attempt to gain some control over wicked problems: use of czars, high-level committees, working groups or task forces (Chaudhri & Samson, 2000; Pike, 2002; Sholette, 2010; Smith 2011; Vaughn & Villalobos, 2015). I will refer to these as interagency approaches, defined as the coordination of activities across two or more government agencies, which can span across or sit over government jurisdictions. Interagency approaches to collaboration are discussed further in Chapter 3.

However, in the U.S., interagency approaches are relatively ad hoc, with no rulebooks or established processes. They rely on the notion of experts who can lead and coordinate around massively complex problems, or they place responsibility for addressing wicked problems into one individual agency with a mission that only addresses one part of the problem, not the whole.

There is clearly a need for an approach that provides a more systemic understanding in the face of the extreme complexity of wicked problems. Wicked problems require methods that bring multi-agency stakeholders together to collaboratively structure the issue at hand, and deal with the differing perspectives and conflicting values that arise.

Because of the complexities of interdependent wicked problems, the organizational design approach to address them must be highly systemic and adaptive. Therefore, the research reported here was conducted utilizing Midgley's (2000) Systemic Intervention approach, because it involves the creative use of multiple systems methods. Also, Systemic Intervention and the choice/design of methods is usefully underpinned by Boundary Critique to address the power imbalances and conflict that always arise when agencies and organizations are asked to work together. The Systemic Intervention approach was employed to design an interagency response to international organized crime and its interface with local gangs in Chicago, which is currently within the missions of multiple U.S. federal, regional, and local agencies, and organizations.

1.1 Motivation for the Research

To introduce the motivation for this research, I would like to summarize my professional career up to the point I started my PhD studies. This is to help put into perspective (1) my experiences with attempts to solve wicked problems using hard systems approaches (those that seek to objectively-quantify and optimize real-world systems, regarding the people within them as components with predictable agency), (2) my knowledge of the challenges of whole-of-government, cross-agency challenges, and (3) my discovery of systems thinking (in particular Critical Systems Thinking), and why I believe it offers enormous potential for dealing with wicked problems across agency boundaries.

My background as an environmental scientist, specializing in sustainable land use and geographical information systems (GIS) at two federal U.S. laboratories, led me over time to the field of integrated spatio-temporal modelling and simulation for decision support. Much of my research, and that of the research teams I led, were focused on computer architectures that would enable the integration of multiple scientific models into a single framework capable of

addressing the interdependent environmental processes of ecosystems. These first integrated modeling approaches were developed for decision support around land management (Sydelko, Christiansen, Dolph, & Taxon, 2000; Anderson, Sydelko, & Teachman, 2001; Sydelko, Hlohowskyj, Majerus, Christiansen, & Dolph, 2001).

Later, I began to move further from environmental work to explore how integrated modeling approaches could be used in infrastructure support for military deployment (Bailey, Perkins, Simunich, Brown & Sydelko, 2009) and local response planning for biological attacks. All these approaches were based upon breaking down problems, modeling them individually, and then integrating them to work as one large simulation. In these integrated approaches, the roles of humans in the ecosystem were held relatively constant (i.e., treated as predictable), with different scenarios introduced to anticipate how change would affect the ecosystem and the relatively passive human beings within it.

To begin to address the fact that human beings are not so passive and predictable in the face of change, and to bring human and social behavior into these integrated modeling approaches, I began working with a Complex Adaptive System (CAS) and Agent-based Modeling (ABM) team at the Argonne National Laboratory (North, Sydelko, Vos, Howe & Collier, 2006; North, Collier, Ozik, Tatara, Macal, et al., 2013). These CAS approaches sought to observe and understand basic human behaviors and encode them into computerized agents using algorithms. The agents, with their simple behaviors, would then be simulated, allowing them to adapt these behaviors as a result of interactions with other agents and with the environment (which can be represented by a physical process model embedded in the simulation). The overall system behavior would then emerge as a result of simulating agent behaviors over a series of time steps.

Although the CAS research was interesting, in that it sometimes gave insights into how system behavior emerges from agent interactions, it had real shortcomings when the team was faced with complex problems requiring interdisciplinary collaboration. Data collection becomes a huge challenge in these circumstances, and there are no capabilities to handle multiple perspectives on agent behaviors, short of encoding multiple versions of each agent to represent differing opinions on its behavior, and running numerous simulations, altering the agents' behaviors each time.

It was during this time that I was first introduced to the Project on National Security Reform (PNSR), by a new colleague, Dr. Sheila Ronis. This project sought to recommend a systemic U.S. national security reform that would produce a 'collaborative government' approach, which would

include the many agencies and government organizations engaged in some aspect of national security (Locher, 2008). Dr. Ronis, a systems scientist and foresight expert, led the Vision Working Group for the project, which ultimately created narrative scenarios reflecting various potential future complex problems to stress-test the PSNR recommendations (Ronis, 2010). Through Dr. Ronis, I was fortunate to meet and interact with the PNSR director, James Locher. Locher also led the effort that resulted in the Goldwater-Nichols Defense Reorganization Act of 1986, which caused sweeping changes to the U.S. military and unified the military services under a joint command. I also met Leon Fuerth (national security adviser to former U.S. Vice President Al Gore, and director of the Project on Forward Engagement at the George Washington University). He is an influential strategist who has written on the use of foresight to address wicked problems that cross agency boundaries (Fuerth, Bezold, Juech & Michelson, 2009; Fuerth, 2011; Fuerth & Faber, 2012). In addition, I met and worked with Dr. Linton Wells, Director of the Center for Technology and National Security Policy (CTNSP) at the National Defense University (NDU).

These scholars all have a clear focus on the need for whole-of-government approaches and the creation of interagency responses to highly complex wicked problems. They are also systems thinkers, with many years of experience with the global wicked problems that challenge U.S. national security. The interactions I had with them made a very big impression on me and began to change my views on how to approach wicked problems. Dr. Ronis and I, working with Dr. Wells, organized two systems conferences at the National Defense University. The first was held in 2010 and was entitled 'Integrative Systems Approaches to 21st Century National Security'. The second conference, 'Energy Security as a Grand Strategy', was held in 2012 (Sydelko, Ronis & Guzowski, 2014). Systems thinking resonated with the conference attendees, but most said they struggled with how they would use it to improve their own systems to better tackle wicked problems.

It was at this time that I wrote a research proposal to Argonne National Laboratory called "Crime on the Urban Edge (CUE)". I proposed to conduct a 3-year research study to develop a systemic approach to interagency design that can facilitate a coordinated respond to commonly-understood wicked problems, using transnational illicit trafficking and its interface with crime in U.S. cities as the example wicked problem. Shortly after I was awarded the grant, I attended the International Society for the Systems Sciences (ISSS) annual conference in Washington D.C., where I met and learned from systems researchers from across the world. One of the people I met there was Professor Gerald Midgley, the president of the ISSS at the time (2014), who described his Centre for Systems Studies and Systems Science PhD program at the University of Hull. Through follow-up discussions with Midgley, I decided to write a proposal to be considered for the PhD program at Hull, using the CUE project as my thesis topic. The proposal was to research the

application of Critical Systems Thinking to create interagency responses to wicked problems. In addition to the thesis research, the CUE research included the development of a prototype anticipatory model of drug supply chains and some initial research into advanced visualization of systems behavior (described in Appendix 4 of this document).

In summary, it is my experience with scientific approaches to systemic problems, my exposure to the urgent need for interagency responses to our most challenging and threatening wicked problems, and my introduction to Critical Systems Thinking, that motivated this research. I am furthering my career as a systems practitioner after retiring from Argonne National Laboratory and have formed a consulting firm called Fat Node Consulting. I intend to bring what I have learned through this PhD research to develop cross-organizational responses to wicked problems at varying scales.

1.2 The Research Problem

Wicked problems pose significant challenges to human well-being, security, and safety. Governments need approaches to designing and improving interagency cooperation that are robust, agile, and sustainable. To illustrate the types of overarching problems that the U.S. government is currently trying to understand and manage, there is an Energy Czar, Drug Czar, Asian Carp Czar, Climate Czar, Auto Recovery Czar, and Intelligence Czar. As these titles illustrate, Czars can be appointed to oversee very broad issues, most of which have characteristics of wicked problems. Yet Czars or task force leaders are asked to address these highly complex policy issues as if there was a well-established explanation of the problem and clear goals to be pursued, when this is not the case: because these are wicked problems, they are notoriously difficult to define. The focus of the Czar or task force leader is therefore on coordinating agencies around a wicked problem that they do not have a sufficiently systemic understanding of. This is a potentially dangerous approach to managing wicked problems with innumerable interdependencies: the purposes, perspectives and values of the government agencies and other stakeholders can often come into conflict, and therefore they become part of the problem (Rittel & Webber, 1973).

While there have certainly been Czars (and their task forces) who have made important contributions, there is clearly a need for methods to improve systemic understanding in the face of the extreme complexity of wicked problems. These methods also need to support stakeholders in creating an effective interagency response. They have to bring the appropriate agency personnel together to collaboratively structure the wicked problem at hand, deal with the differing perspectives and conflicting values that will no doubt arise, and help stakeholders organize

themselves across agency boundaries. Currently, the U.S. government does not employ systemic methods that meet these needs.

Because wicked problems are perceived and valued differently among agencies, departments, and other impacted organizations, these systemic methods must account for the perspectives of multiple stakeholders. The design of interagency organizations must also align the functions of the interagency directly to the wicked problem. Additionally, the interagency design needs to keep the agencies relatively autonomous. This helps because agencies will often be responding to many wicked problems at one time, and a single-issue interagency structure with a command-and-control relationship with its sub-agencies will most likely prevent these agencies from being sufficiently agile (Seddon, 2008). As an example of dealing with more than one wicked problem, the FBI has parts of the agency that is focused on the illicit drug trade, but clearly is also engaged in counterterrorism and combatting arms dealing.

1.3 Research Purposes

I started this research by trying to develop research questions, which is quite usual for qualitative PhD work. However, this felt uncomfortable, as I was intending to immerse myself and my evolving methodology directly within the context of a wicked problem with real-world stakeholders. It became clear to me relatively quickly that I would be undertaking systemic action research, yet research questions are most usually addressed in projects where it's possible to position oneself as an observer rather than an intervener. In my case, I was clearly going to facilitate the design process with the primary purpose of *developing, trialing, and assessing a mixed-method Systemic Intervention approach (Midgley, 2000) to design a specific interagency response to a wicked problem – illicit drug trafficking and its interface with local gangs in Chicago, USA.*

The primary purpose of my research, specified above, was broken down into two research *purposes* (rather than questions) corresponding to two different phases of the study:

Research Purpose for Phase One: Develop, trial, and assess a participatory Problem Structuring Method, underpinned with Boundary Critique to create a common interagency understanding of a wicked problem (the illicit drug trade) among multiple agencies.

Research Purpose for Phase Two: Building on the results from phase one, develop, trial, and assess a Viable Systems Model (VSM) (Beer, 1979, 1981, 1984, 1985) board game for designing an

interagency meta-organization that is (1) tailored to the specific framing of the wicked problem that the stakeholders have themselves created, and (2) capable of effectively addressing illicit drug trafficking at multiple scales.

Explanations of why these methodological foci were chosen can be found later in the thesis, but for now it is sufficient to note that my overarching aim was to establish the potential value of a synthesis of systems methods, within an overall systemic approach, that could address any specific wicked problem when two things are required: facilitating a common understanding of that problem, and then creating an interagency organization with the capacity to respond in a coordinated manner.

1.4 Thesis Structure

This document is divided into 8 chapters. Chapter 1, which you are currently reading, introduces the motivation and purposes of the research. Chapters 2 through 5 cover a variety of systems methodologies to provide a background on the methods that were chosen for this work. Chapter 2 discusses the first wave of systems thinking (System Dynamics, Systems Analysis, Systems Engineering, and Cybernetics) from the 1950s to the 1970s, when systems were often viewed through the lens of a machine metaphor – i.e., viewed as complicated but inherently predictable if we can gain sufficient knowledge of them (Morgan, 1986; Flood & Jackson, 1991a). It also includes a section on the important critiques of these 'first-wave' approaches (the wave metaphor was first introduced by Midgley, 2000, 2003a,b, 2006b, who argues that there have been three waves, or paradigms, of systems thinking since the 1950s).

Systems researchers and planners who were frustrated with the inadequacy of first-wave approaches to deal with large, complex social problems created the concept of a 'wicked problem' (Rittel and Webber, 1973). Chapter 3 summarizes the characteristics of wicked problems, discusses their prevalence in public policy, describes the challenges of managing them, introduces the importance of interagency working, and ends with an argument for why addressing wicked problems requires a systems approach that goes beyond the first-wave methodologies discussed in the previous chapter.

Chapter 4 provides a review of systems approaches that were developed, mostly in the 1980s, to specifically address socially-complex problems characterized as wicked. These approaches are referred to as second-wave systems thinking. Chapter 4 provides an overview of four examples: Strategic Assumption Surfacing and Testing (SAST), Interactive Planning (including Idealized

Design), Soft Systems Methodology, and the second-wave rethinking of some first-wave approaches.

More recently (from the late 1980s onwards), a third wave of systems approaches has been introduced, and this is described in Chapter 5. Major additions to systems thinking covered here include (1) Boundary Critique for addressing power and conflict when engaging with multiple stakeholders, and (2) Methodological Pluralism. Methodological Pluralism is about the use of mixed methods when designing interventions. Chapter 5 also introduces Systemic Intervention (Midgley, 2000, 2006b, 2015, 2018, 2022b; Boyd, Brown & Midgley, 2004; Midgley and Rajagopalan, 2021) as the underlying approach for this research.

The discussion of a two-phase methodological design for this study begins in Chapter 6. This chapter introduces the overall design as an action research study, describes the wicked problem chosen to trial the approach, and discusses the first phase of this research, which involved developing a new method called Systemic Perspective Mapping. The rationale for developing this method is given, and a detailed account of how it was trialed as part of the research is provided.

Chapter 7 provides an overview of the second research phase, which involved the development and implementation of a Viable System Model (VSM) Board Game. The VSM (Beer, 1984), which will already have been covered briefly in Chapter Two, is explored more deeply as a model for developing the design of an inter-agency organization specifically tailored to adapt to and remain viable within its environment. This chapter will include the basic principles and tenets of the VSM; a summary of the model's basic structure and functions (sub-systems); and a review of some successful VSM interventions. It also describes how the VSM was applied using a novel board game.

Chapter 8 provides a summary and conclusions for each of the research phases and for the overall Systemic Intervention. It offers some reflections on the contributions of this research to knowledge. It also provides insights into how this research deals with some of the challenges of interagency collaboration.

Chapter 2: Treating Systems as Machines

To better understand the concept of 'wicked problems' and why it was important to the development of new generations of systems thinkers from the early 70s onwards, this chapter will review the first analytical systems approaches that were developed to address the growing complexity of military missions emerging before and during World War II. These first-wave systems thinking approaches were revolutionary at the time they were introduced, and they quickly expanded beyond military applications to wider use in many civilian domains.

2.1 Wave Metaphor for Systems Approaches

Before proceeding with the review, however, I need to explain my use of the wave metaphor: i.e., first-wave, second-wave and third-wave systems approaches. This is a metaphor that was originally used by Midgley (2000, 2003a, 2006a), and it was overlaid onto Jackson's (1991) explanation of the progression from 'hard' (emphasizing objectivity, quantification and the expertise of the analyst) to 'soft' (stressing intersubjectivity, qualitative modeling and stakeholder participation) to 'critical' systems thinking (focused on dealing with power relations and using the best from both the hard and soft traditions). Midgley introduced the wave metaphor because, if we now believe that it is legitimate to mix methods from previous paradigms, then the old pejorative language of hard and soft systems thinking (coined by Checkland, 1981) is no longer appropriate (Midgley, 2000). Midgley (2006a, p.12) also explains the wave metaphor as follows:

> "A wave throws useful materials onto the beach, and these are then added to and sometimes rearranged when the next wave hits. I argue that there have been three waves of systems research since the 1940s, each of which offers a different basic understanding of systems and consequently a different methodological approach. Inevitably, all metaphors highlight some features of a situation while hiding others (Morgan, 1986). In this case, the fact that some researchers continue to develop older ideas in useful directions even after new waves come along is made less visible than I might like by the wave metaphor. Nevertheless, the advantage of using this metaphor is that it focuses attention on some of the major shifts in understanding that have taken place, leaving us with a wide range of systems approaches to learn from".

First-wave analysts were considered 'systemic' because they recognized that many problems are non-linear, with interdependencies between elements that must be addressed. However, these analysts were highly mechanistic, as they viewed systems as collections of parts that are interrelated in ways that can be mathematically modeled to represent the whole, as if social

systems were no more than predictable machines (Jackson, 1991; Midgley and Richardson, 2007). Given that these early systems analysts came from strongly empirical backgrounds, where the methods of science were expected to be the underlying framework for understanding any problem, it is not surprising that they sought to deal with complex problems using highly analytical methods.

Some of the most influential first-wave systems thinking, such as that found in Operations Research (OR), Cybernetics, Systems Analysis and Systems engineering, will be discussed below. Mention of OR in the previous sentence might be seen as controversial because, as Keys (1991) notes, there have been various moves over the years by the OR community to try to claim that systems thinking is an OR approach, and conversely there have been occasions when systems thinkers have talked about OR as if it was a branch of systems thinking. I should be clear at this point that my mention of OR does not imply that I believe either OR or systems thinking to be a subset of the other. They are best thought of as overlapping research communities (Midgley & Ochoa-Arias, 2004; Midgley, Johnson, & Chaichirau., 2018), with some writers (e.g., Churchman, 1970; Ackoff, 1981a; Checkland, 1981; Jackson, 1991; Midgley, 2000) contributing to both.

One of the first-wave approaches, the Viable System Model (VSM), is especially pertinent to the research study described in this thesis and it will be covered in detail in Chapter 3. The chapter will close with a summary of the significant critique by a new generation of systems thinkers, who would later form a second wave of research, that took issue with an observation-based mechanistic approach to addressing highly complex social systems. In particular, C. West Churchman and Russell Ackoff, both highly respected systems thinkers, issued strong critiques and presented an argument that there are moral and ethical implications of treating complex social systems containing free-willed human beings as machines. Others also expressed frustration after valiantly trying and failing to apply first-wave approaches to social planning problems. The chapter will end with an introduction to Rittel and Webber's (1973) article that sought to describe the characteristics of wicked problems (covered in detail in Chapter 4).

2.1.1 The Inception of First-Wave Systems Approaches

Between the 1st and 2nd World Wars, military missions were becoming larger, more complex, and were made up of many interconnected activities. Military leaders asked for new approaches that could ensure that the military units (parts) were performing together to accomplish the goals of the overall mission (whole) (Ackoff, 1979b). They had observed that, even when units met all their goals, it did not mean that the overall mission objectives were being met. During this same time,

there were rapid advancements in science and technology, and scientists and engineers were becoming as much a part of the mission as soldiers were. The military looked to the science and engineering community for new analytical approaches that could produce military plans that allowed interrelated units to meet the stated objectives of their missions.

These analysts used the term *system* to refer to "a set of parts coordinated to accomplish a set of goals" (Churchman, 1968b, p.29). Therefore, they referred to the analytical methods they developed as *systems approaches*. They based these systems approaches on an empirical scientific paradigm, where expert observation was used to build a model of the real-world situation for use in running experiments on the problem.

The procedure was typically as follows: first, the researcher or analyst (as the expert observer) directly observes and collects information about the system, its parts, and the relationships between them; once observations are collected, the analyst formulates the problem in light of the given aims of the study (this is based on the assumption that the clients have clearly articulated their objectives from the start; a mathematical model (stochastic or deterministic) of the problem is then constructed (Jackson & Keys, 1984), which attempts to deal with the multiple interacting variables of a problem when certain changes are made to the system (Churchman, 1970); experts then collect the data needed to run the model; and then, given the goals of the organization, which are assumed to be rational (Churchman, 1968b), the mathematical model is run to estimate the change that maximizes the value of the system (Churchman, 1979).

After World War II, as the military scientists and engineers returned to civilian careers, first-wave systems theories, methods, and models were transferred into civilian applications, especially for organizational management and industrial engineering. These approaches, which were categorized as either operations ('operational' in Europe) research (OR) or Cybernetics, later came to be called 'hard systems approaches' (Checkland, 1981; Jackson, 1991; Mingers & Gill, 1997) for reasons that have been touched upon above and will examined in more detail in Chapter 5 of this thesis, where soft systems approaches will be discussed. Other hard systems (or first-wave) approaches include Systems Engineering (e.g., Hall, 1962; Jenkins, 1969), Systems Analysis (e.g., Miser and Quade, 1985, 1988), and System Dynamics (e.g., Forrester, 1961).

The discipline of OR was developed as the "application of the scientific method to the broad strategical and tactical problems of warfare" (Kittle, 1947, p.150). Morse (1948) also describes OR as an application of the scientific method, which is used to study operations that involve organizations of men or men and machines, opening the opportunity that OR could be used

outside of military applications. Morse considers OR to be a branch of engineering, and a discipline that is a blend of physics (to understand the operations of the machines involved) with biophysics and psychophysics (to understand the capabilities of the human components).

OR approaches typically follow the empirical scientific procedure described above. As OR became more mainstream in non-military applications, it also began to be called Management Science (MS). OR and MS refer to roughly equivalent disciplines, and it is common to see the combined abbreviation OR/MS in the literature. OR has been heavily used on operations such as supply chains, scheduling, inventory management, plant management, and resource allocation. OR remains a key discipline taught and used in many universities and research organizations today. Hillier and Lieberman (2005) provide a good summary of key OR applications. A brief overview of some systems approaches commonly used within, but also beyond, OR is given below.

2.1.2 Overview of System Dynamics

System Dynamics is a popular OR/MS approach (Forrester, 1961, 1993, 1994 1995; Richardson & Pugh, 1981; Sterman, 2000; Richardson, 2013) that seeks to create structural explanations of system behavior, including social systems. The concept of System Dynamics grew out of Jay Forrester's early work (starting in 1956) at the Massachusetts institute of Technology (MIT) in Control Engineering and Industrial Dynamics (Forrester, 1958). The term Industrial Dynamics was replaced with System Dynamics to indicate that the approach could be used in domains outside of industrial settings (Forrester, 1961). Forrester describes the beginnings of System Dynamics as the process of pen and paper modeling of inventory controls (Forrester, 1995). Over time, System Dynamics has evolved into formal computer modeling. A popular use of System Dynamics to this day is in supply chain management (Angerhofer & Angelides, 2000; Akkermans & Dellaert, 2005; Özbayrak, Papadopoulou & Akgun, 2007).

System Dynamics is a widely used approach and has been applied in several fields, including water resource management (Mirchi, Madani, Watkins & Ahmad, 2012; Winz, Brierley & Trowsdale, 2009); health care (Tidwell, Passell, Conrad & Thomas, 2004; Lane & Husemann, 2008; Merrill, Deegan, Wilson, Kaushal & Fredericks, 2013), and energy generation (Palensky & Dietrich, 2011; Hsu, 2012; Ahmad, Mat Tahar, Muhammad-Sukki, Munir & Abdul Rahim, 2016). Importantly, system dynamics computer modeling (Forrester, 1994; Maani & Cavana, 2007) has been employed to explore interactions among the multiple global issues that are currently challenging humanity (He, Okada, Zhang, Shi & Zhang (2006). 1996; Simonovic, 2002; Meadows, Randers & Meadows, 2005; Hjorth & Bagheri, 2006). Causal loop diagramming and qualitative group model building

(Vennix, 1996) have also been a particular focus (Hjorth & Bagheri, 2006; Kwakkel & Pruyt, 2013; Vo, Chae & Olson, 2007). A recent example of causal loop modeling that has gained significant attention is Lane, Munro and Husemann's (2016) examination of the systemic failings of the English social work system.

SD is based on information feedback and delays and represents the system's structure as causal-loop diagrams and stock-and-flow diagrams. The simplest possible diagram of a System Dynamics model represents a problem as an ongoing circular movement (Figure 2.1) that starts when conditions give rise to some sort of action, resulting in a change in conditions, which in turn causes further actions (Forrester, 1993).

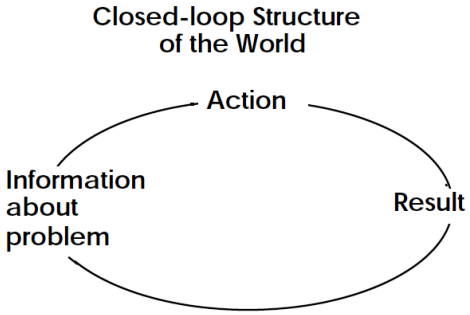

Figure 2.1: From Forrester, 1993, p.8.

By joining and intertwining these simple closed loops, a System Dynamics model can be constructed where the actions in one loop can be chained together so that changes in conditions caused by one action can change the conditions that drive other actions. Hence the 'dynamics' in 'System Dynamics'. In addition, the timing of these actions can be altered to determine the impacts of time delays or lags (Meadows, Meadows, Randers & Behrans, 1972; Sterman, 1992; Kwakkel & Pruyt, 2013). These System Dynamics models are coded into a computer simulation and can then be used to run experiments that test how potential decisions might impact the overall system structure by simply altering the actions (and/or their timing) within these feedback loops.

Like physical systems, Forrester considers experimental model-building to be similarly useful for social systems. He considers the model is a statement of system structure. Properly used, he argues that models of social systems can lead to better real-world systems, laws, and programs. Forrester began using System Dynamics within broader social systems after interactions with John F. Collins, a former Boston mayor and a Visiting Professor of Urban Affairs at MIT. Working with Collins, Forrester set about to gather insights from Boston city managers into the structure and processes that could explain stagnation and unemployment. This modeling effort is described in Forrester's (1970) *Urban Dynamics* book.

2.1.3 Overview of Systems Analysis

Systems Analysis emerged out of the RAND corporation in the mid-50s, and again was developed to address complex military problems. Originally, SA was focused on scientific methods for military weapons design, and the deployment of military forces (Quade & Miser, 1981). However, as RAND continued to develop SA and apply it outside the military, they brought in a collection of different techniques (Kahn & Mann, 1956). RAND stopped defining Systems Analysis as a method or technique, or even a set of techniques, but put an umbrella over a general research approach:

> "A systematic approach to helping a decision maker choose a course of action by investigating his full problem, searching out objectives and alternatives, and comparing them in the light of consequences, using an appropriate framework – in so far as possible analytic – to bring expert judgement and intuition to bear" (Quade & Boucher, 1968, p.2).

This is certainly a broad definition that could be applied to any OR, perhaps with a bigger focus on requirements analysis. The kinds of techniques usually associate with Systems Analysis are highly quantitative and include resource analysis, cost-sensitivity analysis, mathematical modeling, logistics simulation, and scenario analysis (Quade & Boucher, 1968). Recognizing that quantitative analysis alone was not adequate, however, systems analysts use experts when judgements need to be made. The criteria for being identified as an expert include years of professional experience, number of publications, and academic rank (Quade & Boucher, 1968).

Like System Dynamics, Systems Analysis has been used extensively in various domains from supply chains (Charu & Sameer, 2000) through power flow analysis (Cheng & Shirmohammadi, 1995) to an agricultural robot feasibility study (Pedersen, Fountas, Have & Blackmore, 2006). Almost all these applications rely on inputs from experts and focus on large mathematical models and simulations (Hoos, 1969; Lee, 1973).

2.1.4 Overview of Systems Engineering

First-wave systems approaches also include Systems Engineering. It is hard to identify when the term was first used, but Schlager (1956) believes it was coined at Bell Laboratories in the 1940s. Schlager (1956) describes a situation in which engineers began to observe that, with complex systems, individual components can be designed to meet specifications, but the system as a whole often could not.

There is no consensus on how Systems Engineering should be defined. Hall (1962), a Bell Laboratories electrical engineer, describes Systems Engineering as a method consisting of a set of steps: problem definition, choosing objectives, systems synthesis, Systems Analysis, systems selection, system development, and current engineering. Jenkins (1969, p.1) defines Systems Engineering as

> "The science of designing complex systems, by the efficient use of resources in the form of Men, Money, Machines and Materials, so that the individual sub-systems making up the overall system can be designed, fitted together, checked and operated so as to achieve the overall objective in the most efficient way."

Jenkins (1969) also describes four basic phases (activities) of Systems Engineering process: Systems Analysis, Systems design, implementation, and operation.

The International Council on Systems Engineering (INCOSE) considers Systems Engineering to be a systematic application of the scientific method to the engineering of a complex system (INCOSE, 2007). They describe the process in terms of four basic activities applied successively: requirements analysis, functional definition, physical definition, and design validation. INCOSE provides this definition (INCOSE., 2007, p9):

> "Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs."

Systems Engineering can be seen as a process made up of phases of subprocesses (Schlager, 1956; Sage & Rouse, 2009; Kossiakoff, Sweet, Seymour & Biemer, 2011). It often consists of applied mathematical modeling with a typical goal of finding optimal solutions for physical systems (Sage & Rouse, 2009). The U.S. Department of Defense (DoD) was an early adopter of Systems Engineering for use in the development of missiles and missile-defense systems (Goode & Machol, 1957) and developed its own set of Systems Engineering standards (Institute of Electrical and Electronics Engineers Standards Association, 2014).

Systems Engineering has grown substantially and is now applied to many other domains (Hou, Zheng, Li, Shen & Hu, 2000; Nasir, Daud, Kamarudin & Yaakob, 2013; Ng & Ng, 2013). It has a

strong history of application in the aerospace industry (Ivancic, 2003; Tobiska, 2004; Chang, Hwang & Kang, 2007). The U.S. National Aeronautics and Space Administration (NASA) issued a Systems Engineering handbook (National Aeronautics and Space Administration, 2017). The International Standards Organization has also issued ISO/IEC/IEEE 15288:2015: Systems and Software Engineering – System Life Cycle Processes (Iso/Iec/Ieee. (2015).

2.1.5 Cybernetics

Cybernetics is another systemic approach that came out of World War II research efforts. The term 'Cybernetics' was first used by Norbert Wiener (1948), who considered Cybernetics to be a new science; one whose theory would cover the control of and communications between machines and/or living organisms (Wiener, 1948, 1961). Beer (1959) argues that the problem of control is something all sciences have in common, and the nature of control is more-or-less uniform across them. Beer (1959, p.2) calls this theory the "the theory of organic control". The structure of systems and the rules that govern their behavior (mechanisms) are the aspects of a system that can be interfered with (Beer, 1975).

The central concept of Cybernetics is feedback (Wiener, 1948), or mutual causal relationships (Maruyama, 1963) that respond to stimuli and then communicate instructions that then modify the system's performance. Feedback mechanisms are used in Cybernetics to provide 'purposive' and 'adaptive' behavior (Wisdom, 1951). A negative feedback mechanism responds to information provided by the system (stimuli), resulting in opposing system performance (reducing the magnitude or changing direction), while a positive feedback loop increases the magnitude within the same direction (Eisenhart, 1949). These feedback mechanisms encompass what Cybernetics terms a 'learning machine', which Beer (1959) defines as a conditional probability mechanism.

Cybernetics is popularly known for its influential applied mathematics and computer science techniques, such as cellular automata (von Neumann, 1951: von Neumann & Burkes, 1996), neural networks (McColloch & Pitts, 1943; Cowan, 1989), and autonomous robots (Bekey, 2005; Bladin, 2006). These breakthroughs later led to the field of Artificial Intelligence (Nilsson & Nilsson, 1998).

However, cybernetic approaches to management have also been developed. This use of Cybernetics is particularly pertinent to my own research study on designing interagency organizations. Beer (1959) states that his theory of control is applicable to both mechanical and

social systems. Beer reasons that "Cybernetics is the science of control, management is the profession of controlling a certain type of system" (Beer, 1966, p.239). Beer developed his Viable System Model (described in detail in Chapter Three) as a Cybernetics tool that provides a set of concepts for managers to create self-managed and self-regulated operations.

Jackson (2007) argues that management Cybernetics describes organizational activities in terms of an input-transformation-output system, with objectivity of the manager/observer assumed. However, Beer (1979) himself does not consider organizational activities to be input-output transformations, and he is clear that the purpose of the enterprise is to be observer-determined by people within the organization, so objectively is not actually assumed. In his later work, Jackson (2019) concedes that the VSM allows for the system to be seen from a particular perspective, or indeed could be viewed differently from different perspectives, and objectivity cannot be taken for granted). This is important, because although the VSM is considered a cybernetic model, it does not fit neatly into a mechanical interpretation of Cybernetics. In this sense, the VSM was ahead of its time: while many of the first-wave systems approaches took the possibility of objective analysis for granted, Beer was already developing the first buds of a more sophisticated approach that would come into full flower in the second wave of systems thinking.

2.1.6 A Brief Introduction to the Viable System Model

Before introducing second and third-wave system approaches that were developed to address the messiness of social problems through stakeholder engagement, it is important to introduce a particular organizational Cybernetics model called the VSM, which was developed by Beer (Beer, 1979, 1981, 1985). As we will see later in the thesis, the VSM was included in the mixed method intervention designed for this study. One important reason the VSM was chosen is because it is a conceptual framework for diagnosing organizational problems or designing new organizations to be better prepared to deal with a complex and turbulent environment. Particular to this study, it will be shown that it is important to design the interagency as an 'organization', while allowing each agency to remain an autonomous entity (appreciating that the term 'autonomy' refers to decision making coming from within; it assumes interrelatedness and not isolation from wider systems). A more thorough discussion of the VSM is given in Chapter 7, and only a brief overview will be given here.

Figure 2.2 is Beer's original depiction of the VSM, showing five subsystems interacting with the environment of the viable system. The environment (or niche) for the viable system is shown as a

large oval to the left (

Figure 2.2). For this study, the environment is the wicked problem to which the interagency is designed to respond.

Figure 2.2 also shows that each System 1 (S1) has a local environment in which it is operating. These local environments are certainly part of the overall environment for the interagency, but as will be discuss later, the interagency environment is more than the sum of the local environments.

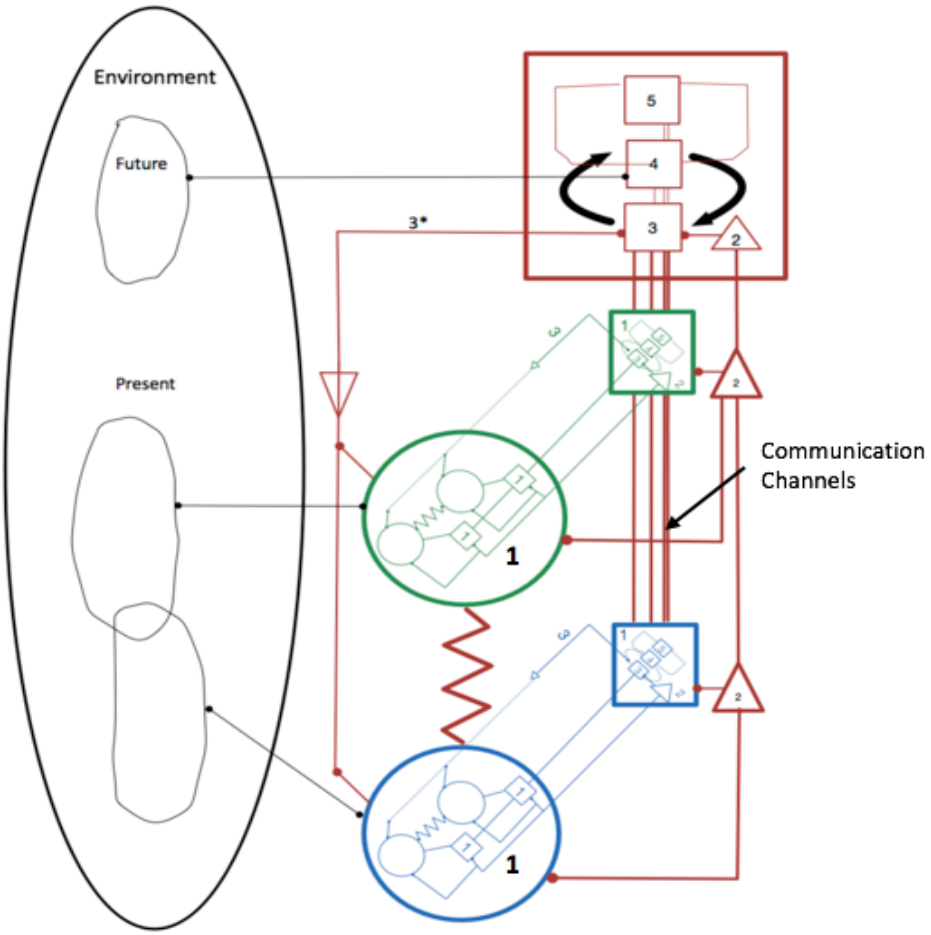

Figure 2.2: Diagram of the Viable System Model (Beer, 1979)

As shown in

Figure 2.2, the viable system has 5 major subsystems. Brief descriptions of these subsystems and their roles and functions are provided in

Table 2-1.

Table 2-1: The VSM Subsystems

System 1 (S1):	S1 is the operations of the organization, where the production of products or services happens (Beer, 1985; Espinosa, Reficco, Martínez & Guzmán, 2015). Within an interagency viable system, the S1s can be the individual agencies that will provide the operational functions within the interagency organization (Midgley, Munlo & Brown, 1997, 1998). S1s remain autonomous individual agencies, but within constraints set by S3, S4 and S5 (see later in this table), and because the VSM is elegantly recursive, each agency is a viable organization in itself.
System 2 (S2):	S2 deals with support for day-to-day operations, providing shared languages, protocols, procedures, and information. It is also involved in avoiding oscillations and providing conflict resolution when discord exists between the S1s (Espinosa & Walker, 2017). S2 is a set of coordinating mechanisms needed to keep the agencies in homeostasis. It can include already existing mechanisms that can be leveraged, and it can help to identify when new mechanisms are needed to keep the interagency operations running smoothly.
System 3 (S3):	S3 is responsible for generating synergies among the S1s, and for regulatory issues, such as resource distribution, accountability, and legal requirements (Espinosa & Walker, 2017). S3 also handles resource bargaining to ensure that all parts are running in the best interests of the whole organization (as defined by the strategic S5 subsystem discussed below). S3 is an especially challenging function to design because it embodies the resource bargain that all stakeholders must agree to, as well as the performance management of each of the autonomous units (S1s). Working with S2, S3 facilitates the continued operations of the interagency. S3 also uses a sporadic and informal auditing system (called S3*) that monitors the activities of the S1s (Hilder, 1995). It offers an alternative channel to generate unstructured information to complement the more formal S3 accountability information. It can probe the details of the operations without taking over and micromanaging.
System 4 (S4)	S4 is the adaptation function of the organization. It is responsible for understanding the total relevant environment in which the organization is embedded (Hilder, 1995), appreciating that what counts as 'relevant' requires a values-informed boundary judgment (Ulrich, 1981). Whereas S3 is concerned with management of the operations of the organization, S4 is concerned with the outside environment in which the organization sits (Beer, 1979). It is responsible for scanning the outside environment; anticipating potential disruptions to this environment (either in terms of threats or opportunities); suggesting strategic development paths; and recommending the internal operational changes needed to adapt to anticipated environmental and organizational changes, working closely with S3. Through these mechanisms, S4 (in conjunction with S3) creates the space in the organization for thinking strategically about the balance between maintaining current operations and responding to the need for change (Hayward, 2004)**.**
System 5 (S5):	S5 defines the identity of the organization and provides its ethos, purpose and policy (Leonard, 2009). S5 works with S3 and S4 (creating an S3/S4/S5 homeostat) in monitoring the adaptation capability. S5 may be called in to make decisions on the recommended adaptive changes S4 recommends if any conflict exists between S3 and S4, and in this sense, it provides an essential strategic overview and decision-making function.

It is important to emphasize the fact that S1s are autonomous viable systems themselves. This is especially important for designing interagency organizations because agencies needing to cooperate and to coordinate their activities highly value their autonomy and appreciate that a top-down approach can be problematic, as the senior management cannot cope with all the variety the interagency has to deal with (Sydelko, 2017). What is needed instead is a set of mechanisms (all equally important) that allow the interagency to manage variety and behave like a networked whole, which is what the VSM, as originally advanced by Beer (1972, 1975, 1979, 1984, 1985) and deployed by Espinosa and Walker (2006, 2013). This important nuance is important because it makes it clear that a purely mechanical and hierarchical interpretation of the VSM, as was put forward by Jackson and Keys (1984), is inadequate.

2.2 Important Critiques of First-Wave Systems Approaches

In the mid-20th century, critics began to voice their concerns about mechanistic first-wave approaches, especially as they were being used for highly complex social planning problems. C West Churchman was a highly influential systems thinker who produced several important books and articles criticizing mechanical approaches, especially in OR (Churchman, 1968ab, 1970). The full extent of Churchman's in-depth critique is too wide-ranging to cover here in its entirety, but because Churchman set the stage for the emergence of theory and practices that are used in this study, a summary of his most salient points is presented.

Churchman says that there are substantial ethical and moral issues surrounding the OR profession, and he questions the view that an expert or analyst can ever be a rational, scientific, and 'objective observer' of a highly complex social system (Churchman, 1970). He stresses that the data collected in OR do not come from observations alone but are influenced by strong assumptions concerning what it is appropriate to observe in the first place and where to place boundaries around an analysis (Churchman, 1970). In fact, he says it is an "absurd myth" (Churchman, 1968a, p.86) to think that the scientist/observer of social systems can stand apart from those observed and ascertain how people behave without introducing their own biases: the analyst always observes the system from a vantage point, and the question is not how to be objective, but how to choose the most appropriate perspective (Churchman, 1968b). In Churchman's view, an analysis only becomes systemic when the boundaries and ethics defining what is 'appropriate' are subjected to scrutiny (also see Ulrich, 1988a).

Churchman questions how analysts approach defining and describing the overall system objectives of any given project or organization. He criticizes what he calls the engineering

approach that OR analysts typically take to define these objectives (Churchman, 1968b). This engineering approach puts the onus of defining the needs and objectives of the whole system primarily on the shoulders of the client, thereby relieving the analyst of that responsibility. Churchman points out that, not only can objectives be stated incorrectly by clients, but often they can also often be too narrow, posing a danger that the system will be sub-optimized. This is because, like the analyst, the client too has a partial perspective, so uncritically accepting his or her objectives can be problematic (Churchman, 1968a). Churchman (1968b) especially takes exception to the engineering approach for multiple-decision-maker problems, because there are sure to be multiple, conflicting objectives. In these situations, the challenge is to determine whose objectives should be served, and whether it is possible to evolve new objectives that satisfy a broader stakeholder constituency. Here, Churchman (1968a) questions the morality of OR, because it produces plans that can affect many inhabitants of the system, without permitting any of those impacted (except the client) to object. He argues that "the fundamental systems question is: Where in the total human system should freedom of choice be permitted for the inhabitants of the system?" (Churchman, 1968a, p.15).

Churchman (1968b) critiques the failure of first-wave approaches to adequately take the environment of the system into account. He calls this the 'environmental fallacy', and loosely defines the environment as anything outside of the system that is not controlled by the decision maker (Churchman, 1979). As simple as this definition is, determining what is outside and therefore a part of the environment is extremely difficult. Systems are always parts of larger systems. Thus, it is not possible to define the conditions under which an open system achieves a steady state unless the system constants include mediating boundary conditions (von Bertalanffy, 1950). The importance of the environment is that it determines (in part) how alternate courses of action are related to the goals and objectives (Churchman, 1968b). The question of what is outside the system requires the consideration of system boundaries. Who gets to decide on those boundaries is a very important question raised by several third-wave systems writers (e.g., Ulrich, 1983; Midgley, 2000; Boyd et al, 2004; Foote Gregor, Hepi, Baker, Houston et al., 2007; Midgley and Pinzón, 2011, 2013; Midgley and Lindhult, 2017, 2021; Midgley et al, 2018; Torres-Cuello, Pinzón-Salcedo & Midgley, 2018; Ufua, Papadopoulos & Midgley, 2018; Sydelko, Midgley & Espinosa, 2021), and this topic will be covered in detail in Chapter 5.

Churchman's PhD student, Russ Ackoff (1973), also strongly criticizes what he refers to as the 'machine age'. The machine age, he argues, has two basic ideas: reductionism and mechanism. He refers to reductionism as the "belief that everything in the world and every experience of it can be reduced, decomposed, or disassembled to ultimately simple elements (Ackoff, 1973, p.1).

He further explains that reductionism gives rise to an analytical way of thinking, which involves explaining the behavior of these disassembled parts and using these explanations together to explain the behavior of the whole. This is highly problematic because it ignores the *interactions between* the parts, which are usually highly significant.

The other basic idea of the Machine Age is mechanism, which contends that the behavior of all phenomena can be explained in terms of invariable cause-effect relationships. This represents a deterministic view of the world (see Skinner, 1971, and Maze, 1983, for examples of highly deterministic worldviews). Ackoff vehemently challenges determinism and the lack of teleological concepts in science, such as functions, goals, purposes, choice, and free will. Similar to Churchman's environmental fallacy, Ackoff (1973) charges that mechanism leads to 'closed-system' thinking, as if complex problems could be enclosed in a laboratory where any environmental effects on the system can be excluded.

Ackoff (1979a), like Churchman, also challenges first-wave approaches for their dependence on elite experts with special skills and knowledge about the system being planned, stating that "there are no experts when it comes to answering the question: what ought a system to be like'? Here every stakeholder's opinion is as relevant as any other's" (Ackoff, 1979a, pp.191-192). Despite advances in systems thinking in subsequent decades, this observation from Ackoff (1979a) remains relevant today, as with governmental agencies that are still full of expert analysts. This represents a deterministic view of the world (see Skinner, 1971, and Maze, 1983, for examples of highly deterministic worldviews).

Churchman (1970) and Ackoff (1979ab), who were both viewed as seminal pioneers in OR, began to reflect on why OR was proving to be less successful than originally anticipated in complex contexts (in 1961, they had produced a seminal textbook presenting an optimistic vision of OR and its capabilities, which they later critically reflected upon). Notably, Ackoff's two articles, *Resurrecting the Future of Operational Research* (Ackoff, 1979a) and *The Future of Operational Research is Past* (Ackoff, 1979b) and, caused quite a stir in the OR community. However, Ackoff (1979a) credits other authors for initiating a 'paradigm shift': he cites articles by Tocker (1977) and (Rosenhead, 1978), who discuss how inappropriate it is to use mathematical modeling when dealing with an organization that is struggling with a 'messy' issue (wicked problem). He likewise cites Stringer (1967), Friend and Jessop (1969), and Friend, Power and Yewlett (1974) who address the inadequacy of OR in the context of multi-agency planning.

Other writers were expressing concerns with first-wave systems approaches too. Hoos (1969) highlights such weaknesses as (1) sub-systematization (assuming that the whole system is being studied, when only parts are); (2) the hyper-focus on models and methods; (3) the assumption of objectivity; and (4) the belief that more data and more powerful information systems will always produce better results. Lee (1973) expresses concern about the trend towards large-scale modeling that was prevalent in first-wave systems approaches. He claims that the focus of these complicated modeling efforts was more on the methodologies used and not on the policy problem itself. Furthermore, Lee argues that, in the pursuit of comprehensiveness, conglomerate models were developed where the total was *less* than the sum of its parts. It was less than the sum because the modelers thought they could model whole systems (cities, regions, etc.) but they missed the fact that politicians and public servants would have specific information needs tied to limited purposes that large-scale modeling could not address. Lilienfeld (1975) asserts that large-scale Systems Science approaches from the first wave became ideological: faced with the failure of a project, the modeler would say that the modeling had been incomplete, so the solution would have to be even more comprehensive systems modeling. He refers to this as a *closed reasoning loop*, where evidence shows faulty results, but the solution is to continue with the same approach instead of changing to a new one.

The underlying critique of first-wave approaches is that their regimented adherence to a scientific reductionist logic dominated by a naïve objectivity failed to account for human subjectivity and intersubjectivity, and it simply did not work when practically addressing complex social problems. In addition, the assumption that every effect can be traced to a single, deterministic cause doesn't hold in the context of a highly complex and interdependent wicked problem, and therefore modeling based on this assumption is likely to be naïve. As mentioned earlier, the nature of 'wicked problems' (Rittel & Webber, 1973) will be discussed in more detail in Chapter 3.

2.3 Summary

The intent of this chapter has been to provide a brief history of first-wave systems approaches, and how early attempts to develop and apply systems thinking during and after World War II took place in the context of new disciplines that we know today as Operations (or Operational) Research (OR), Management Science (MS) and Cybernetics. While the systems approaches developed within these disciplines were based upon a relatively mechanistic paradigm (in comparison with subsequent waves of systems thinking), they nevertheless made significant impacts in engineering in particular. However, they began to be heavily critiqued as they were migrated into social systems. In fact, some of the founders of OR/MS (such as Churchman and

Ackoff) were the first to openly criticize first-wave approaches and their underlying objectivist, empirical paradigm. They took particular exception to the tendency for analysts to uncritically accept project remits from clients. Likewise, they criticized an over-reliance on the expert to observe the system, interpret overall objectives, collect data, and set the boundaries for analysis. After all, these social planning problems involve multiple stakeholders, each with their own values and perspectives, and bounding the analysis too tightly will likely marginalize some stakeholders (also see Midgley, 1991, 1992a, 1994).

Meanwhile, many applied scientists and planners, who were trying to use first-wave approaches to design responses to highly complex social problems, were finding these approaches wanting. They felt overwhelmed by the responsibility of defining the complexity of these problems and had ethical issues with single-handedly making judgements about which aspects of the problem were important and which were not. Experience had taught them that, for every solution, there were unhappy stakeholders. They struggled with the notion of true or false answers, given that changing the boundaries of the analysis substantially changed the results. They were beginning to understand that no matter how much data one has, wicked problems cannot be solved through traditional scientific study alone. This realization led to the definition of social planning problems that are not amenable to first-wave systems approaches, and ultimately resulted in the launch of the second and third waves of systems thinking discussed in Chapter 4 and Chapter 5, respectively.

Chapter 3: The Wicked Problem

Very early in the paradigm shift in OR (Ackoff, 1979a; Checkland, 1983), as criticisms began to be voiced of first-wave methods, Churchman invited design theorist and university professor, Horst Rittel, to a seminar at the University of California (UC), Berkeley (Churchman, 1967). In this seminar, Rittel expressed his own dissatisfaction with the prevailing analytical systems approaches of the day (he referred to them as first-generation approaches). Rittel, coming from the design and planning community, wrote an article in 1972, where he claimed that first-wave approaches were only suitable for what he called 'tame' problems, which are well-formulated, easily manipulated, and controlled. Rittel (1972) then described a class of problems he was encountering that were very difficult, if not impossible, to define. Skaburskis (2008, p.277) tells a story of the discussions, and recounts Churchman's response to Rittel as: "hmmm, those sound like wicked problems".

The term 'wicked problem' is generally attributed to Rittel because he went on to publish an article entitled "*Dilemmas in a General Theory of Planning*" with his colleague Melvin Webber (Rittel & Webber, 1973) that officially defined the concept. The article provided a guide of sorts on how to distinguish between tame and wicked problems. They describe tame problems as being like problems of the natural sciences, which can be clearly defined and are easily separable. Tame problems also have clear criteria for determining good solutions. Conversely, wicked problems are characterized as open-ended, with many stakeholders, and these stakeholders may bring contradictory perspectives. In addition, wicked problems are described as having ever-changing requirements that are often difficult to recognize; and these problems have no clear solution, in the sense that they have no definitive and objective answers. Rittel and Webber (1973) provide an outline of ten features and properties of wicked problems that they claim cannot be addressed using what they refer to as first-generation analytical approaches. They offer this list of properties as a guide for planners trying to distinguish if they have a tame or wicked problem.

3.1 What Makes a Problem Wicked?

In the desire to find neat solutions, wicked problems are often addressed using traditional linear and reductionist (overly simplistic) approaches, as if they are merely complicated rather than complex. A complicated problem is one where the interactions are difficult to comprehend without some kind of decision aid, but there is still an optimal outcome or a 'right answer'. In contrast, a complex problem is beyond complicated because diverse stakeholders bring different

perspectives to bear, meaning that one stakeholder's 'improvement' is a set-back for another (Churchman, 1970), so there can be no definition of 'optimum' that satisfies everyone (Checkland, 1985a).

Complicated ('tame') problems are more amenable to being addressed with traditional MS and Operational Research (OR) approaches (Jackson & Keys, 1984). This is not to say that tame problems are easy to solve, but at least a solution that most people would view as optimal is possible. With a wicked problem, not only are all definitions of 'the optimal solution' problematic, but also what counts as an acceptable time frame can differ between stakeholders (Conklin, 2006). Friend and Hickling (1998, 2012) and Camillus (2008) warn that trying to solve wicked problems with traditional approaches used for complicated problems can lead to unintended negative consequences because of interactions with other issues and decisions. Unintended consequences often happen because many traditional OR approaches unknowingly privilege one stakeholder perspective in the belief that it is objective, while marginalizing others, leading to conflict down the line (Checkland, 1981; Spash, 1997; Midgley, 2000).

3.1.1 What is the Problem?

Those analysts engaged in solving tame problems are often experts who define the problem based on data collected. Although tame problems sometimes require collaboration and integration between sciences, in those cases, all parties can usually agree on the problem definition even ahead of the analysis (Roberts, 2000; Ison, 2008). But a key characteristic of wicked problems is that they are ill-defined (Rittel & Webber, 1973). In fact, Rittel (1972, p.5) states that "the most intractable problem is defining the problem". Furthermore, Rittel & Webber (1973) describe a problem as the discrepancy between what is and what ought to be, and therefore contend that "the information needed to understand the problem depends upon one's idea for solving it" (Rittel & Webber, 1973, pg. 7).

So, in order to describe the nature of the problem, a researcher must have identified at least a set of potential broad-brush potential solution(s) a priori. This is a really important observation because the assumption is that you need to explore the problematic situation before considering possible actions. It is one thing to use data and analytics to describe a problem as it exists today, but quite another to plan for what ought to be and make improvements. In practice the perspectives on what ought to be are unique to each stakeholder, but of course, how one stakeholder frames the problem can be influenced by other stakeholders. These complex intertwined perspectives on how to improve on a wicked problem cannot be simply collected as

data. This is a key reason for the Systemic Perspective Mapping method I developed for responding to wicked problems (discussed in Chapter 6).

Another major issue with trying to formulate and structure a wicked problem is that wicked problems are defined by their complex interdependencies and uncertainties (Rittel & Webber, 1973). Therefore, solving only one part of the problem often generates unexpected and undesirable effects elsewhere in the system. Traditional first-wave systems approaches put the boundary decision in the hands of the expert (scientist or analyst), trusting that he or she can adequately understand the entire set of elements and interdependencies of the complex problem. Often, the expert will attempt to define the problem by setting boundaries that are quite narrow (likely to include only those variables they feel they can control). The result is boundaries that are too tight and only represent a part of the whole problem. Churchman (1967, p.B142) claims that "whoever attempts to tame a part of a wicked problem, but not the whole, is morally wrong".

Churchman recognizes that this is a harsh judgment of traditional empirical scientists who have been taught to only solve feasible problems where they can develop a sound theory and conduct a 'valid' analysis, i.e., one recognized as scientific (Churchman, 1968a). This of course means we should not address wicked problems, or that we should continue to break them down into small enough pieces that we believe we can control. This highly reductionist perspective fundamentally goes against the grain of systems thinking but has persisted in scientific institutions and many scientific journals (especially in the US).

3.1.2 When Do We Have a Good Enough Answer?

In addition to tame problems being easier to define than wicked ones, a tame-problem solver also knows when they have achieved a clear solution. There are agreed-upon criteria that can be used to determine if any given solution is true or false, or is the right solution (Rittel & Webber, 1973). Conversely, wicked problems have a myriad of interdependent components, and making a change to any one component will leave multiple traces throughout the system. In fact, Rittel and Webber (1973) assert that, when dealing with wicked problems, the very word 'solutions' is problematic because wicked problems have no stopping rule. Any attempt to create a solution or to intervene will end up changing the problem in sometimes surprising ways. They also stress that, for every potential policy option generated, there is generally another that is missed. This insight was picked up again in the development of complexity theory, which says that for any given configuration or state of a complex adaptive system, there are multiple 'adjacent possible' alternative configurations or states that are just a step away (Kaufmann, 2008).

Additionally, proposed wicked problem resolutions are subject to assessment by many stakeholders, which causes the concept of a 'solution' to break down (Rittel & Webber, 1973). The solution, or the right set of mitigating actions, will look different from different perspectives. An agreement on any list of options generated by analysis is hard to come by, much less a prioritization of which actions may be more optimal, given that one person's optimal solution could be a set-back from a different values-based perspective on what matters (Churchman, 1970).

To illustrate these differences, let's consider a tame problem, such as producing a specific amount of solar power to provide to a community. A solar farm can be engineered and once installed, it can be assessed for how well it hit the mark. It can be upgraded when analysis parameters such as population density or consumer habits change. However, when attempting to find resolution to a wicked problem, such as creating an overall green economy, one change can result in waves of consequences. For instance, interventions to promote green energy will have consequences for consumer satisfaction, competing energy industries, local utilities, the climate, overall global economic markets, and even geo-politics between energy-producing and consuming nations.

3.1.3 Whose Values Matter Most in the Analysis?

From problem definition to problem resolution, wicked problems are subject to the particular values, worldviews, and interpretations of the numerous and diverse set of stakeholders impacted by the problem (Rittel & Webber, 1973). The failure of OR approaches to adequately address this critical characteristic of wicked problems is a major concern for Churchman (1968ab, 1970, 1979) and other authors (e.g., Ackoff, 1981a; Checkland, 1981, Eden, Jones & Sims, 1983; Jackson & Keys, 1984; Lleras, 1995; Midgley & Richardson, 2007). As discussed earlier, Churchman criticizes traditional systems approaches as suffering from the environmental fallacy (failure to take account of the environment, and treating the system as closed), and he claims they are therefore too conservative in setting boundaries (Churchman 1967, 1970). If not subject to critical thinking and/or dialogue with stakeholders, the boundary judgements made by an analyst can unknowingly privilege one perspective in the belief that it is objective while marginalizing others (Checkland, 1981; Ulrich, 1983; Spash, 1997; Midgley, 1992a, 1994, 2000).

Here again, wicked problems pose a huge challenge for policy makers. It would appear that to resolve wicked problems, the perspectives of all impacted stakeholders need to be considered. Not doing this can have dangerous results, especially for very large and complex social policy problems that can have long-lasting effects on many stakeholders. But it is impossible to sweep

all possible perspectives into the analysis (Churchman, 1979), so difficult boundary judgements must be made. These boundary judgements should be made with critical thought and discussion among those stakeholders impacted by potential actions (Ulrich, 1988a,b; Midgley, 1992a, 1994, 2000; Ulrich & Reynolds, 2010). More on the importance of critiquing boundary judgements and the methods developed to deal with the conflict that arises from setting boundaries can be found in chapter 5.

3.1.4 What happens to wicked problems over time?

Although tame problem solutions might change slowly over long periods of time, they can be improved by knowledge already acquired (Wexler, 2009). But wicked problems, because of their multidimensional and interconnected characteristics, can unfold in unpredictable, multiple, and sometimes rapid ways across space and time. Rittel and Webber (1973, p.163) discuss the temporal dimensions of wicked problems: ‘‘The full consequences cannot be appraised until the waves of repercussions have completely run out, and we have no way of tracing the waves through all the affected lives ahead of time or within a limited time span.” Therefore surprises, fluctuations, and sudden changes are common occurrences in wicked problems (Termeer, Dewulf, Breeman & Stiller, 2013). So even when a way forward might be decided, trouble can often arrive later when further ‘solutions’ are advanced after action has already been taken, and stakeholder conflict opens up again (Wexler, 2009). Also, different time horizons of the problem might matter differently to each of the stakeholders (Conklin, 2001; Midgley & Shen, 2007; Hodgson, 2013, 2016; Hodgson & Midgley, 2014; Helfgott, 2018; Midgley, et al., 2018), which brings up the issue of value judgements again. Does the analysis work for short term gains for certain stakeholders in lieu of the long-term negative impacts of others? Certainly, this is a common occurrence as governments and policy-makers grapple with wicked problems.

3.1.5 Wicked by Any Other Name

It should be noted that other researchers have used alternative terms to differentiate and reconcile those problems that cannot be addressed by first-wave approaches. Around the same time that Rittel and Webber’s article was published, Russell Ackoff was also describing problem complexes or systems of problems that do not lend themselves to decomposition (Ackoff, 1973). He refers to them as ‘messes’ and emphasizes that problems that exist within messes are interdependent and interact with each other (Ackoff, 1979b). Therefore, managers do not solve problems, but instead manage messes. Ackoff (1979b) goes on to point out that, because messes

are highly dynamic and interdependent, they require on-going learning and not analytical optimization.

Also, in the early 1970s, other authors gave still further alternative names to this unruly class of problems. Simon (1973) described 'Ill-structured problems' (ISPs). He contrasted these problems with well-structured problems (WSPs). Simon puts some conditions on what can be considered a WSP but admits that these criteria are not absolute. Essentially, Simon outlines very similar criteria as Rittel and Webber use to describe tame problems. He argues that the problem domains most explored with 'mechanical' (first-wave) techniques do not actually meet the criteria for WSPs.

Peter Checkland (1972) uses the term 'problem situations' to refer to situations characterized by humans seeking purposeful action. Like Churchman, Ackoff, and Rittel and Webber, Checkland also felt that there was a substantial difference between first-wave theory and putting that theory into practical application in real-world situations. Checkland (1981) did not adhere to the first-wave assumption that systems (or sets of interacting systems) exist in the world external to humans, and that improving them was a matter of engineering them to work better, but instead took the term 'system' to mean an interrelated set of actions to be taken in a very complex problematical world. As will be discussed in the next chapter, not only did Checkland describe problem situations, but he also began to outline what new methods a second-wave systems thinking movement would need to provide in order to start addressing this class of problem (discussed in more detail in Chapter 5). Mingers (2008) also uses the term 'problem situation' instead of 'problem' and describes these situations in terms of intractability. He also says they require a process of learning and negotiation, which is an emphasis he picked up from his mentor, Checkland (1981).

Schön (1987) coined the term 'swampy lowlands' for confusing messes where technical solutions are not possible. Swampy lowlands contrast with the hard, high grounds of research-based theory and technique. Schön contends that the high ground is of relatively little social importance, whereas the swampy lowland is where the real challenging problems lie.

3.2 Policy and the Wicked Problem

While not all policy problems are wicked, many are, and they may fall into the public domain, or more frequently require multi-sector, synergistic engagement (e.g., bringing together public, private-, voluntary- and/or community-sector organizations, often working at different scales).

Head (2008) reasons that the attraction of the 'wicked problem' concept is that it provides an explanation for why so many policies and programs are controversial, difficult to manage, and often do not reach the goals set out for them (or worse, generate unexpected side-effects). Certainly, reductionist discourses about problems in the public sector stress the capabilities of governments to cope with them. However, wicked problems are the bane of authoritarian, top-down strategies. Since so many wicked problems cross agency, stakeholder, jurisdictional, political and geopolitical boundaries, they often confound government departments that are designed to address problems that align nicely within their bureaucratic boundaries.

Wicked problems cannot be broken down into parts and solved independently within the silos of government. Discrete root causes and their effects are very hard to identify, and government decision makers charged with 'solving' these problems often become frustrated with how the problem changes and evolves in non-linear ways. Fuerth and Faber (2012) emphasize how complicated problems are easily identifiable and fall within bureaucratic boundaries, but wicked problems span across such boundaries and organizational missions.

Policy makers struggle with wicked problems because (1) they have a tendency to jump to simple short-term solutions, so frequently fail to take the time to adequately understand the problem (Rittel & Webber, 1973; Australian Public Service Commission, 2007; Head & Alford, 2015); (2) they find it difficult to escape the culture of top-down decision making, where a few people with an inadequate understanding of the complexity have the authority to mandate action, and this is uncontested within their organizations but contested by other agencies (Roberts, 2000; Andersson, Törnberg & Törnberg, 2014); and (3) in the absence of adequate understanding, they often end up relying upon ideological judgments and are also prone to succumb to external pressures, particularly to restrict the allocation of time, money and patience (Rittel & Webber, 1973). Indeed, Head and Alford (2015) claim that politicians typically take one of three approaches when faced with wicked problems. Some like to be seen as 'decisive' and are zealous about taking action. Others are overly cautious and cannot commit to tackling something as unstructured as a wicked problem. However, the majority focus on parts of the issue, rather than tackling the whole problem, which is an approach reinforced by administrative and budgeting processes that insist on government departments designing discrete interventions with relatively simple and unambiguous measures of success.

3.2.1 "Super" Wicked Problems

Recently, the concept of 'super-wicked problems' has been introduced. Much of the focus on super-wicked problems seems to stem from frustration over the short-sightedness of policy makers in combating global issues like climate change (Lazarus, 2008; Levin et al., 2009, 2012). The term 'super wicked' was first used by Levi et al. (2009) in their paper calling for an applied forward-reasoning approach to environmental problems (like climate change) that have contingency, uncertainty, and long-time-horizons. Lazarus (2008) explains that climate change is defined as a super-wicked problem, not only because the climate science says there is an issue of concern, but also because of the nature of U.S. law-making institutions that seem unable to formulate an appropriate response to this science.

Levin et al. (2012) say that super-wicked problems have four properties over and above a 'normal' wicked problem: (1) a sense of urgency and/or a feeling that time is running out; (2) those looking for solutions are actually responsible for creating the problem in the first place, or allowing it to emerge, and might want to hide this fact; (3) the institutions needed to address the problem are weak or non-existent at the appropriate scale; and (4) irrational discounting occurs that continually pushes responsibility for acting into the future. Levin and colleagues believe that, together, these features describe the tragedy of our governance institutions and the policies they generate or fail to generate (also see Calvelli (2011) writing about 'massively wicked problems').

This recent interest in super-wicked problems is reminiscent of the Club of Rome, which was formed in 1968. Its founders set out to foster an understanding that the global system is made up of interdependent economic, political, natural, and social components, which must be addressed together systemically. Laouris and Michaelides (2018) explain that, in its original vision, the Club of Rome was strongly focused on the democratic participation of the world's population in formulating both an understanding of the predicament of humankind and potential ways forward, although later it refocused on more technical, expert-led modeling of the interactions between an array of global issues (e.g., Meadows et al., 1972). The Club of Rome's term for the complex of interacting problems that were common to all nations was the 'world problematique' (now most often called the 'global problematique'), which included highly intractable issues such as poverty, environmental degradation, urban sprawl, unemployment, and the alienation of youth. Like super-wicked problems, the world problematique was described as having such complexity that addressing it was beyond the capabilities of traditional institutions and policies.

In addition, because policy makers are a part of the wicked problem and one of the key stakeholders, their perspectives (given budgets, politics, power, etc.) should be included in structuring a problem like climate change, but not exclusively. Perhaps the issue of being 'super wicked' really just comes back to the boundary judgment issue. It may be that solving those wicked problems that are left primarily to the purview of governments do not adequately involve enough stakeholders. Government officials and policy makers can make judgements based too much on politics and governmental pressures, although sweeping in stakeholders and communities in a way that excludes or marginalizes policy makers is problematic too (Midgley & Milne, 1995). Again, poor stakeholder engagement (see Gregory, Atkins, Midgley & Hodgson, 2020, for a new systems perspective on stakeholder identification and engagement) is a danger for all wicked policy problems, and I'm not sure that creating a new class of super wicked problems is as productive as putting the emphasis on methods that can address conflicts over boundary judgements.

3.3 Managing Wicked Problems

The dynamic nature of wicked problems requires planners and decision makers to be highly adaptive and to change their mindset to 'managing' wicked problems. This concept of 'managing' versus 'solving' wicked problems is important because decision-makers cannot expect neat technical solutions to wicked problems but will instead need to deal with them as an on-going learning and adaption process (Ackoff, 1979a,b; Mingers, 2008). Norton (2012, p.43) describes the process this way:

> "There is no substitute for open, ongoing, public discourse in which values are expressed and criticized, in which all assumptions are challenged, and all of our models are supplemental, and recognized as partial, possibly useful tools, but useful ultimately within a public discourse in which problems are formulated, reformulated and hopefully acted upon."

Rittel (1972) also proposes re-thinking the use of short-term projects, and suggests a slower, argumentative process of critique that allows the image of the problem (and the solutions) to evolve over time and shift in response to learning-in-action. Organizations tasked with dealing with wicked problems need to become continuous learning systems capable of constant innovation and recalibration (Waddock, Meszoely, Waddell & Dentoni, 2015). Other researchers have emphasized the need for organizational learning and adaptation when dealing with wicked problems (Beer 1979, 1981, 1985; Checkland, 1981; Head & Alford, 2015; Schwaninger, 2000).

3.4 The Interagency and the Wicked Problem

The U.S. government organization chart (Figure 3.1) illustrates how the government is divided into branches, departments, and other independent government establishments and government corporations. The term for a U.S. federal government agency, as used in this thesis, refers broadly to any government organizational entity below the Executive Branch, including departments. 'Agencies' also refers to regional, state, and local governmental organizations. The term 'interagency' refers to the coordinated activities across two or more government agencies, which can span across or sit over government jurisdictions. Talking about 'coordinated activities' does not imply that an interagency is a formally constituted organization with its own budget: it might just as easily be a voluntary alliance between organizations, where resources and intelligence are pooled for a given set of purposes (see Midgley et al., 1997, for an example of a project in which three statutory bodies decided to form just such an alliance).

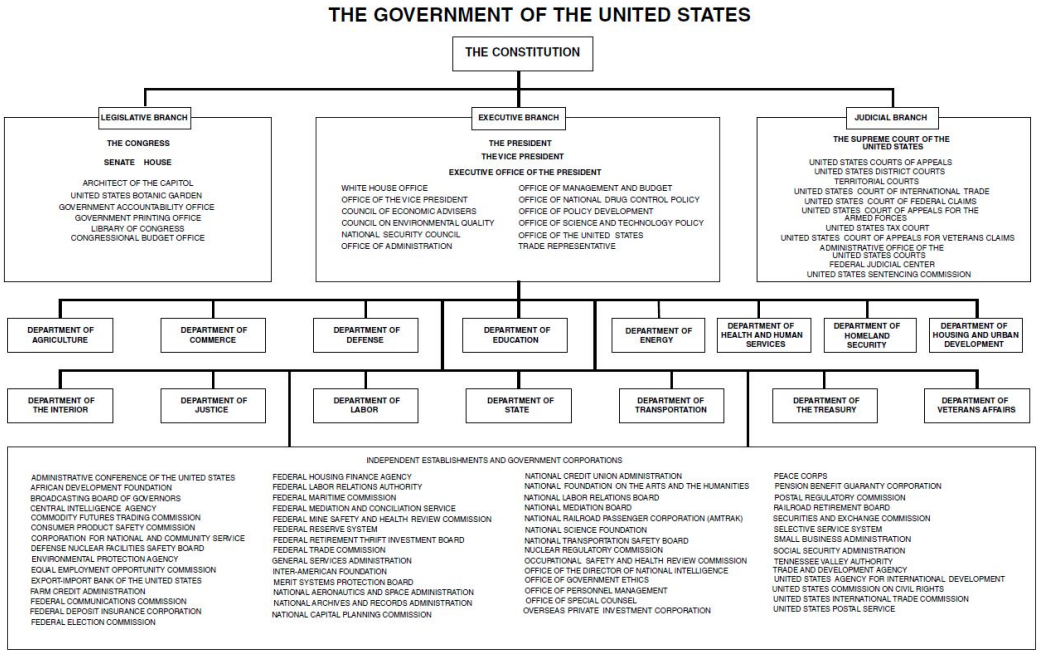

Figure 3.1: U.S. Government Organization Chart (Accessed from https://www.usgovernmentmanual.gov/, April 29, 2019)

3.4.1 Challenges to Multiorganizational Collaboration

There have been many articles stressing the challenges to collaborating across organizations. Bryson, Crosby, Middleton and Stone (2006) extensively review literature on this subject. They provide a framework for understanding cross-sector collaboration, and offer 22 propositions that need to be addressed for success:

"Proposition 1: Like all interorganizational relationships, cross-sector collaborations are more likely to form in turbulent environments. In particular, the formation and sustainability of cross-sector collaborations are affected by driving and constraining forces in the competitive and institutional environments." (Bryson, et al., 2006, p.46)

"**Proposition 2**: Public policy makers are most likely to try cross-sector collaboration when they believe the separate efforts of different sectors to address a public problem have failed or are likely to fail, and the actual or potential failures cannot be fixed by the sectors acting alone." (Bryson, et al., 2006, p.46)

"**Proposition 3**: Cross-sector collaborations are more likely to succeed when one or more linking mechanisms, such as powerful sponsors, general agreement on the problem, or existing networks, are in place at the time of their initial formation." (Bryson, et al., 2006, p.46)

"**Proposition 4**: The form and content of a collaboration's initial agreements, as well as the processes used to formulate them, affect the outcomes of the collaboration's work." (Bryson, et al., 2006, p.47)

"**Proposition 5**: Cross-sector collaborations are more likely to succeed when they have committed sponsors and effective champions at many levels who provide formal and informal leadership." (Bryson, et al., 2006, p.47)

"**Proposition 6**: Cross-sector collaborations are more likely to succeed when they establish- with both internal and external stakeholders-the legitimacy of collaboration as a form of organizing, as a separate entity, and as a source of trusted interaction among members." (Bryson, et al., 2006, p.47)

"**Proposition 7**: Cross-sector collaborations are more likely to succeed when trust-building activities (such as nurturing cross-sectoral and cross-cultural understanding) are continuous." (Bryson, et al., 2006, p.48)

"**Proposition 8**: Because conflict is common in partnerships, cross-sector collaborations are more likely to succeed when partners use resources and tactics to equalize power and manage conflict effectively." (Bryson, et al., 2006, p.48)

"**Proposition 9**: Cross-sector collaborations are more likely to succeed when they combine deliberate and emergent planning; deliberate planning is emphasized more in mandated collaborations and emergent planning is emphasized more in nonmandated collaborations." (Bryson, et al., 2006, p.48)

"Proposition 10: Cross-sector collaborations are more likely to succeed when their planning makes use of stakeholder analyses, emphasizes responsiveness to key stakeholders, uses the process to build trust and the capacity to manage conflict, and builds on distinctive competencies of the collaborators." (Bryson, et al., 2006, p.48)

"**Proposition 11**: Collaborative structure is influenced by environmental factors such as system stability and the collaboration's strategic purpose." (Bryson, et al., 2006, p.49)

"**Proposition 12**: Collaborative structure is likely to change over time because of ambiguity of membership and complexity in local environments." (Bryson, et al., 2006, p.49)

"**Proposition 13**: Collaboration structure and the nature of the tasks performed at the client level are likely to influence a collaboration's overall effectiveness." (Bryson, et al., 2006, p.49)

"**Proposition 14**: Formal and informal governing mechanisms are likely to influence collaboration effectiveness." (Bryson, et al., 2006, p.49)

"Proposition 15: Collaborations involving system-planning activities are likely to involve the most negotiation, followed by collaborations focused on administrative-level partnerships, structures and service delivery partnerships." (Bryson, et al., 2006, p.50)

"Proposition 16: Cross-sector collaborations are more likely to succeed when they build in resources and tactics for dealing with power imbalances and shocks." (Bryson, et al., 2006, p.50)

"Proposition 17: Competing institutional logics are likely within cross-sector-collaborations and may significantly influence the extent to which collaborations can

agree on essential elements of process, structure, governance, and desired outcomes." (Bryson, et al., 2006, p.50)

"**Proposition 18**: Cross-sector collaborations are most likely to create public value when they build on individuals' and organizations' self-interests and each sector's characteristic strengths while finding ways to minimize, overcome, or compensate for each sector's characteristic weaknesses." (Bryson, et al., 2006, p.51)

"Proposition 19: Cross-sector collaborations are most likely to create public value when they produce positive first-, second-, and third-order effects." (Bryson, et al., 2006, p.51)

"Proposition 20: Cross-sector collaborations are most likely to create public value when they are resilient and engage in regular reassessments." (Bryson, et al., 2006, p.51)

"**Proposition 21**: Cross-sector collaborations are more likely to be successful when they have an accountability system that tracks inputs, processes, and outcomes; use a variety of methods for gathering, interpreting, and using data; and use a results management system that is built on strong relationships with key political and professional constituencies." (Bryson, et al., 2006, p.52)

"**Proposition 22**: The normal expectation ought to be that success will be very difficult to achieve in cross-sector collaborations." (Bryson, et al., 2006, p.52)

The final proposition seems appropriate given the sheer magnitude of challenges that studies have stated need to be overcome. In particular, attempts to create mechanisms for interagency working have often resulted in dissatisfaction – and worse, ineffectiveness. Major criticisms are particularly of existing mechanisms for interagency collaboration. There have been a few studies in the UK assessing the joined-up government (JUG) that was initiated in Tony Blair's New Labour administration, which was aimed at reducing contradictions, duplications and fragmentations in policy delivery that came from traditional siloed government (Pollitt, 2003). In a review of JUG, Pollitt (2003) suggests that JUG can be very beneficial if done right, but the risks are great. One of these risks is the higher expense that comes from delays, plus higher transaction costs. Pollitt also refers to a UK Cabinet Office's review (Cabinet Office, 2000) of cross-cutting issues, which argues that JUG can blur lines of accountability, make measuring effectiveness and impact more difficult, and result in greater opportunity costs. He also provides a summary of his literature

review and concludes that, if the benefits of JUG outweigh the risks, JUG should be regarded as a long-term project, a selective project, and a cooperative project.

Ling (2002) also looks at the Blair Government's JUG, particularly in terms of responding to wicked issues (described by Clarke & Stewart, 1997) that require holistic thinking across organizational boundaries, engagement with public stakeholders, the motivation to work in new ways, and a capacity for learning-style governance. Ling reviews the literature on 'best practices' and finds conflicting and competing strategies. He emphasizes that, no matter the strategy, to developing JUG to address wicked problems, it must include a clear understanding of the problem first.

Many studies focus on organizational culture as a key factor influencing interagency collaboration (e.g., Kim & Lee, 2006; Yang & Maxwell, 2011; Zhang & Dawes, 2006). Weare, Lichterman & Esparza (2014) report that cultural differences between agencies impede collaboration, even when organizations share similar policy goals. Cohen (2018) finds that fragmentation in law enforcement culture plays a critical role in hampering the success of interagency collaboration. In a review of Operation Warp Speed (OWS), a U.S. collaborative effort to develop vaccines to prevent COVID-19, Sachs (2021, p. 89) found three key ways to enhance interagency collaboration in the innovation policy space: "exploring the role of agenda-setting power, appreciating the importance of organizational structure, and establishing a culture of collaboration". Sachs's (2021, p. 99) review paper quotes Dr. Nancy Messonier (Center of Disease Control), who describes collaborative difficulties that come from "rapidly mashing together two cultures," and Sachs concludes that OWS administration was negatively impacted.

In a Canadian study on working horizontally in government, Bakvis & Juillet (2004) describe four case studies in which the authors explore the driving factors for working horizontally, while still maintaining vertical accountability. These authors found that, for large-scale projects, there is often resentment and competition between departments working in the same policy space. By examining the four case studies, this study found that personality and leadership aspects of working across departments were critical, and that the chemistry between individuals has a heavy impact on the success of a multi-departmental initiative. They also found that horizontal working also requires additional funding.

In another review study, Warmington, Daniels, Edwards, Brown, Leadbetter et al. (2004) concluded that most strategies do not adequately counter social exclusion and lack learning processes. They also argue that many studies tout the virtues of 'joining up' to address social problems, but under-acknowledge the tensions and contradictions that it brings, rather

than an ideal model of service delivery. Later, many of these authors participated in a follow-up study on addressing the need to work responsively across professional boundaries (Daniels, Leadbetter, Warmington, Edwards, Martin et al., 2007), because JUG can pose challenges to the way professionals are used to working. JUG can cause issues in the area of expertise and specialist knowledge: how these are claimed, owned and shared can be contested, so crossing boundaries requires not only knowing 'what' others do, but 'why' they operate as they do. These authors argue that coordination between professions from different organizations needs a vehicle that is flexible, responsive, and promotes learning.

Another term for JUG is 'whole-of-government'. Christensen and Lægreid (2007) look at whole-of-government and suggest substantial challenges. First, they argue that the siloed form of government was developed because of the benefits of differentiation of labor and specialization. In contrast, working horizontally can be expensive in terms of time and resources. In addition, there are accountability and risk management concerns when instituting whole-of-government, especially when joint action, common standards, and shared systems are required alongside the vertical accountability for individual agency performance. Ansell and Gash (2008) contend that whole-of-government requires face-to-face dialogue, trust building, and the development of commitment and shared understanding. They suggest a virtuous cycle of collaboration with 'small wins' along the way. Bardach (1998) also stresses the importance of leadership and trust.

Kettle (2006) emphasises that the need to work across boundaries becomes more urgent as we face interconnected wicked problems, and mission, resources, capacity, responsibility, and accountability need to be addressed. Working across boundaries to address wicked problems brings uncertainty and disagreement on what the problem even is. It also requires the development of new skills and new strategies. But wicked problems necessitate complex, interdependent responses. Weiss (1987) also argues that, despite significant transaction costs, a whole-of-government approach is absolutely necessary for addressing highly complex problems that cross interagency boundaries. He emphasizes that the benefits (such as resource sharing, 'political' integration, and reduced uncertainty) outweigh the costs.

Agranoff (2006), after conducting an empirical study of 14 networks, also provides insights for working inter-organizationally. He suggests that networks will certainly not crowd out individual agencies, but can have real value when addressing complex policy and program problems. Networks can be largely self-organizing, but must be managed like an organization. They require strong data/information/knowledge sharing mechanisms. Often at issue is that these

networks rarely have formal powers, although they can make a difference through knowledge-enhancement.

Roberts (2000) explores different strategies that public officials and managers employ specifically to cope with wicked problems. Using a case study of the relief and recovery efforts in Afghanistan, Roberts explains that a collaborative strategy (as opposed to authoritative or competitive strategies) results in a win-win view of problem solving rather than a 'zero-sum game'. While Roberts argues that the collaborative approach is the best strategy, she nevertheless emphasizes that it requires getting the 'whole system in the room' to enable mutual appreciation and useful learning.

Another challenge to successful interagency responses to complex problems lies in data and information exchange. Much of the academic literature on this addresses technological issues involved in interagency collaboration, such as network reliability, data security, data ownership, interoperability, and shared standards (Jarvenpaa and Staples, 2000; Landsbergen and Wolken, 2001; Soliman and Janz, 2004; Henning, 2018; Cavalcante, Fialho, Marotta & Ishikawa, 2022). However, Joyal (2012), in a study of U.S. state fusion centers, emphasizes that, although data and technological incompatibility pose a threat to successful interagency working, it is trust, reciprocity, and genuineness that are key to a sharing interagency environment.

3.4.2 Approaches to Interagency Collaboration

Despite the many challenges to achieving cooperative and collaborative interagency working, various approaches have been devised to enable coordination or attempt to gain some control over wicked problems.

In a study on the formation of security networks as part of interagency capability, Whelan (2017) distinguishes between cooperation, coordination, and collaboration, and puts these on a continuum. The difference between these relate to the strength of the ties between agencies, with the performance of the network increasing from coordination to collaboration. The study finds that collaboration, with greater-intensity ties between network members, is the most effective interagency construct. Therefore, recommendations from this study include "selecting people to work in networks that naturally develop and maintain positive relationships, ensuring a stable membership with minimal staff turnover and creating opportunities for members to develop shared experiences" (Whelan, 2015, p. 325).

One common approach in the U.S. is to employ Czars (or Tsars). The term 'Czar', although somewhat ill-defined in U.S. government, refers to personnel with the task of overseeing specific policies and coordinating inputs from across government and private entities (e.g., Sholette, 2010; Smith 2011; Vaughn & Villalobos, 2015). Czars are often responsible for forming high-level committees, working groups or task forces made up of representatives from agency organizations (e.g., Pike, 2002; Chaudhri & Samson, 2000). There are also committees and task forces that are not run by an appointed Czar but are typically put under the authority of an individual from a single agency who is deemed the most knowledgeable about the subject.

In addition, individual agencies will often have a dedicated sub-unit in charge of establishing and maintaining partnerships with other agencies. For instance, the Federal Bureau of Investigation (FBI), the Federal Drug Administration, and the U.S. Department of Agriculture each have an 'Office of Partner Engagement'. Curnin, Owen, Paton, Trist & Parsons (2015) looked at the use of liaisons to enable interagency collaborations and found that this approach had greater effectiveness when roles in the collaboration, especially for the liaison function, are clearly defined.

But these approaches are relatively ad hoc, with no rulebooks or established processes for how Czars, task forces, committees, or partnership offices should approach highly complex problems. In addition, they are usually organized around an 'expert' leader with few processes that formally gather and incorporate the perspectives of multiple stakeholders.

3.5 Wicked Problems Require New Systemic Approaches

Rittel and Webber (1973) stress that wicked problems are hard to define, partly because they are framed by different stakeholders in different ways. First-wave systems approaches do not have mechanisms for dealing with this issue. Simon (1973), when discussing ill-defined and well-defined problems, felt optimistic that existing first-wave approaches could be augmented with computerized tools, like large long-term memory capable of continuously updating the problem space, natural language to directly translate problem statements into problem structures, and artificial intelligence for interfacing with and collecting information about the outside world.

However, for multi-organizational collaborations to attempt tackling these complex social wicked problems, new systemic methods are needed to help people work collectively toward a common problem specification while retaining agency autonomy. They must be able to directly address issues like synchronization, overlapping goals and missions, divergent perspectives of the problem,

and how to allocate power and authority where it is needed. Different stakeholders will have different functions, goals, purposes, and choices. Because capturing stakeholder perspectives when defining the problem was considered so important to the ethical analysis of large, complex, social systems and wicked problems, Churchman, Ackoff and Checkland continued down a path toward what Rittel and Webber (1973) called 'next-generation' systems approaches. These next-generation systems approaches are now called second-wave systems approaches and will be discussed in the next chapter.

3.6 Summary

Horst Rittel and Melvin Webber wrote their seminal article (Rittel & Webber, 1973) because they too were struggling with the afore-mentioned issues with first-wave approaches. Their article likely generated a real 'aha!' moment for many in the design and planning fields who were experiencing the same frustrations. Although other names for these problems have been offered, the 'wicked problems' terminology seems to have gained most traction and is still widely used in many fields. As discussed earlier, there is even a movement to have the term 'super-wicked' problem accepted, highlighting the need to address the political issues that arise with wicked problems. Perhaps 'wicked problems' gained traction because the term was thought to be coined by authors outside the systems thinking and OR communities (Rittel and Webber), who were regarded as mainstream social scientists with a policy specialism; or perhaps 'wicked' is a metaphor that conjurers up images of dark, dangerous problems that many find intriguing; or maybe it was simply because Rittel and Webber provided a practical and convenient checklist for determining if you had a wicked or tame problem on your hands.

In this chapter, I have discussed the significance of wicked problems in public policy and governance, particularly examining how they challenge the formation of interagency responses. Interagency collaboration might appear costly, time-consuming, and difficult to operationalize, but many authors also make the case for why, with wicked problems, some sort of cross-agency and cross-sector coordination is crucial. Finally, I ended the chapter by examining the profound arguments in the 1970s from respected systems thinkers, and the urgent plea from the planning and design community, for a next-generation of systems thinking that could more successfully address wicked problems and help governments to design new ways to bring cross-agency talent and resources together.

Chapter 4: Second-wave System Thinking – Engaging Stakeholders

The cautionary voices regarding the ethics and effectiveness of using first-wave systems approaches for highly wicked social planning problems resulted in a desire for new systems approaches that can consider multiple worldviews and directly bring stakeholders into the problem-defining and intervention-planning processes. The criticisms leveled at first-wave approaches (reviewed in Chapter 2) began a paradigm shift in both the OR and systems thinking communities. Checkland (1983) calls this period of shifting ideas the "OR crisis" (p.661), and he argues that there is a big gap between first-wave theory and first-wave practice in real-world situations. He contends that first-wave theorists fail to handle real-world situations well enough because they fear that bringing individual and social perspectives (with their impacts on human behavior) into systemic processes would make those processes appear unscientific.

New approaches began to evolve in response to first-wave criticisms. These approaches have been called 'second-wave' approaches (Midgley, 2000, 2003a, 2006b), a term that will be used in this thesis. Second-wave approaches do not consider the practitioner to be the expert about the problem, but more of a facilitator who enables systemic learning by stakeholders (Checkland & Winter, 2006). Systems are not viewed as real world entities that would continue to exist as observed, even without the presence of that observer (Checkland, 1981); rather, they are seen as inseparable from humans, human behavior and human observation. Midgley (2000) recognizes the second-wave systems pioneers for their bold stance, as their new approaches greatly deviated from the prevailing observational neo-positivist philosophies typical of first-wave systems thinking (Midgley & Richardson, 2007).

The second-wave systems methodologies were designed to address several properties of wicked problems, such as multiple stakeholder perspectives on both means and ends, which the first-wave approaches were weaker on. Furthermore, they require acceptance that wicked problems have no optimum solution, but that continual learning and adaptation need to become goals (Checkland, 1981). This chapter will cover second-wave systemic approaches proposed by members of both the systems and OR communities, and their advantages of these approaches when dealing with wicked problems.

4.1 Second-wave Terminology

The second-wave paradigm shift happened simultaneously in both the systems thinking and OR communities. However, the methodologies associated with it came to be called different things in the two communities: 'soft systems thinking' in the systems community (e.g., Jackson, 1982), and problem structuring methods (PSMs) in the OR community (originally it was Soft Operational Research, but this early term was abandoned by many people who didn't want to perpetuate the divisive soft/hard distinction). The term 'Problem Structuring Methods' was first coined by Pidd and Woolley (1980) and Pidd (1988) to describe processes used to gain sufficient understanding of the dimensions and symptoms of a problem that lead to the involvement of an analyst and to some sort of formal modeling. Rosenhead (1989) and Rosenhead and Mingers (2001) then picked up the term and used it in a different way, to refer to a family of methods that are used to gain a shared understanding of a problematic situation where there is a high level of complexity, uncertainty and pluralism of perspectives.

There are second-wave approaches that are explicitly systemic (Jackson, 2000; Midgley, 2000, 2003a). They focus on both supporting 'bigger picture' analyses (Midgley, Cavana, Brocklesby, Foote, Wood, et al., 2013). Within the systems community, these new second-wave methodologies were termed 'soft systems thinking (SST)' which places emphasis on the value of these systems ideas. Foote et al. (2007) proposed the label 'systemic problem structuring' because these approaches support learning about how issues interact across stakeholders' initial boundaries of concern. Systemic PSMs are used to facilitate the creation of new framings, strategies and actions (Midgley et al., 2013). Because the terminology from the systems/OR communities around PSMs, soft OR, soft systems thinking, and systemic PSMs is so varied, the term 'second-wave systems approaches' will be used in this thesis to encompass all four previous terms, as it fits with Midgley's (2000, 2003a, 2006b) wave metaphor, and is general enough to refer to all these types of methodology.

4.2 Second-wave Methodologies

So, the term 'second-wave systems thinking' refers to a family of methodologies and methods that are used to gain a shared understanding of a problematic situation where there are high levels of complexity, uncertainty and/or conflict (Rosenhead & Mingers, 2001). Jackson (1982) emphasizes that second-wave approaches are underpinned by the 'interpretivist social paradigm' which Burrell and Morgan (1979) describe as a paradigm understands the social world as

consisting of subjective and intersubjective experiences, with explanations of social behavior and actions stemming from the perspectives of participants (i.e., they are not objective). Therefore, second-wave approaches use qualitative methods focusing on how reality is interpreted by stakeholders with differing worldviews (Jackson, 2006).

Rosenhead (2006, p.1) describes the characteristics of problematic situations where second-wave approaches can be used:

- "multiple actors
- differing perspectives
- partially conflicting interests
- significant intangibles
- perplexing uncertainties"

In second-wave approaches, multiple stakeholder perspectives are usually brought together in participative workshops to provide a broadened focus and deeper learning about the problem situation and possible ways to address it (Franco, 2006). While Franco (2013) advocates the use of models as "boundary objects" (p.720), which stakeholders imbue with their own meanings relevant to their different purposes and contexts, he equally emphasizes the importance of the social interactions that evolve during the intervention. Models are used less to 'solve' the problem, and more as 'transitional objects' around which dialogue and improved trust can be constructed (Eden & Sims, 1979; Eden & Ackermann, 2006; Cronin, Midgley & Jackson, 2014).

While second-wave approaches are used to achieve a common understanding of a problem situation and how to act on it, it is important to point out that this is not same as a consensus because it may just be an acceptance of people's differences, and an agreement on some accommodations or next steps forward that can be taken (Checkland & Scholes, 1990; Checkland & Poulter, 2006). That these agreements can be reached is a very significant assumption. In the face of wicked problems, even modest accommodations might be a stretch without significant, facilitated help (Franco, 2007).

There are several second-wave approaches that have emerged from both the OR and the systems thinking community. A review of some of the more pertinent approaches is provided below.

4.2.1 Strategic Assumption Surfacing and Testing (SAST)

Mason and Mitroff (1981) developed a second-wave methodology called Strategic Assumption Surfacing and Testing (SAST), which follows Churchman's (1979) concept of 'dialectic processes'

(which in turn came from Hegel (1807). This methodology addresses the different assumptions, beliefs, and worldviews that exist among stakeholders around highly complex social (wicked) problems. The goal is to surface the assumptions embedded in preferred strategic responses and generate dialogue about them, thereby enabling the evaluation of policies and strategies against alternatives that others are advocating (Mason & Mitroff, 1981). SAST was developed through reflection on a set of case studies with organizations facing unstructured wicked problems, and it involves a four-stage process:

Stage 1 (Group Formation): Mason and Mitroff (1981) believed that in order to address complex problems, as many perspectives as possible should be brought together. However, they also argued that performance suffers in large-group problem-solving. Therefore, the first stage of performing SAST is to divide key stakeholders into several small groups, each group consisting of members with similar perspectives on the strategic solutions that should be considered.

Mason and Mitroff (1981) provide a series of five methods that might be used to make decisions on the working groups to be formed:

1. *Problem-Solving Style*: this method groups people according to how they approach problem solving, with four styles identified: sensing-thinking (ST), sensing-feeling (SF), intuition-feeling (IF), and intuition-thinking (IT). See the literature as referenced for definitions of these terms. The idea is that each of these styles will surface different assumptions.
2. *Basic Philosophy*: this grouping method focuses on bringing stakeholders with similar philosophies together. The idea is that different fundamental belief structures will make different assumptions visible to people.
3. *MAPS (Multivariate Analysis, Participation, and Structure)*: originally developed by Killmann (1977), this method involves asking participants to respond to a series of questions using a scale of 1-7. Computerized cluster analysis is then used to group participants into those likely to agree with each other.
4. *Policy Preference*: this method simply askes participants to rank order identified policies that they prefer, or that they would be willing to argue for.
5. *Issues*: this a detailed method that basically groups participates by their preferred responses to a set of issues.

Stage 2 (Assumption Surfacing and Rating): During this stage, each group develops a preferred strategy which is then discussed by all participates to uncover and analyze key assumptions (Flood & Jackson, 1991a). First, for each strategy, group discussions revolve around delineating the

individuals (or groupings of individuals) upon which the success or failure of the strategy would rely. This process results in a list of key stakeholders. Second, working groups create a list of assumptions that are being made about their strategy. This is accomplished by the members of the workings groups putting themselves in the shoes of each stakeholder, to reflect on assumptions from their perspective. Third, groups rank their assumptions against two criteria: *importance* to success or failure of the strategy and *certainty* (how confident is the group that the assumption is well justified). This stage results in surfacing the most significant assumptions for each strategy: those that are both important and uncertain. Generally speaking, when an important assumption is viewed as certain, there is widespread agreement on it, so there is not much to gain by subjecting it to further analysis; but when it is *uncertain*, further analysis and consequent learning becomes useful to the evaluation of strategic options.

Stage 3 (Dialectic Debate): Once each working group has clearly identified their key assumptions, they present their favored strategy and those assumptions to the larger group (Mason & Mitroff, 1981). Cross-group discussions and debate are generated around the assumptions to thoroughly question and strongly critique all assumptions arising from the groups. This process can result in immediate agreement on assumptions, but most often, assumptions are challenged, changed, and reworked though negotiations among participants.

Stage 4 (Final Synthesis): Mason and Mitroff (1981) emphasize that, during the assumption surfacing and dialectical debate processes, conflicts will very likely arise, and those conflicts must be revisited and managed during the final synthesis, through cooperation and compromise. This synthesis stage is designed to result in a final, agreed set of assumptions, after which an overall strategy can be created that is compatible with those assumptions. It might be that one of the original strategic options is chosen, but more often the participants create some kind of synthesis of ideas from different options (Flood and Jackson, 1991c). Arguably a weakness in Mason and Mitroff's (1981) description of this phase is that they do not specifically prescribe how to overcome conflicts to achieve a unified decision on the path forward.

Mason and Mitroff (1981) describe the successful use of SAST in practical application. However, they identify a limitation as being the presumption that participants actually want to have their assumptions surfaced. Another critique is offered by Jackson & Keys (1984), who say that, in practice, SAST requires the researcher to identify strategic options in advance, so the 'landscape' of strategies to be debated is clear, making it difficult to apply to highly-complex wicked problems characterized by a messiness that precludes such early clarity. In addition, although SAST addresses the issue of wicked problems having multiple stakeholders with different perspectives,

it does not address the highly interdependent, systemic nature of these problems (Jackson & Keys, 1984; Flood & Jackson, 1991c).

4.2.2 Interactive Planning and Idealized Design

Russel Ackoff, who argued that first-wave approaches were not adequate for dealing with 'messy situations', began to explore how a new type of systems thinking could provide planners with a better way to manage complex social problems. As part of his analysis, he observed that there are four kinds of managers with different attitudes towards planning, as summarized below (Ackoff, 1974):

1) *Inactive*: these managers are inclined to stick with the status quo and will shy away from changing what the organization is doing. They are also the most likely to be crisis managers because they act only when they are forced to. These managers also tend to organize by committee (like through commissions or task forces). Ackoff argues that this type of management is only useful if an organization is subsidized in some way, as subsidies create an artificial stability in the relationship between the organization and its environment. Organizations that he feels exemplify this type of management are universities, government agencies, and protected private monopolies (although it has to be said that these kinds of organizations are very different today compared with what they were like in the 1970s).
2) *Reactive*: these managers, like inactivists, are resistant to forward-looking change, but work hard to restore a previous state they view as 'better times'. They are most likely to respond to proposed new changes with 'been there, done that'. Organizations with this type of management style prize experience and seniority over innovation and new-idea generators. Ackoff contends that reactivists do not deal well with complexity and are most apt to try to reduce messy problems to simple ones, often with serious consequences.
3) *Preactive*: a preactive manager is not happy with the present or the past and is keen to prepare for the future. While they strive to predict, they believe the future is uncontrollable, so they try to accelerate its arrival in order to impose more control. These organizations prioritize research and development over common sense and intuition, and they are preoccupied with resource allocations and making changes within the system. Ackoff believes that these managers are preoccupied with making plans and pay less attention to implementing them.
4) *Interactive*: interactive planners are idealizers who endeavor to design a desirable future and then plan to bring it about. They believe in experimentation over experience (gaining

the latter is seen as being too slow). They don't live in the past but are not too obsessed with predicting the future either. They believe that no part of the system is immune from change, and organizations should be in a constant state of self-development, self-realization, and self-control. This means a willingness to change system structures, functioning, personnel, organization, and resource use and allocation. Ackoff sees those promoting interactivity as radicals who "desire neither to resist, ride with, nor ride ahead of the tide; they try to redirect it" (Ackoff, 1974, p 27).

It may not be a surprise, given the descriptions of these attitudes towards planning, that Ackoff is a proponent of Interactive Planning (IP), although he concedes that there are times when the other attitudes may be useful. Ackoff (1974) asserts that interactivism can and should assess the consequences of current behavior for both short-term and long-term consequences. While problem solving requires knowledge, planning requires wisdom, which Ackoff emphasizes comes from both the humanities and science. An interactive planner creates the future by "continuously closing the gap between where it is at any moment of time and where it would most like to be" (Ackoff, 2001, p.3).

4.2.2.1 Phases of Interactive Planning and Idealized Design

Ackoff (1974) puts forth four principles of planning practice in support of IP: (1) be participative, by bringing stakeholders into the planning process, including all aspects of the organization, (2) co-ordinate all aspects of the system, 3) integrate by using both strategic and tactical planning, (4) make planning continuous, to accommodate learning and adaptation. Built upon these principles, Interactive Planning can be seen as consisting of two phases, idealization and realization (Ackoff, 2001) each consisting of discrete activities.

1) Idealization-Phase Activities

Formulating the Mess: Ackoff, Magidson and Addison (2006) define a mess as the set of interacting threats and opportunities that an organization faces. The process of formulating the mess endeavors to envision what the future of the organization will be if it continues with its current behavior. The first step is to describe how the organization currently operates, usually through the creation of flow charts to describe the processing of materials through the organization. This is followed by careful assessment of the organization's characteristics and properties that operate to resist change and prevent progress. Next, an exercise in foresight is conducted. Ackoff (2001, p.5) calls it preparing a "reference projection" that will project the future state that would result if no changes

to the current situation were made. Once this is done, a scenario is developed that combines the current state and the reference projection.

Ends planning: This principle is at the center of Idealized Design because it is the process of envisioning what the current organization would look like if it was just the way the participants would want it, subject to a few constraints (Ackoff, 1979a; 1981b). First, envisioned futures should be 'technologically feasible' and not rely on technologies that could have not been invented. Second, the ideas for design have to be 'operationally viable' and realistically sustainable by the organizations that are expected to implement them. And third, designs must be able 'adaptable', capable of rapidly responding to internal and external changes. Designs should also provide for anticipating future changes so that actions can be taken beforehand. These constraints prevent the designs from being utopian (unrealizable) or from preventing future change that might not be predicted in the here and now.

By comparing the definition of the current organization with the idealized one, managers can make plans to close the gap between the two without enacting any destructive behavior discovered in the formulation of the mess. Only after the idealization process is complete can means planning begin to identify the courses of action needed to approximate the Idealized Design.

IP, with its focus on Idealized Design, offers several advantages when creating a system that can manage wicked problems. Mess formulation can be used to assess the state of the wicked problem and how the organization is currently dealing with it. Ackoff (1974) highlights the use of flow-charts in the formulation stage, but other methods that better account for the intricate interdependencies between wicked problem elements could also be used. I particularly like the term 'idealized' because it does not mean 'ideal'. This points to the fact that wicked problems (a.k.a. messes) don't have a recognizable end state, and in fact it is the continuous planning that creates the learning and adaptation needed for wicked problems. Also, the participative means for creating an idealized state brings the differing values of stakeholders to light, but importantly it looks to the future, and Ackoff claims that there is usually more agreement on the desired future than people might expect. There may not be a complete consensus about what the idealized state is, but the process of determining idealized states makes it possible for all perspectives to be heard and integrated.

2) Realization Phase Activities

Means Planning: this activity requires the creation of the courses of action that are needed to realize the Idealized Design in practice and avoid the destruction described in formulating the mess (Ackoff, Magidson & Addison, 2006). This can include the development of new policies, practices, projects, or programs.

Resource planning: resources will be needed to achieve a design that approximates the ideal. This activity determines what resources (for example, people, equipment, materials, funding, or space) will be needed, how much of them are needed, how they will be acquired, and how are they are to be allocated (Ackoff, 1997).

Design of implementation: this activity requires the production of an implementation plan that determines who is to carry out which task and where will that task take place. This plan should include a task schedule and spell out the allocation of resources to each task (Ackoff et al., 2006).

Design of controls: in this final activity, the specifics of how to implement decisions and control them is decided (Ackoff, 1997). This can include how to monitor tasks to ensure they remain on schedule and in budget, and to check that they are producing the expected results (Ackoff et al., 2006). The design of controls also determines how to maintain and improve the plan under changing internal and external conditions (Ackoff, 1997).

4.2.3 Soft Systems Methodology

Soft Systems Methodology (SSM) is a career-long endeavor by Peter Checkland to find ways to help practitioners practice systems thinking in real-world problem solving (Checkland, 1972, 1981,1983, 1985,2000). Like Rittel and Webber (1973), Checkland (1972) argued that a systems approach is needed to deal with situations where objectives are hard to define, there is a great deal of uncertainty, and measures of performance have to be qualitative. Over time, as he began to develop his ideas about such an approach, a distinction began to evolve between first-wave systems thinking and what Checkland began to see as a circular learning cycle (Checkland, 1981, 1985a) where theory begins to inform practice and practice feeds back to theory with enriched ideas.

In conceiving of SSM, Checkland (1985a) adopts Vickers's (1968, 1984) concept of 'appreciation' where a set of conceptual models about the world can be developed and then compared against the problem situation (as expressed by different people). The process of comparison reveals the norms and values present in the problem situation and generates learning and when conveyed as a cycle, this learning can be continuous.

Checkland emphasizes that SSM is a methodology, not a method. He defines a methodology as a "set of principles of method which in any particular situation have to be reduced to a method uniquely suitable to that particular situation" (Checkland, 1981, pp.151-162). Checkland (1985a) also questions the notion that a methodology can be divorced from theory, given that any form of practice is heavily steeped in theory, even when the participants don't realize it because the theory has been developed in the past and has become implicit. He argues that the set of ideas about a problem are linked to (but should be differentiated from) the process (methodology) for applying those ideas in practice. In 1985, he created a model to illustrate this organized use of rational thought (Figure 4.1).

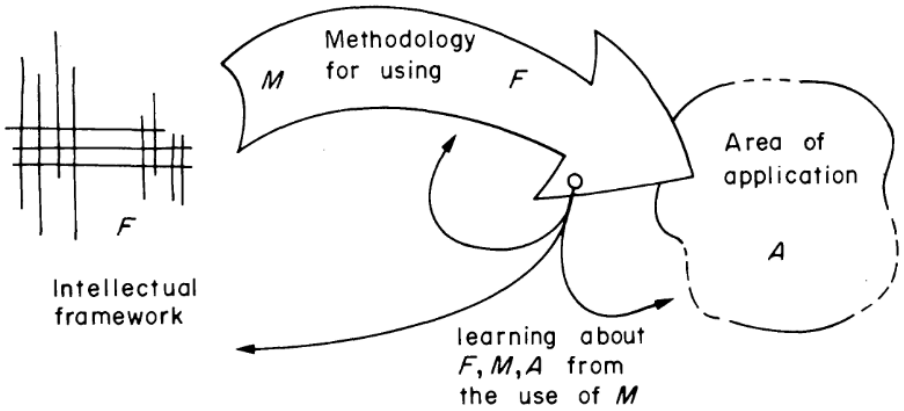

Figure 4.1: The organized use of rational thought from Checkland, 1985a, p.758)

Figure 4.1 shows how the framework of ideas (F) is used in a methodology (M) that is applied to an application area (A). Even if F consists of well-tested ideas and theory, using a methodology in an application area that consists of human activities can produce unexpected results. This is why the boundary of application area (A) in Figure 4.1 is drawn with a broken line). For systems thinking, where A is the rational intervention in human affairs and F is the body of systems ideas and theory, M is the methodology chosen to move from theory to intervention. The entire process generates learning about all three elements. Not only does a methodology (M) use ideas and theory (F) to better understand the application area (A), but the process of applying the methodology can result in learning about the theory.

SSM has developed over thirty years into one of the most widely used second-wave approaches, and a series of articles and books chronical this evolution of SSM (Checkland, 1972, 1981, 1983, 1985a,b; Checkland & Sholes, 1990; Checkland & Holwell, 1998; Checkland & Poulter, 2006, Checkland & Winter, 2006). Checkland also provides a review of the 20th Century aspects of that evolution in Checkland (1999).

4.2.3.1 Seven-Stage SSM

The first instantiation of the SSM (even before the term SSM was used) is what Checkland calls 'Blocks and Arrows' where systems practice is expressed as a series of steps for use in action research. This approach later solidified into the 'seven-stage methodology' (4.2). The diagram outlines seven stages that are divided into two domains: the real-world and systems thinking. The real-world is about better understanding the problem situation, whereas systems thinking models systemic actions, from different perspectives, that might address the problem.

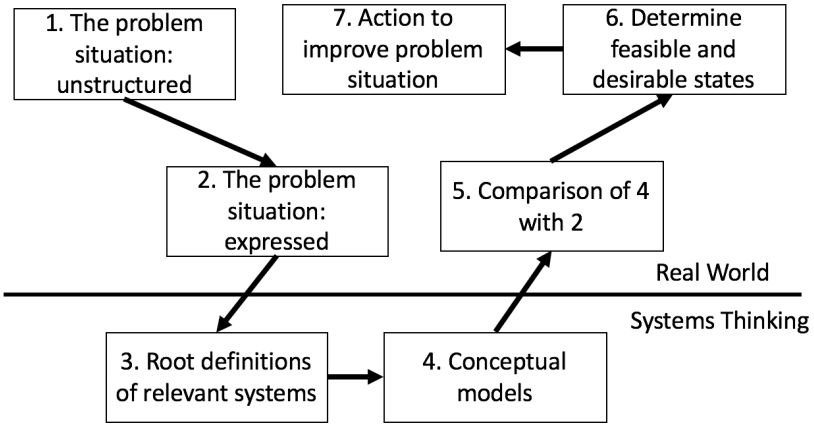

Figure 4.2: Diagram of the seven-stage systems methodology for tackling unstructured problems (reproduced from Checkland 1981, p 163)

Checkland (1981) is careful to stress that, in a real-world application, practitioners need not follow these stages in the sequence shown, but could work on more than one stage simultaneously, or backtracking and iteration may be needed.

4.2.3.1.1 Stage 1 (The Problem Situation):

The diagram in 4.2 does not start with the problem, but with a problem situation (stage 1). Checkland (1981) uses this term to emphasize that we are not dealing with a concrete problem,

per se, but a broader situation in which a problem is perceived to exist. This may sound nuanced, but Checkland thinks it is very important to distinguish 'problems', which are clearly specified and have a right and wrong answer, from 'problem situations', which are messy and there are different perspectives on what is best, with the final decision being a value judgement rather than being absolutely right or wrong. This distinction recognizes the difference between first-wave and second-wave thinking, with first-wave approaches being more suited to handling 'problems' in the conventional sense. Checkland's characterization of a 'problem situation' is very similar to Rittel and Webber's (1973) wicked problem or Ackoff's (1981a) 'mess'.

1.1.1.1.1 SSM Stage 2 (Expressing the Problem Situation):

To structure the problem situation, a way for stakeholders to easily describe it is needed. When Checkland first described his seven-stage methodology, he mentioned that it is useful to "make the analysis stage a building up of *the richest possible picture* of the problem situation being studied without pressing the analysis in systems terms" (Checkland, 1972, p.96). In his 1981 book, Checkland does not mention creating a rich picture, except to put a definition for it in the back of the book: "an expression of a *problem situation* compiled by an investigator, often by examining elements of *structure*, elements of *process*, and the situation *climate*" (Checkland, 1981, p.317). In 1985b, Checkland describes 'rich picture-building' as a process that turns an unstructured problem situation (stage 1) into a problem situation expressed (stage 2), as referred to in his diagram (4.2).

While Checkland acknowledges the usefulness of diagrams and pictures when expressing a problem situation, he does not endorse a specific way to do it. However, Checkland and Scholes (1990) did begin to recognize that many SSM practitioners were using pictorial ways to describe the problem situation, combined with notes and written prose. They were often using drawings with lines and arrows to show the interrelationships among problem elements. Below is a rich picture developed by Coyle and Alexander (1997) depicting the international drug trade (Figure 4.3).

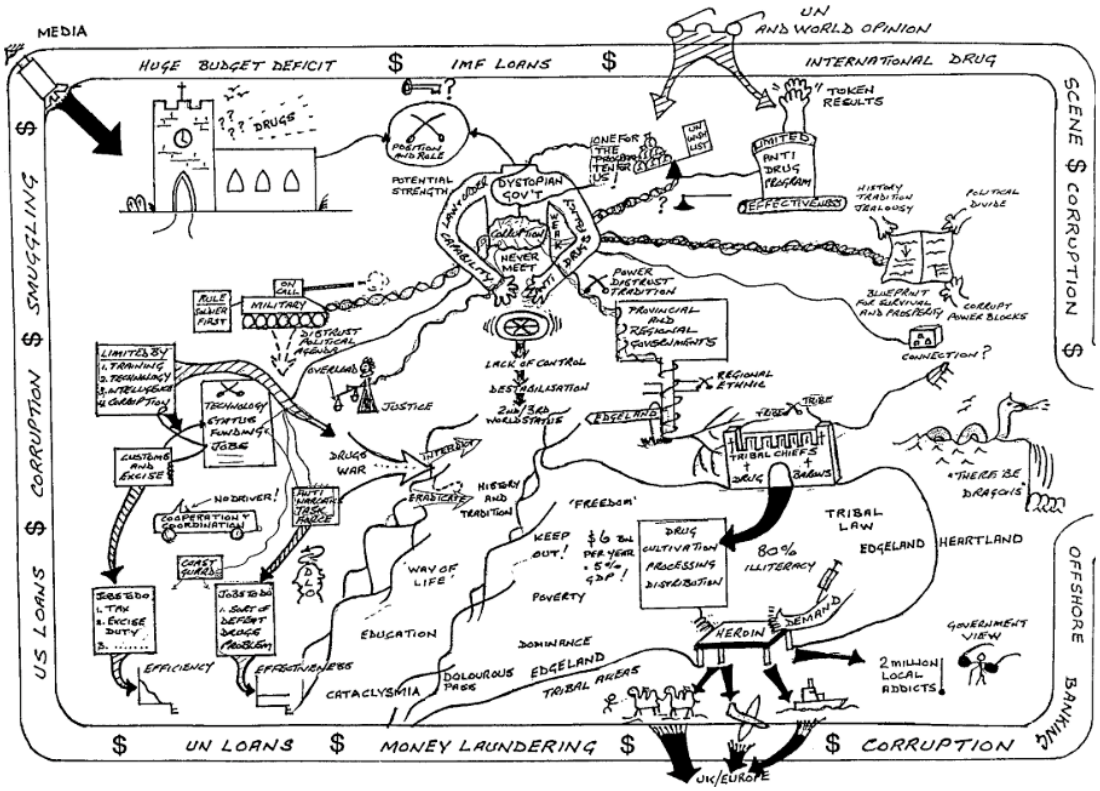

Figure 4.3: Example of a rich picture of international drugs trade (from Coyle & Alexander, 1997. p.219).

Avison, Andrews and Shah (1992) introduced the concept of a toolkit for use in rich picturing that would consist of a computer program with an interface with symbols (icons) and lines for constructing the picture. Others have also reported on the use of rich picturing when conducting soft Systems Analysis (e.g., Avison et al., 1992; Lewis, 1992; Monk & Howard, 1998; Boyd et al., 2004; Berg & Pooley, 2013; Espinosa & Walker, 2017; Espinosa & Duque, 2018).

4.2.3.1.2 SSM Stage 3 (Formulate root definitions):

In the 3rd stage in 4.2, participants begin to identify the purposeful systems that might be relevant to improving the problem situation. Checkland encourages a look at more than one purposeful system that could provide improvement. This stage involves the creation of a clear definition, or 'root definition', of each purposeful system, which includes naming the relevant system and describing its core purpose. Stages 1 and 2 begin to unpack the problem situation, which is the source of ideas for changes to be explored in stage 3 (Checkland 1985b). Checkland (1981) contends that all purposeful systems can be expressed as a set of transformations, and a transformation takes a description of how things currently are and places it next to a description of what the desired end goal of the transformation is. An arrow can then be placed between the two, indicating that a transformation involves changing a given aspect of the current problematic

situation to a better end state. This stage is very important because it enables the development of conceptual models (in the next stage) to examine the human activities that will be needed to bring about the transformations.

Because defining purposeful systems can sometimes be difficult, Checkland offers the mnemonic CATWOE (Smyth & Checkland, 1976; Checkland, 1981; Checkland & Sholes, 1990) as a checklist for systems thinkers to generate these root definitions through the consideration of multiple aspects of each system.

There are six elements that comprise the mnemonic CATWOE, as defined by Checkland (1985b, p.826):

> "**C**: (customers) Who are the system's victims or beneficiaries?
> **A**: (actors) Who would do these activities?
> **T**: (transformation process) What input is transformed into what output?
> **W**: (Weltanschauung) The worldview which makes this definition meaningful
> **0**: (owners) Who could abolish this system?
> **E**: (environmental constraints) What does this system take as given?"

Note that the transformation process, which is the core purpose of the system, is especially considered under elements 3 and 4 of CATWOE. Here, it is important to emphasize that there will likely be multiple worldviews linked to a corresponding number of alternative transformations. The transformations associated with all worldviews should be explored, as the purpose of this exercise is not simply to reach an agreement on the change that is needed, but to explore the ramifications of differing perspectives on possible changes, so the participants can develop better mutual understanding (Checkland & Scholes, 1990). Later in the SSM process, they may reach agreements on actions, as I will shortly explain. The full consideration of worldviews enables reflection on the purposes and values associated with transformations, and the critical assessment of ethical impacts is part of the process.

The other elements of CATWOE bring attention to those who will benefit (**C**); those who will bring about the transformation (**A**); those who own the transformation (**O**), not in the sense of financial ownership, but in the sense that they can stop it from happening; and the things people can't change but must accept as given (**E**).

There is also an alternative version of this mnemonic: BATWOVE (Midgley & Reynolds, 2001, 2004). The B replaces the C (on the grounds that words like 'customer' and 'client' are too narrow

in scope), and it stands for Beneficiaries (who will gain from the transformation). Also, a V has been added to represent Victims. While Checkland and Scholes (1990) explain that victims should be considered alongside the customer or client, Midgley and Reynolds (2001) observe that this appears to be a bit of an afterthought, and in practice victims are often missed. Explicitly adding them means that participants are put in the situation where they must confront the potential negative outcomes of the transformation being discussed and decide whether they are acceptable, whether the transformation should be modified, or whether another BATWOVE needs to be produced to consider mitigating action to address the victimhood.

After a CATWOE or BATWOVE has been produced, it can be used to construct the 'root definition', which is a concise statement of the transformation with all the necessary elements required to understand what it involves, short of the actual actions needed to bring it about.

4.2.3.1.3 SSM Stage 4 (Build Conceptual Models):

Conceptual models are made up of a set of human activities needed to bring about the transformation that has been expressed in a root definition, and connections between the activities are shown using arrows. Models consist of a minimum set of required activities needed to accomplish the transformation described in the root definitions developed in stage 3. Because this is a model of human activities, it does not need to include detailed diagramming of all activities, but only those deemed essential to making the transformation.

4.2.3.1.4 SSM Stage 5 (Comparing Models with Real World Actions):

Once conceptual models are developed for each relevant system, they can then be compared to the problem situation, as expressed by participants in Stage 2, to assess whether they would actually result in desired improvements. Checkland (1981) suggests that these comparisons can be done through informal discussions, formal questioning, scenario writing, or implementing the modeled activities in the real world.

4.2.3.1.5 SSM Stage 6 (Determine Feasible and Desirable Changes):

Once the comparison is complete, an action plan of feasible and desirable actions can be developed (Checkland, 1981). However, creating an action plan is not as simple as it sounds. It is actually one of the most challenging elements in the process because it requires the participants to use the enhanced mutual understanding, they have developed in stages 3 and 4 (and the

comparisons of the outputs from stage 4 with those from stage 2) to find accommodations so that an action plan can actually be agreed. The term 'accommodations' is important because it indicates that the participants can modify their expectations of action, and accept elements of what other people want, without having to reach a consensus, given that it is unlikely that stakeholders with very different worldviews will ever come to a full agreement on everything.

4.2.3.1.6 SSM Stage 7 (Improve the problem situation):

Once accommodations are found, the analyst helps support action to implement them to improve on the problem situation (Checkland, 1981).

4.2.3.1.7 The two-stream model of SSM

After years of action research using SSM, Checkland felt that the seven-stage version of SSM did not adequately capture the flexibility of the methodology, especially as it became apparent that some other practitioners were implementing it mechanistically, without the iteration between the stages recommended by Checkland (1981). This iteration ensures that all the outputs, from the understanding of the problem situation that has been expressed to the decisions on actions to be taken, are harmonized so the final actions are based on a fully explored systemic logic. Also, early experiences with using SSM created an awareness of just how much the cultural and political contexts of each problem situation mattered to the success of an SSM exercise (Checkland, 1999). An evolution in the thinking about SSM occurred from 1981 to 1990.

Because cultural and political contexts were often expressed in terms of conflicting interests among stakeholders, Checkland and Scholes (1990) expanded SMM beyond just a logic-based stream of analysis and into a two-stream model (Figure 4.4) that also allows for judgements to be made on conflicting interests, resulting in the incorporation of a cultural stream of analysis.

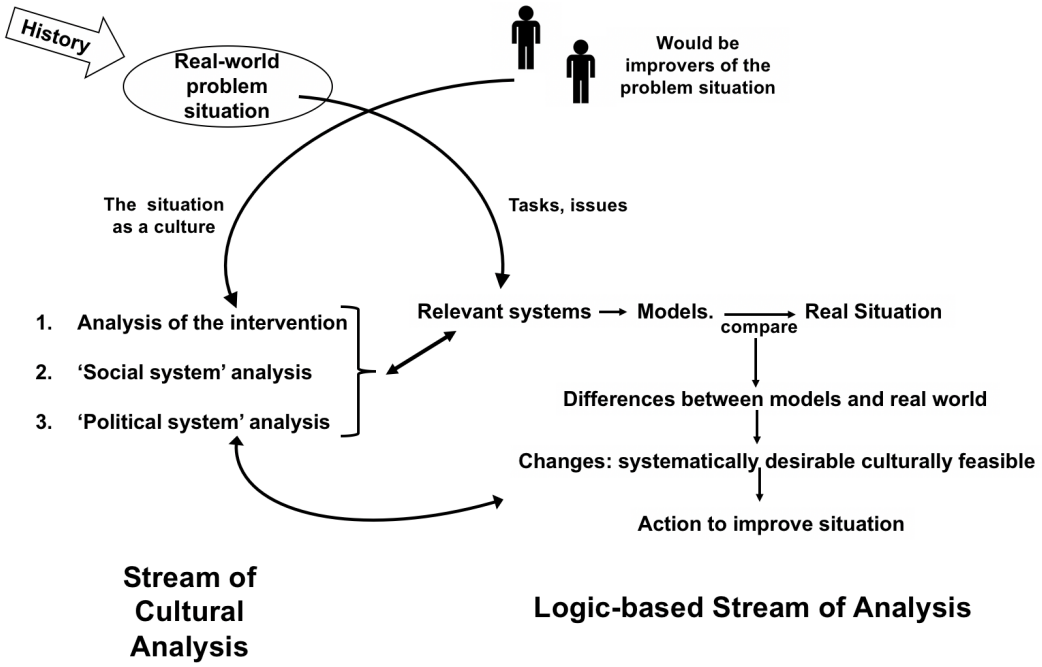

Figure 4.4: The two-stream enquiry process of SSM (Reproduced from Checkland & Scholes, 1990, p.29)

This two-stream model describes 'a real-world situation of concern', which yields choices of 'relevant systems of purposeful activities', followed by a comparison of models with the perceived real situation, and finally 'action to improve the situation'.

The 'stream of cultural analysis' contains three types of analysis (Checkland & Sholes, 1990):

Analysis One (analysis of the intervention): Thinking structurally about the intervention as a problem situation in itself.

Analysis Two ('social system' analysis): Addresses the social system as a continually changing interaction of roles, norms, and values.

Analysis Three ('political system' analysis): Addresses how power is expressed in the problem situation.

Like when he designed the seven-stage model, Checkland stresses that practitioners need not follow these analyses in the sequence shown in Figure 4.4.

Through reflections on the practical use of SSM, a closer look was paid to 'Analysis One' (Figure 4.5) and the fact that it is really made up of three elements: 1) the methodology, 2) the use of the methodology by a practitioner, and 3) the problem situation (Checkland & Poulter, 2006). Further, these three elements could be characterized by three roles (Checkland & Winter, 2006): 1) the

'client' (causing the intervention to happen), 2) the 'problem solver' (working on improving the problem situation), and 3) the 'problem/issue owner' (any individual impacted by the problem situation). The problem solver can list and name the problem owners; and further, both the client and the problem solver can be on that problem owner list.

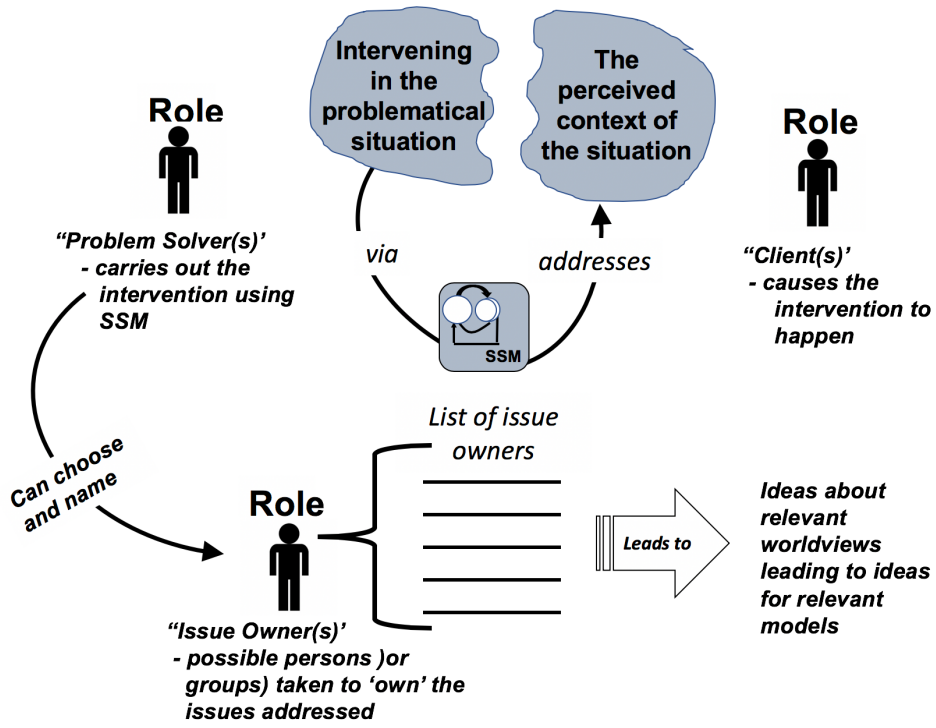

Figure 4.5: SSM Analysis One reproduced from Checkland & Poulter, 2006, p 29

4.2.3.2 Four-step Learning Cycle

After years of implementing the seven-step and then two-stream versions of SSM, Checkland (1999) still expresses some frustration that even the two-stream depiction (which was supposed to convey more flexibility than the seven-step model) did not truly capture the extent of the flexibility of how SSM can actually be used. A new version was then created that emphasizes the ability of SSM to be used for continued learning (Figure 4.6). This four-activity learning cycle version of SSM emphasizes the use of the methodology as an ongoing, real-world, purposeful activity (Checkland & Poulter, 2006).

Checkland (1999, pA15) defines these steps as:

> "1. Finding out about a problem situation, including culturally/politically.
> 2. Formulating some relevant purposeful activity models;
> 3. Debating the situation, using the models, seeking from that debate both (a) changes which would improve the situation and are regarded as both desirable and (culturally)

feasible, and (b) the accommodations between conflicting interests which will enable action-to-improve to be taken;

4. Taking action in the situation to bring about improvement."

Although not explicitly stated, Checkland (1999) implies that the three analyses introduced in the two-stream version are now subsumed within this new version of SSM, and they are implemented while comparing the models to the real-world situation.

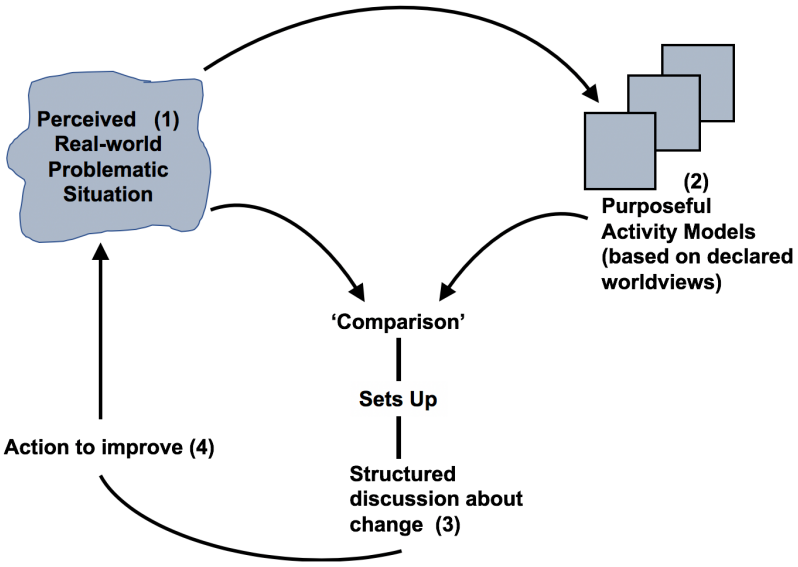

Figure 4.6: SSM Four-step Learning Cycle reproduced from Checkland and Poulter, 2006, p13

Thinking of SSM in this way led to more reflections on the potential of Analysis One. Not only can the SSM be used to deal with the content of the problem situation, but it can also help with carrying out the intervention itself (a separate purposeful activity). Therefore, two ways of using SSM (Figure 4.7) were conceived (Checkland & Poulter, 2006; Checkland & Winter, 2006): 1) an analysis of the perceived problem situation (SSMc), and 2) an analysis of the potential process for intervening in that problem situation (SSMp).

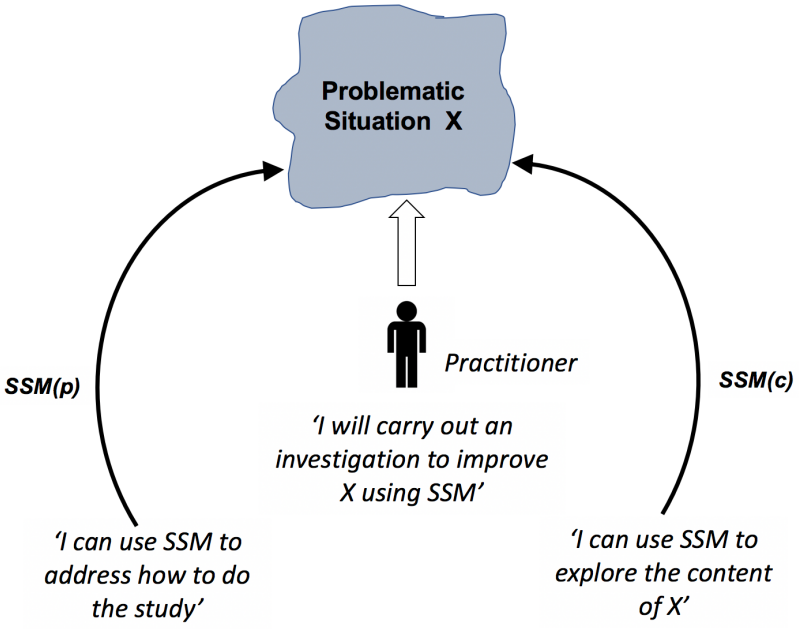

Figure 4.7: Two modes of using SSM - SSM(p) and SSM(c) reproduced from (Checkland & Poulter, 2006, p 31)

4.2.3.3 SSM Applications

There are many research studies involving the application of SSM (for example: Patel, 1995; Checkland & Winter, 2006; Delbridge, 2008; Proches & Bodhanya, 2015; Antunes, Dias, Dantas, Mathias, & Zamboni, 2016). Some SSM analyses are undertaken by an analyst talking with stakeholders and doing the SSM modeling themselves (Azadeh, Darivandi & Fathi, 2012; de Lima Medeiros, Terra, & Passador, 2020). Some SSMs are workshop-based, with participants directly doing the modeling (e.g., Gregory & Midgley, 2000; Kotiadis, Tako, Rouwette, Vasilakis, Brennan et al., 2013). Still others use a hybrid approach (Cronin et al., 2014; Ameyaw & Alfen, 2018).

Examples of applications to address wicked problems include Checkland and Winter (2006), who used SSM to redesign the contracting mechanisms for the National Health Service in the UK. Charles (2016) employed SSM in a study to address conflicts between the mining industry and some of its stakeholders over the balance between achieving economic benefits for shareholders and addressing social and environmental concerns (e.g., environmental degradation and the failure to improve quality of life in affected communities). SSM has also been used to address the issue of nanotechnology commercialization policymaking in Iran (Azar, Vaezi & Mohammadpour, 2017). Finally, a systems approach based on the principles of SSM and causal loop diagrams (Forrester, 1994) was developed by Markowska, Szalińska, Dąbrowska & Brząkała (2020) for

running a water management facility in Poland. These are just a few of the many applications of SSM to wicked problems that can be found in the literature.

4.2.3.4 Critique of SSM

Even though the methodology has been widely applied, it has not gone uncriticized. Jackson (1982) and Mingers (1984) argue that Checkland's subjectivism (taking for granted the interpretive paradigm) is inherently conservative because the structural material conditions that cause and perpetuate poverty and exploitation are not seen as objective realities, but instead are reduced to a stakeholder viewpoint that is no more valid than any other. The use of SSM is therefore unlikely to bring about radical changes.

Jackson (1982) argues that Checkland's subjectivist attitude when developing SSM is too conservative and therefore could not bring about radical changes. Checkland (1982) counters that, because SSM is a learning system, there are really no limits to the degree of change it can bring about. Perhaps some of Jackson's criticisms may have influenced Checkland's latter emphasis on the learning cycle, and particularly the two-stream version that includes an element of political analysis (Checkland and Scholes, 1990).

Jackson (1982, 1983) also criticizes SSM for not being able to deal with power imbalances inherent in organizations and society. Especially when it comes to workshop-based applications of the methodology, the assumption that dialogue between participants will be free-flowing and honest could be seen as rather naïve. For example, how many shop floor workers will openly criticize managerial policies in front of senior managers who have the power to terminate those workers' employment?

Mingers and Taylor (1992) found, in a survey of practitioners, that the use of SSM received mixed reviews. While many practitioners praised the concepts behind SSM, they lacked confidence in using it. They also listed some problems, such as difficulty in securing participation from key actors, a lack of specific techniques to support client interaction, an inability to easily connect to information systems, and failure to directly address conflict and resistance to change.

Some of the major criticisms discussed above, relating to power imbalances and adherence to an interpretivist paradigm, have resulted in the evolution of a third wave of systems thinking, outlined in Chapter 5.

4.2.4 Second-wave Rethinking of First-Wave Approaches

During the time that second-wave systems thinking was expanding, there were some first-wave scholars and practitioners who began to combine first-wave systems thinking with second-wave concepts. Both System Dynamics and Cybernetics began to undergo a transformation.

4.2.4.1 Dialogical Version of System Dynamics.

As covered previously, practitioners of first-wave System Dynamics often utilize computer models to conduct 'what-if' experiments to find solutions to complex problems. It was not uncommon for modelers to consult with clients while building these models (Forrester, 1961; Roberts, 1977; Weil, 1980), initially in a loose and informal fashion, but later using more structured methodologies, such as the Policy-Delphi approach, cognitive mapping (Eden, 1988 Eden & Simpson, 1989)), and other forms of computer-supported model-building (Richardson, Vennix, Andersen, Rohrbaugh & Wallace, 1989). Vennix (1990, 1996) argues that, by working with clients and stakeholders participatorily during model building, a great deal of useful policy information can be generated. Andersen and Richardson (1997) noticed that, when engaging groups, modelers tend to use rather sophisticated processes, which these authors codified into a set of group model-building 'scripts'. Ackermann, Andersen, Eden and Richardson (2010) took these scripts a step further and built a group decision support tool around them.

Some authors have stated that attempts at knowledge elicitation can be quite time consuming and costly (Vennix, 1990; Vennix & Grubbels, 1992), but Andersen & Richardson (1997) believe the benefits are worth it. They argue that individual mental models of the problem are improved, and group model building helps to align System Dynamics models with participants' mental models, thereby increasing involvement in collective decision-making. Examples of the use of group model building techniques include applications in health care (Lane & Husemann, 2008); safety performance and culture (Goh, Love, Stagbouer & Annesley, 2012); and integrated wetland management (Chen, Chang & Chen, 2014), among many others.

Although group model building brings System Dynamics closer to the participative approach that is characteristic of second-wave approaches, and it allows for mutual learning between the client and the modeler, I nevertheless argue that practitioners in this tradition still approach complex problems in an expert mode. While clients are more involved throughout the process than in first-wave System Dynamics, the model is still primarily driven from the modeler's perspective, simply because it is the modeler who understands the technical demands of the methodology. Indeed,

the goal often stated for using group model building techniques is to increase 'buy-in' from clients (Williams & Ackerman, 2003; Carhart & Yearworth, 2010; Stave, 2010; Hovmand, 2014; Brown, Lemke, Fallah-Fini, Hall & Obasanya, 2022) not necessarily to allow the clients to develop the overall problem definition themselves.

4.2.4.2 Second-order Cybernetics

In first-wave Cybernetics approaches, systems are typically treated as if they are objects external to the observer. The idea was that an observer could model the system objectively and manipulate it mechanistically. However, many cyberneticians felt the need for an approach that would recognize the role of the observer in modeling a system. Heinz von Foerster (1974) named this new trend the 'Cybernetics of Cybernetics', or 'second-order Cybernetics'. Second-order Cybernetics is included as a second-wave approach because it represents the understanding that, when working with social systems, the system is an agent in its own right, interacting with the observer, who in turn affects the system (Heylighen & Joslyn, 2001). Von Foerster (1974) characterizes Second-Order Cybernetics as the cybernetics of the observing system, as opposed to the observed system. One cybernetic model that has been considered by some researchers to embrace this second-order concept is the VSM, and this is especially evident in the works of a second generation of authors (e.g., Espejo & Harnden, 1989; Espinosa, 1995, 1998, 2006; Espinosa & Walker, 2006, 2013, 2017; Espinosa, Harnden & Walker, 2008; Espejo & Reyes, 2011; Espinosa et al., 2015; Espinosa & Duque, 2018) following in the footsteps of Beer (1984). The VSM was introduced in Chapter 1 and will be described in more detail in Chapter 7.

4.3 Summary

I contend that second-wave systems thinking is arguably more useful in the context of designing interagency organizations capable of responding to wicked problems than first-wave approaches alone. Unlike first-wave approaches, second-wave approaches directly address many of the wicked problem characteristics laid out by Rittel and Webber (1973), such as being able to define the problem through the value lenses of multiple agency stakeholders, not just experts, and modeling the system as a way of facilitating dialogue and mutual understanding, not as a real-world object with a single optimal solution. For the purposes of this study, second-wave systems methodologies designed to facilitate systemic analysis and enhance mutual understanding amongst multiple stakeholders offer a rich set of approaches to consider for better interagency understanding of messy, wicked problem situations.

Chapter 5: Third-wave Systems Thinking – Critical Systems Thinking (CST)

While second-wave systems approaches were extremely important because they brought stakeholders into the analysis of wicked problems, criticisms were raised over the inability of these approaches to address deeply-rooted or entrenched conflicts between stakeholder groups, and there is the potential for the undemocratic or coercive exercise of power (Mingers, 1980, 1984; Jackson, 1982). Indeed, Jackson (1982) argues that, in capitalist economies, conflict and coercion are built into the very structure of society, so methods relying on dialogue alone fail because those with power can simply bypass them, or use them to impose their will, knowing that their 'subordinates' will not challenge them for fear of the consequences.

Second-wave approaches were also criticized (along with first-wave approaches) for *isolationism*: viewing different approaches as mutually exclusive and incompatible, instead of complementary (Jackson & Keys, 1984; Jackson, 1987a,b; Flood, 1989, 1990; Flood & Jackson, 1991a,b; Mingers, 2011). Because multi-faceted wicked problems are characterized by both complexity and conflicting worldviews, and they evolve over time, it seems unreasonable to expect them to be addressed using only one methodology. The variety (i.e., potential responses) inherent in any single methodology is inadequate to address the variety (i.e., diverse aspects) of wicked problems and their connections with other such problems.

This chapter will introduce and discuss the third wave of systems thinking (Midgley, 2000), also called Critical Systems Thinking (CST) (Jackson & Keys, 1984, 1987a,b; Flood & Jackson, 1991a,b; Jackson, 1991; Ulrich, 1993; Gregory, 1996a,b; Midgley, 2000), that emerged to address the criticisms of the second wave. This third-wave paradigm includes two major foundation stones:

1) Boundary Critique (e.g., Ulrich, 1983, 1988b, 1994; Midgley, 2000; Mingers, 2011), which seeks a more critical understanding of conflict and power and looks at how to address them through intervention.
2) Methodological Pluralism (e.g., Jackson & Keys, 1984; Jackson & Keys, 1987; Midgley & Floyd, 1990; Flood & Jackson, 1991a,b; Jackson, 1991; Gregory, 1996a) to address the isolationism issue.

In addition, this chapter will cover the approach that Gerald Midgley developed to support "purposeful action by an agent to create change in relation to reflection on boundaries" (Midgley, 2000, p.132). This approach, called Systemic Intervention, is a contribution to the third wave that

accommodates multiple stakeholder participation and the analysis of power relationships throughout the intervention process. It also promotes the mixing of methods from other methodologies but encourages the evolution of one's own methodology over time by interpreting and learning from other methodologies. It thus unites the work represented by the two foundation stones mentioned above.

5.1 Dealing with Conflict and Power

As discussed in section 2.2, West Churchman was a powerful influence in both the Sciences and Operational Research, and his concepts of the 'environmental fallacy' and 'unfolding process' (Churchman, 1979) have guided the works of systems researchers who developed both 2nd and 3rd wave systems thinking approaches. But of course, being totally comprehensive is impossible, so bounding of the analysis is inevitable. Werner Ulrich, a PhD student under Churchman, focused on this issue of bounding an analysis (Ulrich, 1983, 1987, 1988ab, 2000, 2003). Ulrich contends that the unfolding process is inevitably subject to practical constraints, and therefore bounding the exploration more narrowly than we (or some of the participants) might ideally like can and should be explicitly justified. Boundary dilemmas need to be explored, and transparent decisions should made on what to include within an analysis, and whose voices should be listened to.

Ulrich (1983) emphasizes that, when considering improvements, one should critically reflect on any factual or values-based assumptions that lead to the exclusion of elements from a planning effort that others involved or affected might want included. He said that these assumptions involve boundary judgments (Ulrich, 1996). Ulrich recognizes that boundary judgements are intimately tied to the values of the various stakeholders, and he therefore believes that the values of all stakeholders must be carefully considered when setting boundaries.

Ulrich (1988) reflects on Habermas's (1976) call for undistorted communication, which allows the 'better argument' to prevail (as opposed to 'distorted communication', where the exercise of power closes dialogue or creates false consciousness, so the 'better argument' cannot win out). While Ulrich appreciates the logic of aspiring to undistorted communication, he concedes that Habermas's model is an *ideal*, because complete rationality cannot be expected: for true undistorted communication to exist, it would (in principle) be necessary to involve all citizens of the world, in both the present and future, in every decision that might affect them, and this is quite simply impossible. So, the key question is how we can rationally justify narrower boundary judgements when these cannot be avoided (Ulrich, 1983).

In addition, Ulrich warns that, when we assume that perfect rationality is possible, the unequal distribution of decision power is enhanced because coercive agents might claim their choices are completely rational (i.e., objective), when all choices of all citizens are necessarily partial (in the sense of being based on both value judgements and limiting boundary judgements).

Ulrich (1987) discusses these issues of judgments in terms of applied science (in contrast to basic science), where he says the difficulty lies in the normative context of applied work. This normative context includes not only value judgements, but a consideration of consequences and side-effects of any action taken. Ulrich contends that, during practical discourse, "every justification attempt must start with some material premises and end with some conclusions that it cannot question and justify any further" (Ulrich, 1987, p.27). Ulrich calls the point when justification ends a 'justification break-off', and he stresses that applied scientists and planners need to be clear and transparent about these if they hope to address the normative context. Another way to express this is, if a decision maker decides to stop the dialogic exploration, they are obliged to explain to others why this is required.

The meaning of justification breakoffs closely aligns to the concept of boundary judgements. Boundary judgements are the assumptions and decisions that are made within a Systems Analysis about what is in and what is out of the analysis. There is a potential danger in any Systems Analysis that those who consider themselves more powerful stakeholders or 'experts' will simply take their boundaries and values for granted and coercively impose them on others (Ulrich, 1996). Resulting power plays and turf-protection can ultimately threaten an intervention. So, in order to deal with this dilemma, Ulrich maintains that special care must be taken to critique boundary judgements so that no stakeholder's perspective should, in principle, be beyond question (Ulrich, 1983).

Some (e.g., Flood & Jackson, 1991a) have labelled systems approaches that can address conflict and power as being 'emancipatory', with this word taken from Habermas's (1972) theory of knowledge-constitutive interests, in which he describes three inherent human interests:

1) Technical: the need to predict and control the environment around us in the context of work,
2) Practical: the desire to achieve mutual understanding through communication with others, and
3) Emancipatory: freedom from power relationships that ideologically distort communication and work.

5.1.1 Critical Systems Heuristics

Ulrich proposes an 'emancipatory' systems approach to help systems practitioners (as well problem stakeholders) critically discuss the normative implications of potential interventions (Ulrich, 1997). Ulrich (1983) calls this approach Critical Systems Heuristics (CSH), and his aim is to help practitioners introduce 'critique' to the systemic planning process and deal with power imbalances through dialogue. To help practitioners deal with the difficulties in putting boundaries around the systems they are analyzing, Ulrich offers a set of twelve boundary questions, which are based on Kant's (1788) 'categorical imperatives' (fundamental ethical rules that people should obey). The set of twelve boundary questions that should be asked when addressing a problem systemically (Ulrich, 2000, p.258) are:

"Sources of Motivation

1. Who is (ought to be) the client? That is, whose interests are (should be) served?
2. What is (ought to be) the purpose? That is, what are (should be) the consequences?
3. What is (ought to be) the measure of improvement? That is, how can (should) we determine that the consequences, taken together, constitute an improvement?

Sources of Power

4. Who is (ought to be) the decision-maker? That is, who is (should be) in a position to change the measure of improvement?
5. What resources are (ought to be) controlled by the decision-maker? That is, what conditions of success can (should) those involved control?
6. What conditions are (ought to be) part of the decision environment? That is, what conditions can (should) the decision-maker not control (e.g., from the viewpoint of those not involved)?

Sources of Knowledge

7. Who is (ought to be) considered a professional? That is, who is (should be) involved as an expert, e.g., as a researcher, planner or consultant?
8. What expertise is (ought to be) consulted? That is, what counts (should count) as relevant knowledge?
9. What or who is (ought to be) assumed to be the guarantor of success? That is, where do (should) those involved seek some guarantee that improvement will be achieved for example, consensus among experts, the involvement of stakeholders, the experience and intuition of those involved, political support?

Sources of Legitimation

10. Who is (ought to be) witness to the interests of those affected but not involved? That is, who is (should be) treated as a legitimate stakeholder, and who argues (should argue) the case of those stakeholders who cannot speak for themselves, including future generations and non-human nature?
11. What secures (ought to secure) the emancipation of those affected from the premises and promises of those involved? That is, where does (should) legitimacy lie?
12. What worldview is (ought to be) determining? That is, what different visions of 'improvement' are (ought to be) considered, and how are they (should they be) reconciled?"

These twelve critically-heuristic questions, categorized by motivation, power, knowledge, and legitimation, form the basis for system improvement because they are used to focus planners on both 'what ought to be' as well as 'what is' (Ulrich, 1996). However, Ulrich's view is also that CSH can be used in the 'what is' mode in planning situations when the goals are not clear at the beginning. When planning for improvement, a good understanding of the present state can help in knowing where to move from as well as what to move towards.

In addition, Ulrich (1983) believes that CSH can be used in situations where powerful and/or coercive stakeholders might succeed in closing dialogue around boundaries, using the

> "polemical employment of boundary judgments" that "enables ordinary people to expose the dogmatic character of the expert's 'objective necessities' through their own subjective arguments, without even having to pretend to the objective or to be able to establish a true counterposition against the expert." (Ulrich, 1987, p 282)

Several authors have criticized CSH for encouraging the confrontation of coercive agents' assumptions, but not offering a means to examine the underlying political and economic forces that have made these assumptions so engrained (Jackson, 1985; Flood & Jackson, 1991a,b; Mingers, 1992). Also, Ulrich has been accused of naivety for thinking that the powerful would even choose to engage in dialogue with the powerless (Jackson, 1985; Ivanov, 1991, Flood & Jackson, 1991a,b; Mingers, 1992; Romm, 1995a). Willmott (1989), Ivanov (1991), and Romm (1995a) point out that CSH requires the renunciation of dogmatic intransigence, but it does not offer suggestions for how this renunciation could be promoted. There is also some debate about the assumption that people want to work in unison during a planning process, and whether CSH provides a means to educate people to work together cooperatively (Brown, 1996). Midgley

(1997a) points out that CSH is only appropriate in situations where debate among stakeholders is possible, or there is an arbitrator to whom the powerful must yield.

While Jackson (1985, 1991) and Flood and Jackson (1991ab) argue that the application of first-wave approaches often disregards the consequences of accepting given means and ends, they fault Ulrich for being too negative and unnecessarily eschewing the use of these approaches within an integrated framework of methods that can be reflected upon critically. In their 1991a book, Flood and Jackson charge that CSH is an immature methodology. However, there are now numerous case studies and applications using CSH (e.g., Cohen and Midgley, 1994; Midgley et al, 1997 1998; Midgley, 2000; Boyd et al, 2004; Luckett, 2006; Venable, 2009; Green, 2014; Hart & Paucar-Caceres, 2014; Ariyadasa & McIntyre-Mills, 2015; Dehghani, Khazaei & Alinesab, 2018; Gates, 2018; Raza, Siddiqui & Standing, 2019; Stephens, Taket & Gagliano 2019; Goede, 2021; Gadsby, Verbeek & Overbeek, 2022; Gadsby Wistow & Billings, 2022). While the charge of immaturity might have held water in 1991, it is no longer a reasonable criticism. Having said this, it is quite striking that most of the later applications in the literature use the CSH questions in interviews with stakeholders, and then the onus is on the researcher to write up a report for decision makers. This is a fairly traditional social science approach designed to give rise to knowledge about stakeholder positions, not necessarily to change those positions, and I have unanswered questions about how effective those interview-based studies have been in stimulating actual social change. It appears that the earlier, participatory, workshop-based approach developed by Midgley and colleagues (Cohen and Midgley, 1994; Midgley et al, 1997, 1998; Midgley, 2000; Boyd et al, 2004) has not been widely taken up, despite the fact that it is well known that strong participation encourages greater buy-in for change than writing reports (e.g., Rosenhead and Mingers, 2001).

The systemic theory and underlying principles of critically handling boundary judgments has come to be called ‘Boundary Critique’ (Ulrich, 1996; Midgley et al., 1998; Midgley, 2000; Yolles, 2001; Foote et al., 2007; Midgley & Pinzon, 2011, 2013; Ufua et al., 2018). Boundary Critique helps to maintain a stance of critical awareness of different possible boundaries and values and their possible consequences for intervention (Midgley & Pinzon, 2011). This requires a penetrating exploration of the context of the intervention, paying particular attention to the contrasting values and boundaries being used by different stakeholders, and the conflict and marginalization that can unfold as a result (Midgley & Pinzón, 2011). More on Midgley’s work with Boundary Critique will be covered later in this chapter in the discussion of Systemic Intervention.

5.2 Mixing Methods: Toward Methodological Pluralism

Before discussing the mixing of methods and Methodological Pluralism, it is important to note that I distinguish between method and methodology, following Midgley (2000, p.105): "A 'method' is a set of techniques operated in a sequence (or sometimes interactively) to achieve a given purpose. A methodology is a set of theoretical ideas that justifies the use of a particular method or methods."

As systems practitioners engaged in interventions into more and more complex issues, they claimed that the use of any one methodology is not sufficient and broad enough to address this complexity, and they began to advocate for the ability to mix methodologies and/or methods to meet the needs of the intervention, interpreted in context. But this ran up against the scientific convention of 'isolationism', which asserts that only one methodology (and a small set of highly related methods associated with that methodology) can be regarded as valid (Jackson, 1987a; Midgley, 1988; Flood, 1989a; Flood & Jackson, 1991ab).

Jackson (1987a) discusses isolationism in the context of the advancement of MS. He puts forth four strategies for consideration: isolationist, imperialist, pragmatist, and pluralist. He argues that taking an isolationist path would result in the development of different strands of MS, each having their own philosophical underpinnings, but not interacting or learning from each other. This is a recipe for the fragmentation of the research community. He contends that imperialism would result in selecting one methodology that would stand above all others, thus reinterpreting and denaturing other approaches. There are two problems with this. First, finding or developing that one ideal methodology to cover the breadth of wicked problem situations is an unreasonable expectation, as no single methodology has sufficient variety (Jackson & Keys, 1984; Jackson; 1987a; Flood, 1989a). Second, denaturing other approaches would be resisted by the advocates of the latter, so an imperialist strategy is most likely to increase conflict and division in the research community (Jackson, 1987a).

At the other end of the spectrum, pragmatists seek to join elements of different approaches based on what works in practice. There was a push for a pragmatist movement at the turn of the 20th century (James, 1904; Pierce, 1934, Dewey, 1946), and Walker (2006) argues that critical systems thinkers have not taken this sufficiently seriously. However, Jackson (1987a) and Flood (1989a) take issue with pragmatists who do not necessarily work with theory (Midgley, 1989b), and instead use a trial-and-error, 'tookit strategy' that fails to reflect on why some

combinations of methods work better than others. Flood and Jackson (1991a) warn against the pragmatist's approach of atheoretical 'pick and mix', saying that, without a critical understanding of both the context of application and the assumptions made by different methodologies, it is very difficult to align the right ones with that context, as alignment is aided by high-quality theory. Walker (2006) replies to this, saying that all the above critical systems thinkers are mistaken in their view of pragmatism: they have set up a straw man to knock down, when actually, pragmatists are very interested in theory that has practical benefits, like knowledge of how methodologies align with contexts. However, we need to acknowledge that Jackson (1987a) and subsequent authors in the late 1980s and early 1990s were writing in the context of debates in systems/OR, where a 'degraded' understanding of pragmatism had taken hold and was not being questioned. In retrospect, it is regrettable that true pragmatism wasn't taken seriously (as Walker, 2006, says, a lot could have been learned from it), but at the same time, it is certainly reasonable to argue against the atheoretical, degraded form that Jackson (1987a) was attacking.

Jackson (1987a) ultimately champions the fourth strategy, pluralism, because he says it respects the strengths of different approaches and encourages further theoretical development to deal with their weaknesses. He believes this approach can suggest how differing methodologies can be combined 'appropriately'. This pluralistic view of mixing multiple methodologies certainly ran up against very strong criticisms from the scientific fields that were immersed in isolationism (see Midgley, 2000, for a specific example). Classically, scientific isolationists claim that 'paradigm incommenserability' is in operation when methodologies are combined, especially if the researcher draws from across the positivist, interpretive, and emancipatory paradigms (Jackson, 1987a). Paradigm incommensurability is the idea that methodologies drawn from different paradigms make fundamentally different philosophical assumptions about the nature of the world and our knowledge of it, so mixing them introduces unresolvable contradictions. Midgley (2000) and Midgley, Nicholson and Brennan (2017) give an example: if methodologies from realist and idealist paradigms are mixed, it requires us to simultaneously believe that reality is both material ('out there', giving rise to our conscious understandings of it) and conscious (entirely in the eye of the beholder, so it's not meaningful to speak of an external reality). Of course, it can't be both (unless, of course, a new position is proposed that transcends and then reconstructs these two stances, which is what Midgley, 1992ab, 1996b, 2001, 2016a, sought to achieve in his early research).

Jackson (1990) argues that pluralism is granted validity through the use of Habermas's (1972) theory of human interests (discussed earlier): first-wave (analytical) methodologies help us to

pursue our interest in predicting and controlling the natural world; second-wave (dialogical) methodologies support our interest in getting better mutual understanding of each other's perspectives; and third-wave (boundary-challenging) methodologies help us identify the distorting effects of ideology, thereby supporting the emancipatory interest in freeing ourselves from restrictive power relations.

There is a similarity between Midgley's (e.g., 1992b) and Jackson's (1990) perspectives: both seek a theory that can make sense of the diversity of methodologies and harness them together for different purposes. However, Jackson presents this as somehow 'aparadigmatic' – floating above and co-ordinating existing methodological paradigms – while Midgley is explicit that use of this kind of theory *reconstructs* the original methodological paradigms to render a coherent approach. Such theories make unique assumptions that the advocates of the original methodologies might not feel comfortable with, so inevitably Critical Systems Thinking needs to acknowledge that it constitutes a proposal for a *new paradigm* (Midgley, 1989b, 2000; Midgley et al, 2017).

Ultimately, Jackson (1987a, p.462) defines pluralism as a process "where theoretical and practical developments will be mutually informing", and an approach to pluralism is offered (Jackson and Keys, 1984) that involves two types of work: first the 'theoretical' work needed to uncover the underlying assumptions of a range of methodologies; and second, the 'practical' work to ascertain how the methodologies perform in different contexts being analyzed. With pluralism, the analyst needs to determine which methodology is appropriate for each problem confronted. Of course, how an analyst might determine appropriateness is not always straightforward (Midgley, 2000).

5.2.1 The System of Systems Methodologies (SoSM)

Using this approach to pluralism, Jackson and Keys (1984) wanted to address the difficulty practitioners might have in deciding on which methodologies to mix and matching the appropriate methodologies to the problem context. So, they developed a framework, called the System of Systems Methodology (SoSM), that leads a practitioner through choosing appropriate methodologies to select when creating a systemic approach that addresses the context while still being cognizant of the issues around underlying paradigms (Jackson & Keys, 1984; Jackson, 1987a, 1990, 1991, 2000, 2003).

In the first rendition of the SoSM, a four-box grid was presented to guide the practitioner through weighing the strengths and weaknesses of various methodologies aligned with perceptions of

complexity (simple or complex) and the relationships between participants (unitary context or pluralistic context). Later, to account for situations where power is exercised and stakeholders may be able to express their genuine concerns, Jackson (1987b) added 'coercive' as an additional relationship. The grid in Table 5-1, from Midgley (2000), provides specifications of the resulting six contexts.

Table 5-1: The System of Systems Methodologies (from Midgley, 2000, p.219)

	Unitary	Pluralistic	Coercive
Simple	Simple Unitary: key issues are easily appreciated, and general agreement is perceived between those defined as involved and/or affected.	Simple-Pluralistic: key issues are easily appreciated, but disagreement is perceived between those defined as involved and/or affected.	Simple-Coercive: key issues are easily appreciated, but suppressed disagreements are perceived between those defined as involved and/or affected.
Complex	Complex-Unitary: key issues are difficult to appreciate, but general agreement is perceived between those defined as involved and/or affected.	Complex-Pluralistic: key issues are difficult to appreciate, and disagreement is perceived between those defined as involved and/or affected.	Complex-Coercive: key issues are difficult to appreciate, and suppressed disagreements are perceived between those defined as involved and/or affected.

5.2.1.1 Extending the SoSM: Total Systems Intervention

Jackson (1990, p.662) argues that, for the SoSM to realize its potential, it must

> "operate from 'above' the paradigms, assisting in marshalling the various systems approaches, whatever their theoretical assumptions, on the basis of a meta-understanding of the nature of organizational problem-solving."

Following the work on the SoSM, Flood & Jackson (1991ab) sought to extend the framework into Total Systems Intervention (TSI), which is a plain-English version of CST intended to provide non-

academic systems practitioners with guidance on choosing specific methodologies. Using the grid in Table 5-1, methodologies are assigned that are deemed appropriate for each context. Table 5-2 shows the six problem contexts with some methodologies that Flood and Jackson (1991c) suggest are suited for each.

Table 5-2: A Systems of System Methodologies (from Flood & Jackson, 1991c, p.203)

Unitary	Pluralist	Coercive
Simple		
S-U	S-P	S-C
• Operational Research • Systems Analysis • Systems Engineering	• Social Systems Design • Strategic Assumption Surfacing and Testing	• Critical Systems Heuristics
Complex		
C-U	C-P	C-C
• Cybernetics • General System Theory • Socio-technical Systems • Contingency Theory	• Soft Systems Methodology • Interactive Planning	• ?

TSI expands on the SoSM by using 'systems metaphors' that relate to how the organization's functions assist the process of diagnosing problem contexts. Example metaphors include (Flood & Jackson, 1991c, p.202):

> "The organization as a "machine" (closed system view),
> the organization as an "organism" (open system view),
> the organization as a "brain" (learning system view),
> the organization as a "culture" (emphasis on norms and values),
> the organization as a "team" (unitary political system),
> the organization as a "coalition" (pluralist political system), and
> the organization as a "prison" (coercive political system)."

Flood and Jackson (1991c) contend that the use of systems metaphors provides a mechanism for creatively reflecting on current thinking about past, present and future strategies, alternative structures, and human/political aspects of the organization. When a dominant metaphor is determined, the SoSM can be used to select those individual methodologies that are most appropriate for that metaphor.

5.2.1.2 Critiques of the SoSM and TSI

While the SoSM is widely used by systems practitioners as a guide to selecting and mixing methodologies, there are some systems thinkers that take issue with some aspects of it, and highlight inadequacies (Gregory, 1990, 1992, 1996a,b; Midgley, 1989b, 1990a,b, 1992bc; Mansell, 1991; Sutton, 1995).

For instance, Midgley (1989a) and Gregory (1990, 1992, 1996ab) contend that the SoSM can slip into imperialism, as Jackson (1990) argues that it operates from 'above' the paradigms. The idea of operating from 'above' suggests that Jackson believes that the SoSM is somehow paradigmatically neutral, but this cannot be the case because it makes assumptions (e.g., about Habermas's, 1972, theory of knowledge-constitutive interests) that the various methodologists whose work has been put into the SoSM might well disagree with. Therefore, there is a risk of seeing all the methodologies though an imperialist paradigmatic lens. Gregory (1996ab) also points out that the SoSM's focus on conciliation within a single meta-theory can result in a lack of ability to accommodate radically different perspectives. She advocates instead for a form of 'discordant pluralism' that accepts a diversity of methodologies without seeking to reconcile them within a meta-theory, and it encourages the making of locally contextual critical judgments about the utility of each methodology, and such judgements can be made with the help of both critical self-reflection and ideology critique (Gregory, 1992, 2000).

Sutton (1995) also criticizes the SoSM, arguing that the complexity dimension mainly refers to the physical aspects of a situation. Sutton proposes the enterprise design framework, where he extends the SoSM to include the idea that judgements on whether something is simple or complex stem from subjective perspectives, so these perspectives must be considered in relation to the complexity dimension of the SoSM as well as in relation to the relationships between participants. Also, Mansell (1991) argues that while systemic coercion is recognized in the SoSM, there is little advice on how to deal with it.

Midgley (1992c) also finds the rigid use of the SoSM and its creation of a new overarching meta-methodology problematic when developing practical interventions into very complex problems. He argues that, when dealing with complex problem situations, methods need to be drawn out of methodologies and be interrelated systemically (Midgley, 1992c). He actually claims that it is rare to encounter a complex issue and find that one 'off the shelf' methodology will fit the context: more often than not, a mixed-methods design is required, and bespoke intervention strategies

can be developed in response to explorations of the problem at hand (Midgley, 1989b, 1990a). Midgley (1997b, 1997c, 2000) calls his approach the 'creative design of methods'. This perspective on pluralism is the one I have chosen for my own research, and it is covered in more detail later in this chapter (in the discussion of Midgley's, 2000, Systemic Intervention approach).

Mingers and Brocklesby (1997) suggests an approach that combines several methods that can be drawn from different paradigms. The term they use for this approach is multimethodology. However, these authors caution that there are some real challenges to be considered when mixing methods, including:

1) Philosophical feasibility, or paradigm incommensurability: when combining across paradigms, there will be dichotomies between underlying philosophies (ontological and epistemological),
2) Cultural feasibility: organizational and academic cultures are strongly aligned with isolationism and will push back against using multiple methods, and
3) Cognitive feasibility: it is cognitively difficult for an individual to easily move from one paradigm to another.

They suggest a process that requires addressing the inherent problems and assessing overall feasibility. Like Flood and Jackson (1991c), these authors offer a grid framework (see

Table 5-3) for matching problems with appropriate methodologies. Their grid considers three different dimensions of problem situations (material, personal and social) and four different phases of the intervention process (appreciation, analysis, assessment, and action). The idea of distinguishing the material, personal and social reflects Habermas's (1976) three 'worlds' of understanding, which was first introduced into the systems thinking literature by Midgley (1990b, 1992bc) as a theory to underpin Methodological Pluralism.

In Mingers and Brocklesby's table (

Table 5-3), each box is intended to generate questions that are specific to the situation/intervention being addressed. Methodologies can then be assessed for how well they address these questions. These authors point out that they do not intend to pigeon-hole methodologies into particular boxes, but to provide a guide for selecting those methodologies that may offer useful help.

Table 5-3: Mingers & Brocklesby's Framework for Mapping Methodologies, 1997, p.501)

	Appreciation Of	Analysis Of	Assessment Of	Action Of
Social	• social practices • power relations	• distortions • conflicts • interests	• ways of altering existing structures	• generate empowerment and enlightenment
Personal	• Individual beliefs • meanings • emotions	• differing perceptions and personal rationality	• alternative conceptualizations and constructions	• generate accommoda-tion and consensus
Material	• physical circumstances	• underlying causal structure	• alternative physical and structural arrangements	• select and implement best alternatives

5.2.2 Wicked Problems and Methodological Pluralism

With Rittel and Webber's (1973) introduction of 'tame' versus 'wicked' problems, it might be tempting to believe that there is a clear set of methods to use on tame problems and another set to use on wicked problems. Indeed, this was an early suggestion: tame problems were said to be more amenable to being addressed with traditional science, first-wave systems thinking, optimization and other Operational Research (OR) approaches, while wicked problems were thought to respond better to second-wave techniques (Jackson & Keys, 1984; Rosenhead, 1989). However, Simon (1973) contends that the boundary between well-structured and ill-structured problems is vague and fluid, and Midgley (2000) argues that whether a situation is seen as simple, complicated or complex is partly a matter of perspective, so diagnosing problem contexts is not an objective exercise. Kreuter, De Rosa, Howze & Baldwin (2004) therefore suggest that wicked and tame problems can be thought of as two ends of a continuum, allowing for a philosophy of 'and' rather than 'either/or' (Figure 5.1), and sometimes a tame problem can become transformed by events into a wicked problem.

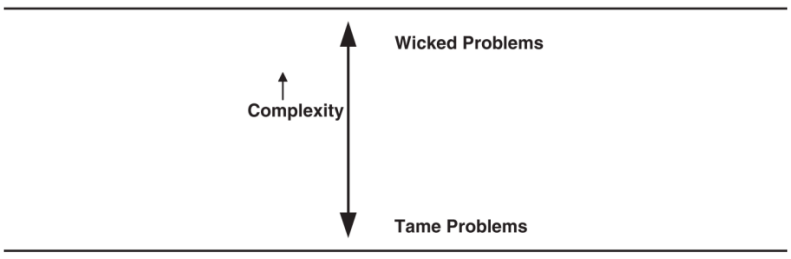

Figure 5.1: Continuum of wicked and tame problems (from Kreuter et al., 2004, p.445)

Andersson et al. (2014) provide a hybrid concept of 'wicked systems', where complexity and complicatedness is mixed, and where 'wickedness' is a system quality. Figure 5.2 shows how systems might be mapped given this understanding. It should be noted that these authors are complexity scientists who believe that there are simple human social subsystems that are relatively unstratified in their organization, and to some extent isolated from their environments. They suggest that it is these types of system where agent-based simulations (Holland & Miller, 1991; Epstein, 1999) can usefully be used.

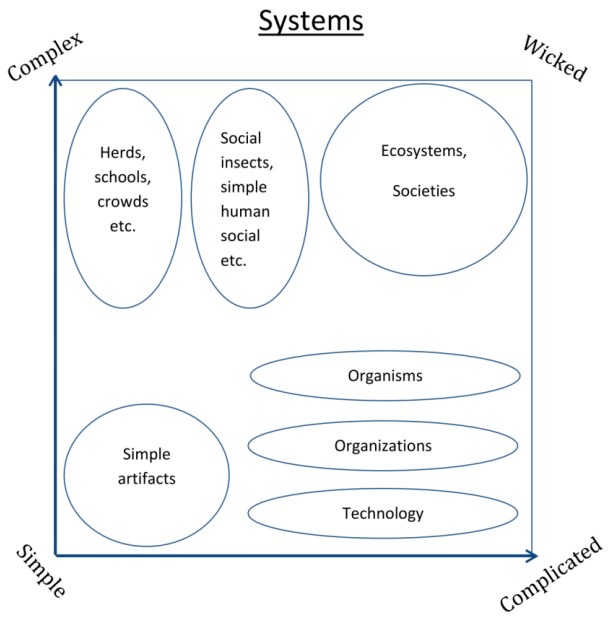

Figure 5.2: Different types of systems mapped onto the complexity-complicatedness plane (from Andersson et al., 2014, p.9)

Many interagency problems include aspects that are tame and other aspects that are wicked. Those wicked problems warranting attention from multiple agencies mostly span across space, time, disciplines, resources, and government jurisdictions. It seems highly unlikely that one single systems method or methodology could provide the interagency with the depth, breadth and diversity it needs to address the complexity of these problems. Schwaninger (2006) describes this situation as a double bind problem: (1) trying to address a complex situation based on one discipline, used to optimize in one single direction, can lead to unstable or even chaotic system behavior, while (2) attempting to use multi-disciplinary approaches is difficult and can lead to what Schwaninger refers to as the "Tower of Babel". It seems reasonable, then, that when trying to address wicked problems, the strengths of both analytical approaches and systemic (including critical systems) thinking should be combined.

5.3 Critical Systems Thinking

The term 'Critical Systems Thinking' (CST) was coined after both the work on CSH and Methodological Pluralism, to name the whole movement in third-wave systems thinking (Flood and Jackson, 1991b). Nevertheless, as both the cornerstones of CST have continued to be used, there have been tensions between the two because (1) CSH was silent about Methodological Pluralism between 1983 and 2012. He finally decided to discuss it in a 2012 paper (Ulrich & Probst,2012), and (2) the early work on Methodological Pluralism put CSH in a box in the System of Systems Methodologies, which makes it seem as if Boundary Critique is only of use in a minority of contexts (instead of being useful for exploring and defining those contexts).

Jackson claims that CST is based on five 'commitments' (Jackson, 1991): (1) critical awareness, (2) social awareness, (3) complementarism at the methodological level, (4) complementarism at the theoretical level, and (5) a dedication to human emancipation. These five were reduced to three by Schecter (1991) and Flood and Jackson (l99la): (1) critical awareness, (2) emancipation, and (3) Methodological Pluralism.

By the early 1990s, it appeared that CST had become a significant movement. However, Midgley (1996a) argues that there really isn't a single, consensually accepted definition of CST, but many perspectives on it. Nevertheless, all these perspectives have an interest in questions relating to the above commitments. Midgley further contends that CST is dynamic and continues to be developed, making it more of an "evolving debate around a set of themes that are considered important by a significant number of systems practitioners" (Midgley, 1996a, p 12). It is for this reason that he is critical of Flood and Jackson (1991b), because he feels that these authors describe CST too definitively, which doesn't allow for the variety of perspectives on it. Midgley also argues against their strong emphasis on Habermas's 'universalization of morality', finding it to be dangerous because it risks making morality appear absolute, which encourages uncritical commitment instead of critical thinking. Other criticisms of CST can also be found in the literature (Midgley 1989a, 1990ab, 1992ab, 1996b; Gregory 1990, 1992, 1996a,b; Tsoukas 1992, 1993), but they will not all be reviewed here, as only some of them have stimulated new methodological developments. Arguably, the most significant new methodological idea to be developed out of critiques of CST took the form of the Systemic Intervention approach developed by Midgley (2000), which is discussed below.

5.4 Systemic Intervention

Midgley and Rajagopalan (2021) boil the problems with CST down to three major ones (Table 5-4), and they reflect on how the resolutions of these problems resulted in a significant rethinking of CST (also see Midgley, 1992a; Munlo, 1997; Ho, 1997).

Table 5-4: Summary of Problems with CST and Proposed Resolutions (adapted from Midgley & Rajagopalan, 2021, pp.122-124)

Problem With CST	**Proposed Problem Resolution**
1) Relegating Boundary Critique to only simple-coercive contexts. Jackson (1987a) tried to subsume Ulrich's Critical Systems Heuristics (CSH) approach and make it into a methodology that is only of use in simple-coercive contexts. Ulrich (1993) objected strongly to this, saying that Boundary Critique is necessary for all interventions because only with Boundary Critique can you have a deep enough understanding of the problem context to choose the right methodology.	Practice Boundary Critique up-front in ALL interventions to accomplish a deeper diagnoses of problem situations with the use of a plurality of methods interspersed, if possible, with periodic checking on boundary questions.
2) The System of Systems Methodologies (e.g., Jackson, 1991) 'freezes' methodological interpretations in an unnecessarily restrictive manner	Allow for the creative choice of methods from across paradigms (designing new methods when existing ones are inadequate) and regard the intervention as a vehicle for learning and coordination.
3) There remains an inability to deal with significantly coercive situations. Midgley (1997a, 2000) challenges the assertion by Flood and Jackson (1991a) that CSH can actually handle coercive situations because the approach still assumes the possibility of debate or arbitration. Highly coercive situations are characterized by a closure of debate and the absence or weakness of institutions for arbitration.	CSH cannot adequately deal with highly coercive situations and therefore, instead of viewing the approach as dealing with coercion, view it as an approach to value clarification, either via an arbitrator or through the mutual exploration and clarification of values. In a highly coercive situation when debate is closed, direct political action is required to help open up channels of communication again (Midgley, 1992d, 1997a).

Reflecting on the above problems with CST and potential resolutions (summarized in Table 5-4), Midgley (2000) decided to develop a new framework for systemic practice called 'Systemic Intervention'. He defined this new approach as "purposeful action by an agent to create change in relation to reflection on boundaries" (Midgley, 2000, p.132). Systemic Intervention essentially combines aspects from both the CST strands of Critical Systems Heuristics and Methodological Pluralism (Midgley, 2000) without either strand being subsumed by the other.

5.4.1 Systemic Intervention: Boundary Critique

By putting Boundary Critique (in the form of CSH) into a box in the System of Systems Methodologies, Jackson (1991) is implicitly suggesting that Boundary Critique is redundant in a simple-unitary context (characterized by minimal complexity and agreement between decision makers on what the problem is), and therefore it is appropriate to move straight to a quantitative systems/OR approach. Midgley's (2000) argument (drawing on the prior thinking of Ulrich, 1993) is that you cannot know that you are facing a simple-unitary context unless you have done some initial exploration of stakeholder perspectives (i.e., have undertaken some initial Boundary Critique) to rule out the possibility that there are initially 'invisible' stakeholders with different perspectives. Midgley (2000, 2006a, 2015, 2018, 2022b) believes that, within any Systemic Intervention, Boundary Critique is always needed upfront to explore the situation deeply enough to identify the most effective systemic response. Of course, CSH alone is not enough for this: rather, Boundary Critique needs to be thought of in a broader manner (Midgley et al., 1998; Midgley, 2000).

In a paper reporting on an intervention to develop housing services for older people, Midgley et al. (1998) illustrate the theory and practice of this broader form of Boundary Critique. It involves the researcher in going beyond a client definition of a problem to find other stakeholder perspectives (if they exist). This allows the evolution of the purposes of the intervention, the boundaries of inclusion and exclusion, and the values (what matters to stakeholders in the context of action) that can be accounted for. Midgley et al (1998) also used Boundary Critique to address marginalization and to critically evaluate the contributions that could be made by marginal groups. Importantly, these authors stressed that Boundary Critique was used to inform the creative design of methods.

5.4.1.1 Marginalization

Midgley et al. (1998) consolidated the earlier work of Churchman (1970) and Ulrich (1983) on Boundary Critique and also swept in a theory of Marginalization (Midgley, 1992a) to inform the analysis of problem situations. Midgley (1992a) suggests that some problematic situations are characterized by two competing stakeholder boundary judgments: (1) a narrow primary boundary, usually (but not always) advocated by more powerful stakeholders, and (2) a wider second boundary, advocated by other stakeholders, which contains elements that have been excluded from the primary boundary (see Figure 5.3). The stakeholders advocating the different boundaries (and their associated values) come into conflict, and those elements that are outside the primary

boundary but inside the secondary one come to be marginalized. These marginalized elements have heavily value-laden ramifications because they become the focus of conflict between stakeholders.

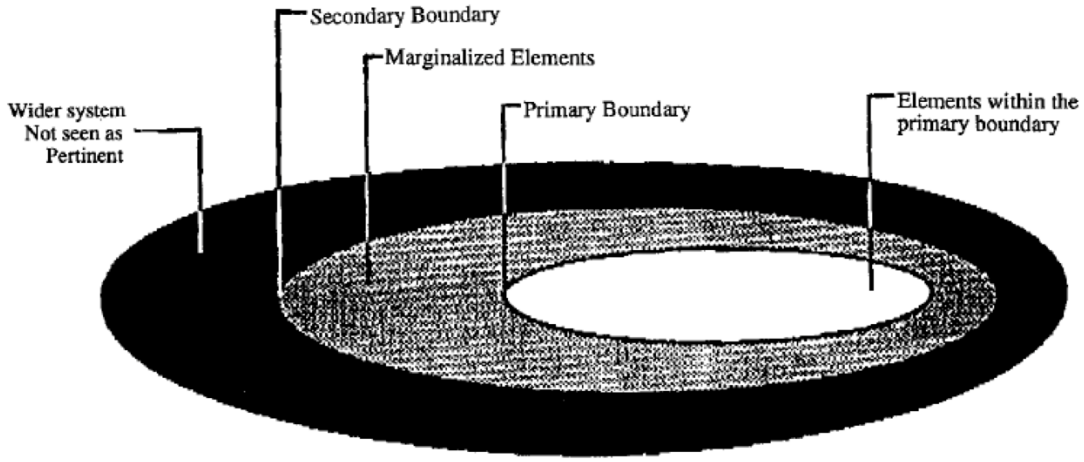

Figure 5.3: Marginalization (Midgley, 1992a, p.7)

Midgley (1992a) proposes a critical assessment of the values or ethics that arise from within both the primary and secondary boundaries (Figure 5.3**Error! Reference source not found.**). Midgley (1992b, 2016b) proposes a 'three-worlds' philosophical view (based on Habermas) as part of this critique of boundaries, as this can guide the choice of boundaries by questioning truth (what is believed to exist), rightness (normativity and shared values), and subjective understanding (how phenomena could be seen in different ways). This approach to Boundary Critique is based upon "three essentially interrelated "worlds" of understanding: the objective natural world, the normative social world, and my individual world" (Midgley, 1992a, p.8).

Midgley (1991,1992a, 1994, 2000) also considers boundary judgements to be rooted in culture, and that marginal elements are characterized as either 'sacred' (strongly valued) or 'profane' (derogated) by the different stakeholders (**Error! Reference source not found.**) (Figure 5.4). Profane elements support use of the primary boundary by devaluing marginal elements. In contrast, sacredness supports the secondary boundary by focusing attention beyond the primary one. It is when this process is then overlaid with social and institutional rituals that one of these interpretations becomes socially dominant. It is suggested that, by exploring these issues of marginalization early in a Systemic Intervention, heavily ethical, moral, and value-laden ramifications may be unveiled and addressed (Midgley, 2000).

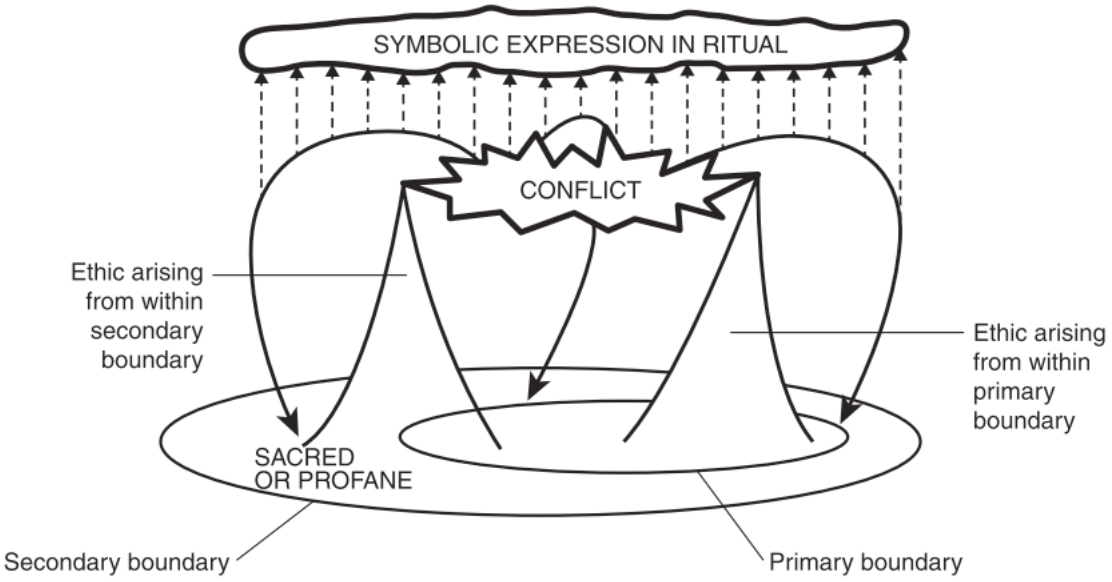

Figure 5.4: Midgley's concepts of sacred and profane (Midgley & Pinzón, 2011, p.12).

5.4.2 Creative Design of Methods

Midgley's view is that,

> "Methodology is one particularly important vehicle through which philosophers can apply their ideas; it is through methodology, which sweeps in philosophical reflection, that we can better understand how methods of intervention can be used to create and sustain valued personal, social and ecological change (Midgley, 2000, p.108)."

Midgley (1989a) finds flaws in how early advocates of CST (particularly Jackson, 1987b, and Flood, 1989a) claimed that CST's Methodological Pluralism is meta-paradigmatic (sitting above the paradigms and operating them, as if CST itself embraces no paradigmatic assumptions). Midgley (1990a) questions CST and the use of the SoSM in practice because he contends that there is a tendency for practitioners to narrow the situation being addressed down to fit into just one of the SoSM's categories of context. Midgley agrees with Gregory (1990) that this narrowing down limits our ability to understand situations.

Midgley (1992b) asserts that, to address complex problems, a mixed-methods approach is needed to deal with the interdependence between ecological harmony, social justice, and individual freedom. And to address the complexities of these problems, Midgley (1992b,c) advocates drawing from parts of older, previously distinct methods to create a genuinely flexible and responsive practice that addresses multiple stakeholder perspectives on the situation (including that of the researcher). This is not paradigmatically neutral, because a mixed-methods practice

inevitably operates with assumptions about the value of Methodological Pluralism that are not shared by many of the originators of the methods that have been borrowed and mixed (Midgley, 2000; Midgley et al., 2017). While Jackson (1987a, 2019) and Flood (1989a) might argue back that this is not 'proper' pluralism, because the presence of guiding paradigmatic assumptions hints at an imperialist reinterpretation of methods within an overarching methodological perspective, Midgley (2000) and Midgley et al (2017) explain that this is inevitable as it's simply not possible for any human being to have a 'view from nowhere', whether looking at methodologies and methods or anything else.

Because of this thinking, Midgley and colleagues recommend explicitly recognizing that we are operating within a new paradigm that focuses on the mixing of *methods*, not methodologies (Midgley, 1989a, 1990a,b, 1992b, 1997, 2000; Nicholson, Brennan & Midgley, 2014; Midgley et al., 2017), and they insist that methods must be separated from their original methodological foundations so they can be operated from the perspective of the new paradigm. In this way, new positions can be created and owned by an individual or small group. This allows a pluralist to use a full range of available methods but reinterpreted through the theoretical lens of their own methodology. In my view, for wicked problems that vary widely in their context and scope, this flexibility of reinterpreting methodologies and methods, and tailoring them to the wicked problem, is highly desirable.

In Systemic Intervention, Midgley promotes pluralism by encouraging the evolution of one's own methodology over time by interpreting and learning from other methodologies (Midgley, 2000; Midgley et al., 2017). This allows for each practitioner or group of practitioners to create their own set of methods tailored to the to the requirements of the unique intervention context at hand (Midgley, 1992b, 1997c, 2000, 2004, 2006a, 2011, 2015, 2018). Midgley (2000) argues that, instead of accepting rigid methodological interpretations advocated by the SoSM, Systemic Intervention creates a paradigm in its own right.

Other systems researchers have promoted the mixing of methods too. Yolles (1996, 1999) suggests that, because paradigms are sets of shared assumptions held in common by groups, we need to be able to understand what is happening when an individual researcher proposes a new methodological understanding. Is this already a paradigm, even though it is not shared beyond one person? Strictly speaking, because paradigms are collective in nature, the answer must be 'no'. However, Yolles (1996) argues that individuals can establish their own sets of assumptions, and he calls this the creation of a 'virtual' paradigm. The virtual paradigm can then be used to interpret 'reality', and ideas from other paradigms can be interpreted too. Therefore,

practitioners can tailor the approach needed to the context they are addressing. Yolles goes on to suggest that, if others want to adopt the ideas, the paradigm can move from 'virtual' to 'true' status over time.

5.4.3 Systemic Intervention to Manage Wicked Problems

Because the number of conceivable definitions for a wicked problem is indeterminate (Ulrich, 1988, argues that there may be as many definitions as stakeholder perspectives), we require a process to richly include as many stakeholders as possible into the intervention. In my view, because Systemic Intervention promotes Boundary Critique upfront and throughout the intervention, it provides a structured approach to considering the values and ethics of those involved in and affected by Systems Analysis and interventions.

Because stakeholder perspectives on wicked problem can often be very strongly held, gathering them into an open dialogue on setting boundaries can result in disagreements. Ulrich emphasizes that simply bringing stakeholders' worldviews together can create the conditions for coercion by more powerful stakeholders who want to suppress others. Thus, dealing with conflict (Midgley & Pinzón, 2011, 2013; Midgley, 2016a) and marginalization (Midgley, 1992a, 1994, 2000) is particularly important for addressing wicked problems, and we must not make the naïve assumption that bringing everyone together in a room is always the best course of action (Midgley, 1989b). As we will see later in the thesis, this observation became very relevant to my research, as the agency stakeholders I worked with initially brought perspectives on the problem that were cemented by their agency missions, defence of budgets, desires for personal and organizational recognition, and limited personal experiences. I had to work with them individually first, and then collectively, to support them in discovering that they all had restricted understandings that could be expanded through a process of learning from others (Sydelko, Midgley & Espinosa, 2017, 2021).

In addition, wicked problems are very complex and contain a plurality of contexts. It seems unreasonable to assert that just one non-pluralist methodology can cover all aspects of the context. Systemic Intervention and its adoption of a multi-method approach allows for the *creative design* of an intervention, tailored to the specific contexts that exist within the problem. This is another very important idea bought into my research. Not only do wicked problems contain a plurality of contexts, but each of them interacts with and influences others. A systems practitioner wishing to bring better understanding and foster improvements is best served when allowed to be creative in the selection and design of methods. Of course, following Jackson (2019), I agree that it is the responsibility of the practitioner to understand the philosophical ideas and

theories that originally informed the development of the methodologies we borrow methods from, as the study of these things can tell us about possible limitations inherent in those methods. But expecting a *non-pluralist* methodology to be sufficient for dealing with a wicked problem can actually be dangerous, because it will inevitably mean only tackling those aspects of the complexity that the methodology recognizes and responds to, while ignoring the rest. Initially hidden issues may later become apparent, and the credibility and effectiveness of the intervention may be undermined.

5.4.4 Systemic Intervention for Designing Interagency Organizations

A range of interagency approaches have been developed that are based on systems thinking (e.g., Coyle & Alexander, 1997; Givens, 2012; Foote, Taylor, Carswell, Nicholas, Wood, et al., 2014ab), and many researchers have specifically used Systemic Intervention to actively create improvements in wicked problems (e.g., Boyd et al., 2004; Midgley, 2000, 2006a, 2015, 2022; Foote et al., 2007; Midgley, Ahuriri-Driscoll, Foote, Hepi, Taimona et al. (2007); Shen & Midgley, 2007; Barros-Castro, Midgley & Pinzón, 2015; Espinosa & Duque, 2018; Helfgott, 2018; Morgan & Fa'aui, 2018; Pinzon-Salcedo & Torres-Cuello, 2018; Ufua et al., 2018; Gregory et al., 2020; Sydelko et al., 2021). This Systemic Intervention work will provide the foundation upon which I can build my own methodological contribution.

5.5 Summary

While second-wave systems approaches help to bring in the participation of multiple stakeholders and open up learning and dialogue, they do not explicitly address Churchman's (1970) valid concerns surrounding the boundary judgements that stakeholders bring with them. We need to take special care to prevent more powerful stakeholders (or 'experts') from simply taking their boundaries and values for granted and imposing them on others (Ulrich, 1996). Third-wave approaches brought in new theory and methodology for dealing with conflict (e.g., Midgley & Pinzón, 2011, 2013; Midgley, 2016a) and marginalization (e.g., Midgley, 1992a, 2000) to address this problem. Additionally, wicked problems span across bureaucratic and disciplinary boundaries, so third-wave systems thinking, embracing Methodological Pluralism, brings a multi-pronged approach.

Third-wave systems thinking is arguably useful in the context of wicked problems because it supports critical thinking about taken-for-granted boundaries; gives people tools to explore interconnections between issues; supports the consideration of multiple stakeholder

perspectives; and accounts for how the parts of a wicked problem interact to form a whole that is greater (more intransigent) than the simple sum of those parts might lead stakeholders to expect (Cabrera & Cabrera, 2015).

Multi-method approaches bring the ability to deal with the fact that every wicked problem is unique (Rittel & Webber, 1973), so will require the careful and creative design of methods (Midgley, 2000), also accounting for ethical considerations associated with how the stakeholders might perceive those methods. Therefore, it is my view that any wicked problem that consumes the attention (time and resources) of multiple government agencies will surely necessitate embracing *both* prongs of third-wave systems thinking (Boundary Critique and Methodological Pluralism). Systemic Intervention (Midgley, 2000) brings these two prongs together, and is therefore the overarching methodology chosen for this work.

Chapter 6: Phase One – Systemic Perspective Mapping and Boundary Critique

My PhD studies were funded by Argonne National Laboratory, where I was working as the leader of a Systems Science research group throughout my fieldwork. I therefore needed to choose a wicked problem for my Systemic Intervention that would allow me to innovate in a manner that would benefit Argonne (e.g., by creating a methodological approach that could be used in subsequent projects, and by building my skills in qualitative systems thinking to complement the quantitative methods used by all the rest of my colleagues).

Much of Argonne's research is on national security and policing issues, so I initially decided to develop a systemic approach to interagency counter drug trafficking, with a special focus on creating new analytical tools for modeling drug and money laundering supply chains. However, my aim quickly evolved into creating an approach that could be used to design interagency organizations that are tailored to specific wicked problems more generally, using the same basic approach. To this end, I realized (through my review of the literature on Critical Systems Thinking and Systemic Intervention, reported in Chapter 5) that I would need to mix various systemic methods that could embody or respond to the following aspects of wicked problems and interagency collaboration:

1) *Participation*. As discussed in Chapter 3, a key characteristic of wicked problems is that they have multiple stakeholders, each with their own perspective on the problem. Because different governmental departments (and other agencies and stakeholders) have their own specific missions, expertise and budgets, it isn't surprising that they also have different understandings of the problem. To engage across agency boundaries and facilitate the development of a common systemic understanding and situational awareness of a wicked problem, a method is needed that allows for each agency to describe the problem from their own unique perspective, and then to bring these perspectives together to evolve a common understanding. The method requires working separately with the agencies and then bringing them together because of the effects of power relations (another feature of wicked problems discussed in Chapter 3): bringing agency representatives together from the start risks silencing those who might be fearful of openly discussing their perspectives in front of others whose reprisals could negatively impact their work. Giving people some space to develop their perspectives separately before coming together with others, mitigates the risk of some being silenced (Midgley & Milne, 1995; Midgley, 1997a; Boyd et al, 2004).

2) *Power and Conflict Resolution*: Since agencies can hold very strong views about aspects of the problem, and because agency stakeholders can bring differing real or perceived power positions (as discussed above), a method is needed to reduce marginalization and deal with conflict between worldviews.
3) *Actionable Design*: While creating a common situational awareness is important for enabling better understanding of a wicked problem, my interest was to go further and actually design a collaborative interagency to operate as one adaptive unit to address the problem. I believed this was necessary because, despite decades of research on interagency co-ordination, the literature tells us that little progress has been made using conventional methods, such as appointing 'czars' to lead task forces (Sydelko et al, 2021).
4) *Flexibility for Analytical Enhancements*: While creating an organizational design tailored to a specific wicked problem is an important goal for this research, I also thought it was vital that the systemic framework should not preclude bringing first-wave analytical approaches into the design, if they proved relevant to the issues being addressed (which is in line with all the thinking about Methodological Pluralism, reviewed in Chapter 5).

This chapter will provide information on the overall two-phase study design I developed and will discuss the first phase and a new method called 'Systemic Perspective Mapping. Details of the second phase can be found in Chapter 7.

6.1 Background for the Systemic Action Research Study Design

In light of the above, it became evident that I would need to mix methods that would cross paradigmatic lines. For this reason, the study design embraced a third-wave systemic approach, which promoted Methodological Pluralism. In particular, I wanted a framework that would allow me to creatively mix methods into an overall approach, and one that would offer some thinking about Boundary Critique particularly to reveal and understand the boundary judgements each agency brings to the interagency table, and also to deal with the conflict that might arise between people making different boundary judgements. For these reasons, Systemic Intervention (Midgley, 2000) was chosen as the framework for the study.

In addition, since I was going to undertake a Systemic Intervention to foster a new interagency response to international drug trafficking, I would need to think in terms of action research. In all three waves of systems thinking, application has involved systemic action research. Although I prefer to view this study as a Systemic Intervention, which is more in line with the terminology of systems thinking explained in the last couple of chapters, it could be described in terms of action

research too. This is because both action research and Systemic Intervention involve facilitating a change and doing research on it.

The term 'action research' was introduced by Kurt Lewin (1946) as a social research approach that allowed for the generation of theory while acting directly on (or in) a social system. The adoption of action research happened first within the behavioral sciences (Checkland, 1972). Lewin promoted action research for its ability to change the system, and in the process create new knowledge about it. Action research also has roots in Collier's (1945) call for a research approach for generating action-oriented knowledge through collaborations between researchers, practitioners, and clients. Reason and Bradbury (2001, p.1) define action research as:

> "a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview which we believe is emerging at this historical moment. It seeks to bring together action and reflection, theory and practice, in participation with others".

Action research contributes to knowledge differently than conventional science. Instead of adhering to prescribed rules that enable independent observation that is judged to be such by a community of peers (Popper, 1972), the focus of action research is toward the emergence of action principles and the flexibility to guide practitioners in the many situations where independent observation is either impractical or is not what is actually needed, because the issue of contention concerns uncertainty about what ought to be done and not uncertainty about facts (Susman & Evered, 1978).

Action research has its critics, who question its objectivity and credibility, particularly because it does not accept the premises of the positivist and neo-positivist paradigms, which insist that valid knowledge can only be generated through observations, and is orientated to the ideal of truth (Susman & Evered, 1978; Winter, 1996). Susman and Evered (1978) contend that action research has far greater potential than positivist science for understanding and managing the affairs of organizations, and they suggest that there are six characteristics of action research that correct for deficiencies in positivism:

1. Action research is *future oriented* and recognizes human beings as purposeful systems (Ackoff and Emery, 1972).
2. Action research is *collaborative*, where researcher and client are interdependent, and the researcher is not a disinterested observer without his or her own ethics and values.
3. Action research *implies system development* by building an appropriate system and then allowing the relationship of the system and its environment to be modified.

4. Action research *generates theory grounded in action* by taking actions guided by theory and evaluating their consequences in the context of organizational change.
5. Action research is *agnostic* because action researchers recognize that they cannot simply use theories and practices from one context of action and apply them to a new one without reexamination and reformulation.
6. Action research is *situational* because action researchers are aware that, even when two contexts appear to be similar, relationships between people, events, and things may still differ in ways that are not immediately apparent, so the focus needs to be on one-off, collaboratively defined situations where planned actions will produce their intended outcomes.

Brydon-Miller, Greenwood, & Maguire (2003, p.17) also state that "Conventional researchers worry about objectivity, distance, and controls. Action researchers worry about relevance, social change, and validity tested in action by the most at-risk stakeholders."

Some action research has the adjective 'participative' put before it because of its emphasis on collaboration between researchers and stakeholders (e.g., Whyte, 1991ab). Walter (2009) states that the key to participative action research is in its name. What is more, the 'action' in action research refers to more than finding out about something: it denotes the creation of positive change. Participative action research directly engages the 'community of interest'.

The capabilities and characteristics of participative action research fit very well with this research, which aims to engage directly with stakeholders and facilitate learning and knowledge. This research is designed to address both (1) the practical concerns of government agencies collaboratively responding to a wicked problem, and (2) the advancement of knowledge in Systemic Intervention practice. All the research undertaken on Systemic Intervention to date has been based around an action research cycle, where the development of philosophy, theory and methodology inform practice, and that practice feeds back to change the philosophy, theory and methodology (Midgley, 2000). Indeed, when editing the 3rd edition of the *SAGE Handbook of Action Research*, Bradbury-Huang (2015) recognized that many authors in the field of systems thinking utilize action research to develop their methodologies over time, and she invited Midgley (2015) to write a chapter on Systemic Intervention, as this is both a systems approach in its own right and also (through its commitment to Methodological Pluralism) provides the capacity to draw upon methods from other methodologies that have likewise been developed through their creators' action research cycles.

As mentioned at the beginning of this chapter, my project was funded by Argonne National Laboratory. My thinking about the project initially began before my acceptance into the Systems Science PhD program at the University of Hull, and the fieldwork did not involve any authorization from a government entity to launch a real interagency organization. This was a constraint that I had to accept, so I worked with real agency representatives on *what an interagency should look like if one could be formed*.

The decision to propose illicit drug trafficking as the wicked problem for this action research, aside from being relevant to the Argonne research agenda (as explained earlier), came from me reading the book *Convergence: Illicit Networks and National Security in the Age of Globalization* (Miklaucic, & Brewer, 2013), published by the National Defense University (NDU). I asked a friend and colleague at NDU, Dr. Michael Miklaucic, one of the editors of the book and the organizer of the workshop associated with its publication, to discuss the possibility of using illicit drug trafficking as a wicked problem for this study, and if interagency cooperation was critical to addressing the problem. The answer was "absolutely, it is a real problem for the U.S. government, across several agencies". During discussions with Dr. Miklaucic, he suggested that the study should be restricted only to Western Hemisphere drug trafficking, and just one city be selected to represent regional/local perspectives. These suggestions were offered to keep the scope of the study manageable within time and budget constraints, and I accepted them.

6.1.1 The Wicked Problem Chosen for the Action Research

The specific action research for this study was designed to engage with U.S. Federal agencies involved in countering the illicit drug trade and trafficking into U.S. urban centers.

6.1.1.1 Background on the illicit drug trade

The National Center for Drug Abuse Statistics (2023) estimates that there are 37.309 million U.S. illicit drug users aged 12 and older, as of 2020, and reports over 70,000 drug overdose deaths occurring in the US annually. In addition to direct health impacts coming from illicit drug use, there are frequently comorbidities, such as increased chances of viral infections.

Illicit drug trafficking from Mexico started in the early part of the twentieth century as a relatively low-level activity, mainly moving locally grown marijuana and opiates across into the USA, but it expanded greatly by the 1970s. This was due to the successful breaking of the "French connection" (Astorga & Shirk, 2010), which was a heroin trafficking scheme where drugs were smuggled from Indochina through Turkey to France, and then to the United States and Canada.

In the 1970s and 1980s, the U.S. consumption of cocaine increased, which led to the rise of powerful Colombian trafficking organizations. Later, in the late 1980s and early 1990s, these Colombian organizations were successfully broken apart, opening up opportunities for Mexican traffickers to control smuggling routes into the U.S. (Toro ,1995).

The following are the drugs associated with Mexican trafficking organizations that are of the most concern (Beittel, 2019):

- *Cocaine*. Although cocaine supply mostly originates in Colombia, most of that supply is trafficked through Mexico, making Mexican drug traffickers the primary wholesalers of U.S. cocaine.
- *Heroin/Fentanyl*: Mexican transnational crime organizations (TCOs) have the greatest reach in distributing white powder heroin and fentanyl within the U.S. Mexico is the leading source of fentanyl and fentanyl-laced counterfeit pills, and there are indications that TCOs have been establishing clandestine laboratories for the synthesis of fentanyl.
- *Methamphetamine*: once a "home-grown" drug within the U.S., Mexican-produced methamphetamine has now overtaken U.S. sources, and Mexican traffickers now control the U.S. wholesale market.

According to the 2020 Drug Threat Assessment (Drug Enforcement Agency, 2021), Mexican transnational criminal organizations are considered the greatest drug trafficking threat in the U.S. because they 1) control the drug market, have established numerous transportation routes, use advanced communications, and have formed strong relationships with U.S. criminal groups and gangs (Figure 6.1). In addition to the health threats posed by the illicit drug trade, TCOs, criminal groups and gangs are also responsible for violence, intimidation, theft, and financial crimes. And these same groups also participate in the smuggling of illegal aliens, firearms trafficking, and public corruption.

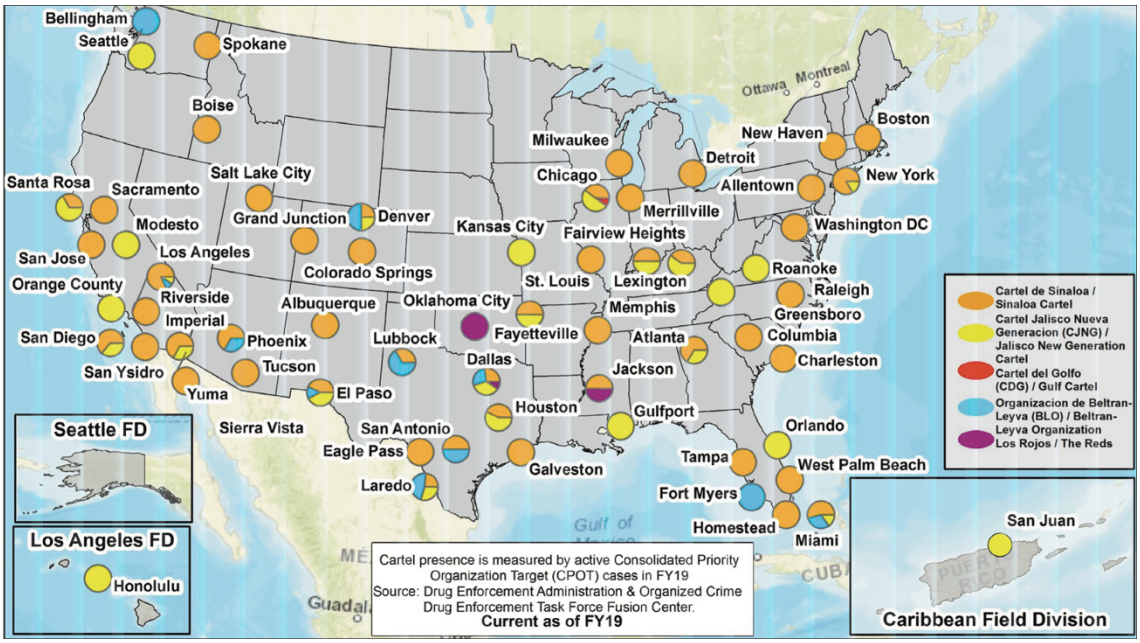

Figure 6.1: United States areas of influence of major mexican transnational criminal organizations by individual cartel (from Drug Enforcement Agency,2021, pg. 65)

The two largest Mexican drug trafficking organizations are the Sinaloa Cartel and the Jalisco New Generation Cartel (CJNG) (Drug Enforcement Agency, 2021). These organizations manage the transportation routes and distribution cells that deliver to the U.S. user markets (with the help of local street gangs). In a survey of Illinois police chiefs and sheriffs, the top drug threats were said to be heroin, prescription drugs, and methamphetamine (Gleicher & Reichert, 2020).

In Illinois, Chicago is a major hub for trucking and transportation, and therefore drug trafficking mostly occurs via commercial trucks, passenger vehicles, mail package delivery services, air couriers, and railways (National Drug Intelligence Center, 2001). The U.S. Drug Enforcement Agency (DEA) considers Mexican TCOs and street-level gangs to be the greatest threat to Illinois (DEA, 2015). This is due to drug-related violence between warring street gangs, using intimidation and violence to propel their drug operations and control drug distribution territories (National Drug Intelligence Center, 2011).

According to the High Intensity Drug Trafficking Areas (HIDTA) program's report to congress (Office of National Drug Control Policy, 2022), the major drug threats in the Chicago are the distribution and use of heroin, fentanyl, and fentanyl-laced drugs. This report attributes the majority of retail distribution to organized criminal street gangs, who also regularly engage in violent criminal activities to protect their drug supplies, distribution territories, and illicit drug proceeds. Additionally, the street gang distribution and related violence has started to spread from the inner city to the Chicago suburbs.

The supply chains for illicit trafficking cross many tiers of a transnational crime network that include supply coming from outside the U.S., the act of smuggling illicit drugs across the 2,000-mile U.S./Mexican border, and the U.S. national-level, state, and city/regional distribution networks (Witt, 2019). Often, the successful movement of illicit drugs relies on corrupt government officials and the infiltration of cartel members into the law enforcement agencies that are supposed to prosecute them (Coyne & Hall, 2017).

In addition to the supply-chain aspects to drug trafficking, another important component is the money laundering process that serves to make illicitly-obtained assets legitimate. The cycle for money laundering generally consists of (Drug Enforcement Agency, 2021):

1. *Placement*: illicit funds enter the financial system through legitimate businesses (money service businesses, casinos, banks, real estate, art, etc.).
2. *Layering*: money is moved to disguise its origin, often through multiple countries.
3. *Integration*: illicit funds become "clean", allowing them to re-enter the economy.

6.1.1.2 The Illicit Drug Trade is a Wicked Problem

Illicit drug trafficking is a highly complex issue, and certainly meets Rittel and Webber's (1973) criteria to be a wicked problem. The illicit drug trade and trafficking is a complex international problem with interrelated social, economic, diplomatic, law enforcement, and health problem aspects. Viewed from different perspectives (whether from different federal agencies, nations, city governments, public health departments), different aspects of the problem are the focus. Alford & Head (2017) argue that the drug trafficking issue is impossible to precisely define, and that efforts to define it do "not necessarily unearth key causal linkages among entities or phenomena" (Alford & Head, 2017, p.405).

A major issue with trying to formulate and structure a wicked problem is that wicked problems are partly defined by their complex interdependencies and uncertainties (Rittel & Webber, 1973). Drug trafficking fits this description because responsibilities for addressing it spans across the jurisdictions of many agencies, each having a unique perspective on the problem that has been shaped by its mission, expertise and budgetary constraints. It is also the subject of considerable public and political debate. For instance, McGinty, Niederdeppe, Heley & Barry (2017) found that, in the U.S., Democrats would be more likely than Independents and Republicans (and

Independents would be more likely than Republicans) to favor legalization of recreational marijuana.

Rittel and Webber (1973) also assert that, when dealing with wicked problems, the word 'solutions' is problematic because wicked problems have no stopping rule. In addition, these authors argue that every solution is a 'one-shot deal', and there are no opportunities for 'trial and error'. Each attempt to create a solution or to intervene will end up changing the problem, and sometimes in surprising ways. Certainly, the U.S. war on drugs illustrates this. An example is the extreme demand-side approach used in the U.S. War on Drugs (Provine, 2011) that has resulted in the punishment and incarceration of poor minorities in the prison system, particularly young African American males. Not only did this process stigmatize minorities, but it also removed many fathers from their families, creating unanticipated spin-off social problems. The interrelationships between drug arrests and other societal issues became very evident.

Another example is when supply-reduction strategies in certain growing areas resulted in a shift to new production areas elsewhere (Falco, 1996), especially if demand remained high. Antidotal evidence was offered by some of my participants during the study that that cocaine crop production in Colombia appeared to be increasing, and this was the result of the U.S. strategy pivoting on strong intervention to counter the opium problem. At the time of my fieldwork, the agencies were discussing whether to shift resources away from opium toward cocaine interdiction, and they noted that, regardless of where intervention is concentrated, it just creates a shift to another drug or another geographical production area.

Finally, Rittel & Webber (193) contend that every wicked problem can be seen as a symptom of another problem. This is illustrated in the area of illicit drug trafficking by the fact that criminal organizations are having increased relationships with terrorist groups (Hernández, 2013). Another example is the link between drug trafficking, gang violence in Central America, and the immigration crisis at the U.S. border (Palmer, 2015).

Illicit drug trafficking has many hallmark characteristics of a wicked problem. It is also a problem that challenges interagency responses, given the number of agencies involved in countering the drug trade. It was selected as the problem for this study for the above reasons; because it fit well with Argonne's agenda (discussed earlier); and also because I had access to the National Defense University and the scholars there who were organizing workshops and research around this issue (especially as it relates to terrorism and national security). This was key to gaining access to

agency personnel who were in the midst of responding to the problem – access that would otherwise have been very difficult to obtain for an academic study.

6.1.2 Initial Boundary Critique and Selecting Stakeholders

The Boundary Critique for this research began prior to stakeholder selection. The research team (myself and my two supervisors) discussed their own attitudes to illegal drugs, the drug trade and the possible consequences for the project. This kind of discussion reflects the understanding in Boundary Critique that researchers are never value-neutral – even in deciding what to research in the first place, value judgments come into play (Ulrich, 1983; Midgley, 2008), and stakeholders will inevitably take a stance on the perceived identities of, and communications with, researchers (Midgley et al., 2007).

All of us agreed that the many harms stemming from the drug trade are worthy of intervention, and we also agreed that there might well be much better ways of addressing them than current U.S. policy allows. We also shared our previous experiences of working with the various law enforcement and military organizations involved in tackling organized crime and discussed the fact that many senior stakeholders in those organizations are likewise critical of the status quo and open to alternatives, so we wouldn't automatically be entrenching current policy by working with them.

Finally, we discussed whether drug consumers and dealers are stakeholders, which carries the implication that they might need to be involved as participants in the research, or at least have their perspectives represented. We agreed that they are indeed stakeholders but involving those who had a stake in perpetuating the harms that stem from the drug trade would be counter-productive: our experience told us that none of the representatives of public sector organizations would be willing to share their insights with people engaged in criminal activities. This might sound like we are stating the obvious, but it needed to be articulated because any decision to exclude stakeholders would inevitably influence the course of the project. In this case, we believed the exclusion was justified, as it would not be possible to discuss interagency relationships without agency representation, and we trusted that the agency representatives would remain open to alternative policy options, if relevant.

The Boundary Critique then continued, going beyond the research team, at a workshop held at the National Defence University in May 2016, to which an initial set of agency stakeholders and subject matter experts were invited. The group of attendees were all well known in U.S. drug

policy circles for their knowledge on illicit drug trafficking. This workshop generated a lot of good discussion, resulting in the generation of a list of suggested agencies that should be included in producing an interagency design.

The set of stakeholders who participated in the study were mid- to high-level decision makers with an average of 15 years of experience working in the following agencies: the Department of Justice (Drug Enforcement Agency, Chicago High Intensity Drug Trafficking Area); the Department of Homeland Security (Customs and Border Protection, Coast Guard); the Federal Bureau of Investigation; the Chicago Police Department; the Department of Defense (counter transnational crime entities); and the Department of the Treasury. There were suggested agencies that were not included, mostly because attempts to recruit specific representatives were not successful. These were the Department of State; local, state, and federal public health departments and agencies; others from the intelligence community; additional local government partners; non-governmental organizations; and international agencies from beyond the USA.

The agencies on the list were contacted to select a representative to participate in the study. A few additional stakeholders were identified during the course of the research and were involved in later workshops. This happened as a result of the systemic learning among the existing stakeholders, who came to appreciate that there were important gaps in their knowledge of parts of the international and local organized crime systems.

It was also at this time that I chose Chicago to be the 'local' city to use in the research. Chicago was chosen because (1) Argonne National Laboratory is located there; (2) there was strong engagement from a Chicago police officer in the initial workshop, with a promise from him to help me secure participation from other local agencies; and (3) other participants recommended Chicago as a city that is representative of urban centers in the USA, in terms of the drug-related harms being experienced. Three of the initial participants for this workshop volunteered to be stakeholders for the study.

All the participants agreed to provide the names and contact information for other potential stakeholders they knew were actively involved in countering illicit drug trafficking. A list of stakeholders was generated, and further networking with stakeholders led to additional stakeholders being identified. This resulted in 13 stakeholders participating (starting with 9, and then later adding 4 after the initial phase of the study had begun). These stakeholders represented 10 agencies (some agencies provided stakeholders from various organizational levels, i.e., one regional and one federal).

Although the final list of stakeholders represents a subset of all stakeholders that would be needed for an actual intervention at the highest levels of government, the research participants did represent mid to high-level decision makers. All the stakeholders had previous experiences in interagency activities. A few were familiar with systems approaches (mostly related to network analysis), but the majority were not familiar with the concept of wicked problems and had not used any systems approaches to organizational design.

After the initial 2014 workshop, a research proposal was submitted to Argonne National Laboratory to embark on a study to create a Systemic Intervention framework whereby first-wave computational system modeling and second- and third-wave systems methods would be used to study very complex and highly interdependent wicked problems impacting many stakeholders. This study was entitled 'Crime on the Urban Edge'. I was the principal investigator (PI), and the study included two other co-investigators (CIs), Ignacio Martinez-Moyano and Michael North. These two CIs were responsible for the computational modeling portions of the study, summarized in Appendix 4 (I have not included discussion of the computational modeling in the main body of the thesis because of the leadership of these other researchers, while the parts of the study that are reported in this and the next chapter were undertaken by me alone, with the support of my supervisors). I was responsible as the overall project manager and integrator of the multiple parts of the study, and I led on stakeholder interactions and communication, as well as implementation of the second- and third-wave systems methods.

Using the second- and third-wave part of the Crime on the Urban Edge project proposal as my focus, I applied to, and was accepted by, the University of Hull Systems Science PhD program in September 2014, and I began my study of systems thinking methodologies under the first-supervision of Professor Gerald Midgley. Initially, Professor Terry Williams was my second supervisor, but when I decided to use the Viable System Model (VSM) (Beer, 1984) within my Systemic Intervention (see Chapter 7), Terry Williams stepped down, and Dr Angela Espinosa took over, as she had specific expertise in the VSM.

Before engaging with stakeholders, I submitted a request for ethical clearance and a data management plan to the Business School Ethics Committee. This was in April 2015, and both were approved.

Each stakeholder was sent a formal invitation letter (see Appendix 1), outlining (1) the goals of the study, (2) what they could expect as stakeholders, and (3) the fact that their identities would

be kept confidential. Because all the stakeholders volunteered their time to participate, even while they were heavily involved in actively addressing this wicked problem, the time allotted to achieving the goals of the study had to be kept manageable for them. See Midgley and Shen (2007), Hodgson (2013, 2016), Helfgott (2018) and Midgley, et al. (2018) for discussions of time management as a Boundary Critique issue. Overall, the estimated time stakeholders dedicated to the Systemic Intervention was 30 hours each. Only two stakeholders dropped out midway because they could not commit sufficient time.

6.1.3 The Systemic Intervention Design

The research goals of the project were to develop a mixed-methods systems approach to (i) generate a multi-perspective, common interagency understanding of a specific wicked problem, and then (ii) design a tailored, agile, interagency response to manage it. A methodological framework was needed that embraced multi-stakeholder engagement in the design process, bringing together the various relevant agencies. It also needed to support the use of multiple systems methods, as third-wave systems thinkers (especially those working under the banner of Critical Systems Thinking) have persuasively argued that wicked problems cannot be addressed with only one method (e.g., Flood & Jackson, 1991b; Flood & Romm, 1996; Mingers & Gill, 1997; Midgley, 2000; Taket & White, 2000). Finally, the framework would need to help participants deal with boundary judgments through focused dialogue, given the very different concerns of the participating agencies.

As mentioned earlier, Midgley's (2000) Systemic Intervention approach was selected for this research because it addresses the above requirements. This is in contrast with most other well-tried multi-method approaches that are participative (e.g., Flood, 1995) and welcome Methodological Pluralism (e.g., Flood & Jackson, 1991a) but do not put the exploration of boundaries up-front (see Ulrich, 1993, Midgley, 1997c, 2000, and Midgley and Shen, 2007, for critiques of multi-method approaches that don't prioritize Boundary Critique).

Midgley (2000, p.132) defines Systemic Intervention as "purposeful action by an agent to create change in relation to reflection on boundaries". As discussed in Chapter 5, it unifies two themes from the literature on Critical Systems Thinking: Methodological Pluralism and Boundary Critique. Methodological Pluralism focuses on the need to draw upon insights and methods from a rich diversity of other methodologies, and to creatively design a tailored approach that responds to the requirements of the unique intervention context at hand (e.g., Jackson & Keys, 1984; Jackson, 1991, 2000, 2003; Midgley, 1992b, 1997b; Mingers & Brocklesby, 1997; Mingers & Gill, 1997).

While Systemic Intervention promotes the mixing of methods from other methodologies, it also encourages learning from the latter to inform the evolution of one's own methodology over time (Midgley, 2000; Midgley et al., 2017).

However, mixing methods and learning from other methodological approaches is insufficient on its own (Ulrich, 1993; Midgley, 2000): there is also the need for a penetrating exploration of the context of the intervention, paying particular attention to the contrasting values and boundaries being used by different stakeholders, and the conflict and marginalization that can unfold as a result (Midgley & Pinzón, 2011). This kind of exploration is often called 'Boundary Critique' (Midgley, et al., 1998). It builds on the previous work of Churchman (1979ab), who describes an 'unfolding process' for systems projects, which includes the consideration of different viewpoints and the 'sweeping-in' of as many factors as possible into systemic analysis (but without compromising intelligibility through over-inclusion). Also particularly relevant is Ulrich's (1983, 1988) insight that the unfolding process is inevitably subject to practical constraints, so the key requirement is to bound the exploration in a manner that diverse stakeholders can agree through dialogue is reasonable – and when this is not possible, decision makers are ethically obliged to explain to others why dialogue needs to stop. Special care must be taken to prevent more powerful stakeholders (or 'experts') from simply taking their boundaries and values for granted and imposing them on others (Ulrich, 1996). Thus, dealing with conflict (Midgley & Pinzón, 2011, 2013; Midgley, 2016a) and marginalization (Midgley, 1991, 1992a, 1994, 2000) is particularly important.

Using Boundary Critique prior to creatively designing a mixed-methods systems approach, and periodically again during the process of application, helps to mitigate the problem of basing the design on an insufficiently systemic understanding of the wicked problem (Córdoba and Midgley, 2006). Other researchers have used Systemic Intervention for actively creating improvements to address various different social issues (e.g., Boyd et al., 2004, 2007; Midgley, 2006a, 2015, 2022; Foote et al., 2007; Córdoba & Midgley, 2003; 2008; Midgley et al., 2007; Shen & Midgley, 2007; Barros-Castro et al., 2015; Espinosa & Duque, 2018; Morgan & Fa'aui, 2018; Helfgott, 2018; Pinzon-Salcedo & Torres-Cuello, 2018; Ufua et al., 2018).

The Systemic Intervention approach developed in this study mixes (1) Boundary Critique on the part of the team when starting to explore the problematic situation, plus further facilitated Boundary Critique by stakeholders on their values and boundary judgments, and (2) development of a new PSM to generate a common, systemic understanding of stakeholders' perspectives on the wicked problem. A detailed discussion of this new method is provided in section 6.2 of this

chapter. Subsequent use of the Viable System Model (Beer, 1984) to design an interagency organization is presented in Chapter 7.

Particularly pertinent to this research study was Midgley et al's (1998) Systemic Intervention to improve housing services for older people, which (as we shall see) has informed the basic structure of my own interagency approach. This study combined Boundary Critique problem mapping and the Viable System Model (VSM) to support the design of an interagency organization, although their problem mapping method was quite different from my Systemic Perspective Mapping. Also contributing to my research was Espinosa and Duque (2018), who likewise combined Boundary Critique and the VSM to explore issues of self-governance in a multi-agency organization (a Colombian indigenous association in the Amazon). Lastly, Brocklesby (2012) was also an important influence, as he worked on a very similar wicked problem: developing an interagency law enforcement response to the problem of organized transnational crime in New Zealand.

6.1.4 Structure of the Systemic Intervention

The design of this action research study was broken down into two phases, each with its own research purpose:

Research Purpose for Phase One: Develop, implement, and assess a participatory Problem Structuring Method, underpinned with Boundary Critique to create a common interagency understanding of a wicked problem (the illicit drug trade) among multiple agencies.

Research Purpose for Phase Two: Building on the results from phase one, develop, implement, and assess a VSM approach (Beer, 1979, 1981, 1984, 1985) to designing an interagency meta-organization that is 1) tailored to the representation (that stakeholders themselves created) of the wicked problem and 2) capable of effectively addressing the problem at multiple scales and across boundaries.

Figure 6.2 shows a depiction of the entire Systemic Intervention approach in which Boundary Critique problem structuring and the VSM were embedded. Boundary Critique and problem structuring were crucial in producing a cross-agency systemic representation of the wicked problem (Sydelko, Midgley & Espinosa, 2021) that ultimately represented the 'environment' used to design the interagency organization using the VSM.

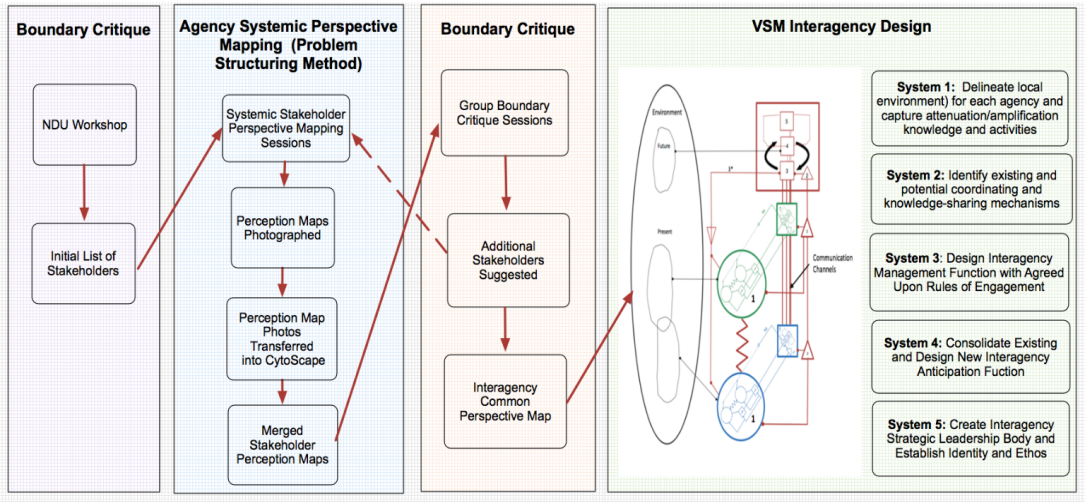

Figure 6.2: Systemic Intervention Approach to Designing an Interagency Response to a Wicked Problem

6.1.5 Evaluating the Systemic Intervention

This entire study was highly participative in both phases of the research. Throughout the study, evaluative information was gathered through observations, debriefing sessions and anonymous questionnaires (adapting the approach taken by Midgley et al., 2013), on (1) how the participants acted and interacted with each other during the process; (2) what they believed they were able to accomplish as a group; (3) what they valued about the approach; and (4) how they would want to improve it.

Midgley et al., (2013) argue that universally applicable knowledge about methods cannot be achieved because knowledge and understanding are too linked to the unique purposes, values and boundary judgements being made (Churchman, 1970; Ulrich, 1994; Alrøe, 2000; Midgley, 2000). Therefore, Midgley et al., (2013) recognized the need for an evaluation approach that could be meaningful locally, but still support longer-term comparisons between methods. Their evaluation framework (Figure 6.3) relies on understanding the relationship between context, purposes, methods, and outcomes.

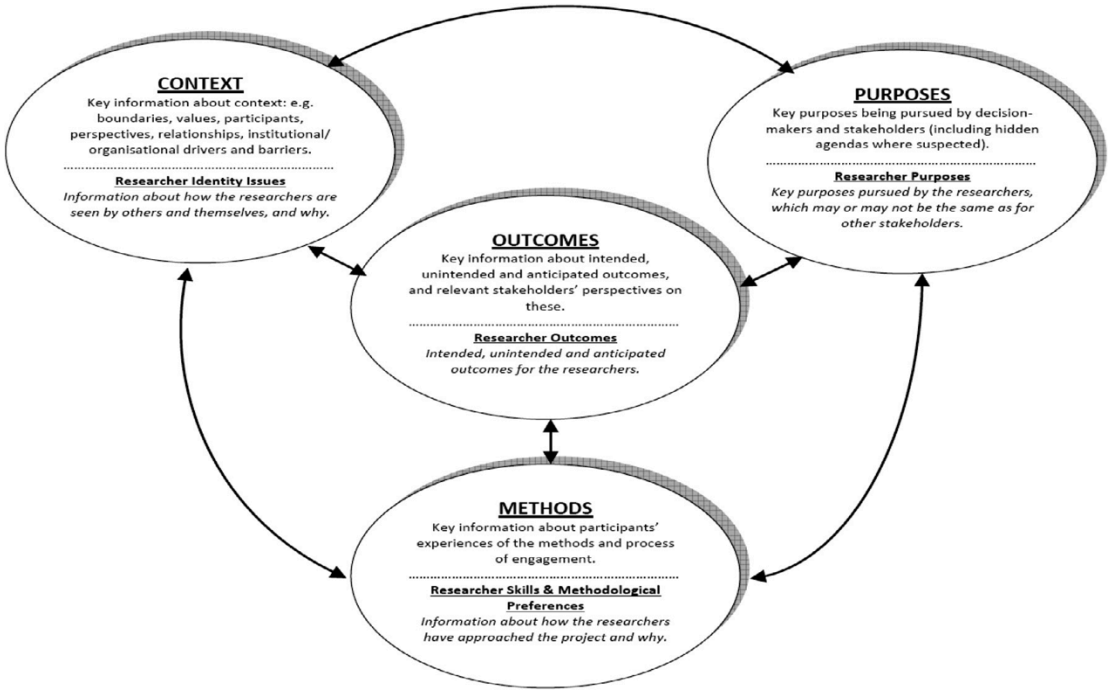

Figure 6.3: Framework for evaluating systemic PSMs (Midgley et al., 2013, p.146)

Related to this framework, Midgley et al. (2013) offer a questionnaire that can be customized for use to gather feedback from participants following systemic PSM workshops. Data from the completed questionnaires can be fed into a reflective workshop where the researchers and key stakeholders can evaluate an intervention and the methods used in it. Thus, the evaluation is more robust than researcher reflections alone.

Ideally, I would have recorded all the sessions with participants in addition to holding debriefings and giving out questionnaires. However, because the participants were concerned about confidentiality, they did not want me to audio-record or videotape the sessions. Instead, I captured observations about stakeholders' behaviors in field notes and used this information along with the formal questionnaires filled in by participants to assess the intervention. Clearly, this restricted the types of post-intervention data analysis that were possible. See White, Burger & Yearworth (2016) for a good example of the use of videotaping to gather data to support theory-building about problem structuring interventions, bringing together Franco's (2013) idea of models as boundary objects with activity theory (e.g., Engeström, 2005, 2008) to explain the behaviors of stakeholders captured on video. When the use of video is not possible, even audio-recording facilitates the detailed analysis of transcripts – for example, it allowed Velez-Castiblanco et al. (2016) to provide rich evidence from a Systems Science team's conversations to support their theory of how practitioners negotiate boundaries when designing their interventions.

Concerning the use of questionnaires, these were sent to stakeholders after the first and second phases of this research (see Appendixes 2 and 3 respectively for copies of these questionnaires). While Midgley et al (2013) recommend convening a reflective workshop with selected participants, this was not possible for my research because the participants were already giving the study as much time as they could afford. It was clear from early consultations with the participants on time expectations that it would not be possible to add in additional reflective sessions, beyond simple debriefs at the ends of interviews and workshops, and the completion of questionnaires.

My data analysis therefore consisted of collating the questionnaire answers along with my field notes about my own observations and reflecting on these to highlight the key strengths and weaknesses of each part of the intervention, making sure that all the points made by participants (whether supportive or critical) were communicated in this thesis.

6.2 Systemic Perspective Mapping

Forging a cross-agency understanding of the wicked problem is vital to any successful design of an interagency response. In the process, respecting and appreciating the various and sometimes conflicting stakeholder perspectives and values is crucial – if formulating an understanding of the wicked problem is done without reference to multiple perspectives, that understanding is likely to be impoverished (Churchman, 1979a). This section will cover the first phase of the research focused on the creation of a common interagency understanding of a wicked problem using a new method I call 'Systemic Perspective Mapping, which combines problem structuring and Boundary Critique at the individual and then at the multi-agency levels. Systemic Perspective Mapping is relatively simple and hands-on, and allows agency stakeholders to add, remove, set-aside, rearrange, and manipulate the elements and interdependencies as they develop the structure of the problem, either alone or in a group. This process is similar to what Wujec (2013) describes in his 'How to Make Toast' video. In addition, my approach includes a way to capture how different stakeholders weight each element and relationship. As will be explained, this information was critically important for later in the study when the stakeholders went on to explore boundary judgments with others.

Because the perspectives on wicked problems and the beliefs on what actions ought to be taken for improvement are unique to each agency stakeholder, being able to fully capture that perspective is important. Traditional PSMs often start by bringing all stakeholders together to

structure a common understanding of the problem (e.g., Checkland & Scholes, 1990). However, this puts stakeholders directly into dealing with conflicts and possibly interagency posturing before they have even had a chance to think more deeply and systemically about their own perspectives and values in relation to those of others. It was our judgment, having had some experience of stakeholder interactions in our first workshop held in May 2016 (discussed earlier), that it would be problematic bringing the agency representatives together from the start if they didn't first get a sense that they could only see part of the picture. The danger would be people assuming that only they could see the whole, and others were simply wrong. To avoid this, I developed Systemic Perspective Mapping where all the stakeholders were allowed to express their viewpoints in individual sessions before we brought the whole interagency group together. This approach (1) addresses stakeholders' purposes and values by allowing them to freely capture what they perceived to be the key elements of the problem, and (2) explicitly identifies what they perceived to be the interdependencies between these elements. Using the Systemic Perspective Mapping as an unfolding process (Churchman, 1979) with individuals (rather than the full interagency group) allows stakeholders to develop, explore, and play with their problem perspectives without having to consider conflicting perspectives from other stakeholders at the outset, and without us imposing boundary constraints. This is an important first step to addressing the potential for marginalization in future cross-stakeholder Boundary Critique because, in this initial stage of the work, every stakeholder has the full, unchallenged opportunity to describe their own perspective on the problem.

Stakeholders were free to come up with whatever problem elements were pertinent to them, and they were also free to draw relationships and interdependencies where they perceived them to be. This work with individuals was done to empower divergent thinking, and (as mentioned earlier) it gave the participants a sense of their inevitably partial knowledge – as they began to explore less-familiar aspects of the problem situation, they were forced to admit to areas of ignorance. I anticipated that this would make them more open minded to other perspectives when stakeholders were brought together for collaborative exploration.

6.2.1 Why Develop Systemic Perspective Mapping?

My experience of the Boundary Critique workshop (and my three decades of prior experience working with similar stakeholders in cross-agency decision support systems development) told me that there was a significant risk of some agency representatives erroneously assuming that they already had a good understanding of the wicked problem. I was concerned that they would all bring different, partial perspectives to bear (with their boundaries strongly influenced by their

agencies' purposes and values), leading to people talking past each other, failing to see that they were making different assumptions about what mattered, or using the same words differently without realizing it. I therefore decided that a priority in the project needed to be problem structuring, for two reasons: first, to reveal to the participants the degree to which their partial perspectives could create miscommunications; and second, to gradually build a common, richly textured understanding of the wicked problem that could inform interagency co-ordination and the design of a meta-organization using the VSM (described in detail in Chapter 7).

There are several PSMs in the literature incorporating visual modeling (which Sibbet, 2012, argues is better for systemic thinking around complex problems than use of verbal dialogue alone), and I reflected on their strengths and weaknesses before deciding to create my own. For instance, a PSM to explore stakeholder values using visual aids was developed by Cronin et al. (2014). While this has been shown to increase mutual understanding, reduce conflict, and build trust among stakeholders, it does not provide a tool for systemically mapping problem elements and their relationships. Causal loop modeling, sometimes used as a precursor to System Dynamics (SD) and sometimes as a PSM without System Dynamics quantification, provides a method for visually mapping elements and relationships, but it only captures relationships that take the form of positive and negative causal interactions and feedback loops (Forrester, 1994; Vennix, 1996). Causal mapping (Bryson, Ackermann, Eden & Finn, 2004) helps to map elements and relationships, but imposes probabilistic cause-and-effect thinking.

While feedback loop methods enable visual mapping of systemic relationships, they impose cause-effect thinking that I felt was too restrictive for describing wicked problems. 'Rich picturing' (Checkland & Scholes, 1990; Checkland & Poulter, 2006) is better in this regard, as stakeholders can capture viewpoints as well as relationships in their models, but even this has three drawbacks in the context of our project. First, the person or people who draw the model are generally the only ones who can fully understand it, as its 'messiness' makes it of limited utility for communicating with others (Boyd et al, 2004). Second, this problem of communication means that it would not be easy to combine several rich pictures into a single model representing an agreed collective understanding. Third, I thought it would be useful if participants could move elements in the model around to experiment with different possible configurations, and the usual pen-and-paper way of doing rich pictures would not allow this.

Because interagency responses to wicked problems can occur in highly political and budget-constrained environments, and agencies can be protective of their missions, structuring the problem with each individual agency first is important to reduce the threat of being marginalized

by other stakeholders arguing for their own perspectives. Individual stakeholders were free to express their perspectives and make their own judgements on what is most important to them. This individual mapping process used for the research is explained in the section below, and examples of the resulting maps are provided.

6.2.2 Implementing Systemic Perspective Mapping

Systemic Perspective Mapping captures the problem perspectives of stakeholders by simply using note cards, sticky notes and felt markers. The process initially entailed facilitating systemic thinking around the problem by having individual stakeholders directly identify and describe what they considered to be key elements of the wicked problem (e.g., cartels, drug laboratories, growers, gang members, distributors, and customers). To begin, stakeholders were asked to write the names of problem elements on note cards and place them on the table.

Checkland (1981) discusses the value of clearly distinguishing between developing an understanding of the problem situation and proposing interventions: often perspectives on the situation and ideas for action are tangled up, and greater insight into both can be gained by analytically separating them. Therefore, the participants were cautioned to only define what they saw at that time as the wicked problem without jumping to solutions (this was understandably difficult for most of the stakeholders and required some facilitative interventions). Stakeholders could include or exclude any elements they wanted, which was important in terms of preventing too much pre-framing by me.

Throughout the process, the participants were given the freedom to arrange and group elements if they wished to. They were also asked to assign a weight (1 to 5) to each of the elements, representing how important to policy and practice it is. They were free to put whatever weight they wanted on these elements, but as a guide I suggested that they assign the highest weight (5) to elements that were a priority for intervention. Elements of only minor perceived importance were given a 1. Stakeholders then assigned the weights 2-4 to the many elements that lay between these two extremes. The participants were allowed to go back and change their weights as their map unfolded. This was necessary because the weighting was started quite early in the process, and as relationships between the elements were added, it sometimes changed people's perceptions of importance. See Dye and Conaway (1999) and Laouris and Michaelides (2018) for discussions of the value of exploring interconnections before prioritizing.

In a couple of cases, this weighting was not completed due to time constraints, but there were to be subsequent opportunities to address this (to be explained shortly). I should note that weights were not assigned to enable quantitative analysis, but as a way of capturing what was important and impactful from the individual's perspective. These weights became particularly important later in the group dialogue among all the stakeholders.

Next, participants were asked to use sticky notes (with single or double-headed arrows on them, or words of explanation) to represent the relationships or links between elements. For instance, the relationship between gang leaders and street corner dealers might be delineated as part of the context of the problem (answering the question, 'what is important about the relationship as it relates to the successful operation of the illicit trafficking enterprise?'). For relationships that represent parts of a supply chain (either drug flow or money laundering), stakeholders indicated direction of flow between elements. In most cases, stakeholders were asked to weight these relationships from 1 to 5 in order of their importance (as was done for the elements). However, in a couple of cases, time constraints prevented all the relationships/interdependencies being weighted. When finished, the picture of weighted elements and relationships formed a systemic perspective map of the wicked problem from each stakeholder's point of view. The final maps for all the individual stakeholders were photographed.

After each mapping session, the photographs taken of the individual stakeholder systemic perspective map were used to create an electronic version using the software package Cytoscape (2017). Cytoscape was chosen because it is a free and open-source software package for mapping nodes and links, is easy to learn and use, produces a dataset that can be edited and exported, and provides the ability to merge individual maps into new, more comprehensive maps representing the start of a collective understanding. To ensure that the electronic versions were accurate representations, an iterative process was used to allow stakeholders to make corrections or add more information, such as additional weightings if the time constraints in the PSM session had not allowed for this step to be completed. Figure 6.4 shows two example photographs (from a larger set) taken following one of the initial stakeholder problem-structuring sessions and the corresponding Cytoscape systemic perspective map that was created using the photographs from the PSM session. In this Cytoscape map, node sizes represent weights 1-5 (smaller to larger). The red links represent drug trafficking and the green represent the money laundering parts of the problem.

Figure 6.4: Example photographs from initial stakeholder problem structuring session and the systemic perspective map associated with them.

All 13 stakeholders who participated in these Systemic Perspective Mapping sessions were sent a questionnaire asking for their feedback on the process. Nine stakeholders responded, and 8 of them rated the PSM sessions as ‘very useful’ (the highest rating on a scale of 5). Many said that they felt they were already systems thinkers but had never used this term before. They liked the way Systemic Perspective Mapping helped them to ‘download’ their thoughts, and they said that it ‘jogged their memories’ to identify elements that they did not include at first. They also felt it gave them the ability to openly and honestly express their perspectives without feeling marginalized by the pressure of having other agencies present. Clearly, the longer-term goal was going to be to work together towards a greater common understanding but starting without this pressure allowed stakeholders to get their views ‘on the table’. This feedback vindicated my

decision to create Systemic Perspective Mapping as a two-stage process, first involving individual mapping before bringing people together in a group.

Stakeholders overwhelmingly remarked on how this process allowed them to see their problem at a 'higher' level than usual. Specific comments included: "it was the first time I had a visual depiction of the interconnectivity of each element"; "I liked the process of making each entity from a strategic standpoint. It forces me to take a step back and really focus on who/what are the main entities"; "The process allowed me to take the time to look at my role when addressing the problem"; and "it helped convey the intricacies of the gang culture. It's more than drugs and turf".

The average time for the in-person session was 1½ hours. When scheduling these meetings, agencies and their representative stakeholders were sensitive to the time it would take away from their duties. However, after the sessions were completed, many stakeholders indicated that they would have liked more time to really explore the problem space. One stakeholder wondered if using the mapping software directly with stakeholders would reduce the length of the session, but the time it would have taken to become familiar with the software, even for a tech-savvy stakeholder, would likely have prolonged the meetings instead of reducing them. Additionally, I feared that introducing formal electronic software too early would have created a distraction and would have been less 'free-form' than working directly with tangible objects like sticky notes.

Cytoscape was then used to merge all the individual systemic perspective maps, including all the elements and interdependencies, as well as their weights (a similar approach was used by Eden and Ackerman, 1998, and Eden and Huxham, 2001, who merged cognitive maps).

Figure 6.5 shows the unedited, merged map, with some enlarged views to show detail.

Because systemic perspective maps for wicked problems can get very large and unwieldy, additional research that augments this PhD thesis was conducted to experiment with the 3D printing of systemic perspective maps (North, Sydelko, Martinez-Moyano, 2016b). This visualization technique is discussed further in Appendix 4.

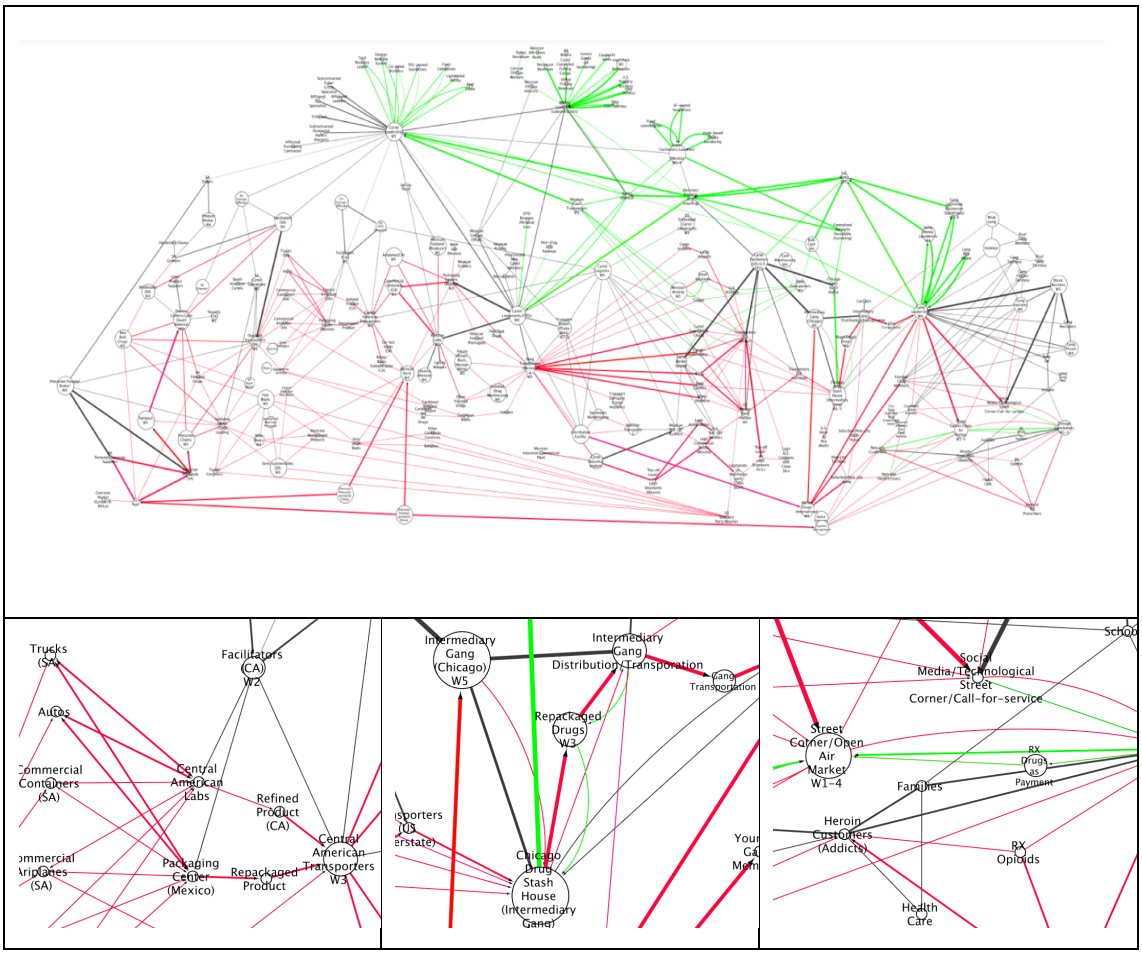

Figure 6.5: Merged individual systemic perspective map with enlargements to show more detail.

6.2.2.1 Boundary Critique Workshops to Create a Common Systemic Perspective Map

Because individual systemic perspective maps were developed without us placing any boundary limitations on stakeholders, each map can be seen as the individual's viewpoint on the problem before they had engaged in any collective learning through our project. However, the lack of boundaries imposed by us didn't result in 'unconstrained' maps: implicit value and boundary judgments are involved in even the most wide-ranging analysis (Ulrich, 1983; Alrøe, 2000; Midgley, 2000), and such judgments were inevitably brought in by the stakeholders.

When these individual perspectives were merged (using Cytoscape) the resulting map can essentially be viewed as a further unfolding of the problem (Churchman, 1979) because it represents the sweeping-in of all the involved stakeholder perspectives. The freshly merged map carried with it every element, relationship, and weight provided by each individual stakeholder. Every stakeholder perspective, no matter the individual's agency, rank or relationship with other stakeholders, was represented in this merged map. This provided a first cross-stakeholder representation of the problem without marginalizing any of the stakeholders. As would be

expected, the merged systemic perspective map was full of discontinuities, conflicting weights, nomenclature issues and missing elements (although the realization that some elements were missing only came when the participants undertook some collective analysis of the map). These discontinuities and conflicts represented some of the difficulties the agencies had in communicating with one another. Nevertheless, the map was a valuable resource to start to find a way forward.

To bring some order to the 'mess' in the combined map, some collective judgments were needed on terminology, linkages and weightings. Boundary Critique can be used to help make such judgments, as it focuses, not only on boundaries of inclusion and exclusion, but also on the value judgments that lie behind boundary choices (Ulrich, 1983, 1996, 2003; Midgley, 1997a; Midgley et al., 1998; Midgley & Pinzón, 2011). In many traditional forms of analysis, boundary judgments about complex problems are the province of only one or just a couple of stakeholders (or 'experts') who have, for historical reasons, been granted decision-making authority. Even when discussing issues and making boundary decisions in a multi-stakeholder group, inequities can arise when certain stakeholders exert disproportionate authority and influence. This risks the marginalization of important value and boundary judgments of other stakeholders, and Boundary Critique not only helps the research team theorize marginalization (Midgley, 1991, 1992a, 1994, 2000; Midgley & Pinzón, 2011), but it also suggests ways to address it in facilitated dialogue (Midgley, et al., 1998; Midgley, 2000; Córdoba & Midgley, 2003a, 2006, 2008; Boyd et al., 2004; Midgley & Pinzón, 2013). The likely implications of marginalization are not only that it can affect how the problem is defined, but also how it is approached and what future interventions are identified. This is why Boundary Critique is so important when dealing with wicked problems that are, by definition, multi-stakeholder.

To reconcile differences in the merged system map and make collaborative boundary judgments, the stakeholders were invited to a one-day boundary-critique workshop. I took two types of notes during this workshop: notes on what changes were made to the map elements, relationships, and weights due to stakeholder dialogue; and notes on the dialogue itself and the interactions among stakeholders as they worked through the map together. The first set of notes was used to help translate the marked-up map into Cytoscape. The second set was used to better understand the dynamics and effectiveness of the group dialogue and Boundary Critique.

Five stakeholders representing five different agencies were available to participate. During this workshop, stakeholders were asked to work through a large, laminated printout of the systemic perspective map laid out on a table (Figure 6.6). First, they looked for elements that had multiple

names. They either decided that these were just nomenclature issues and agreed upon a single name, or they decided that they actually represented different nodes. Separate nodes were then noted with sharpies on the map. The participants also collaboratively added elements they believed were missing.

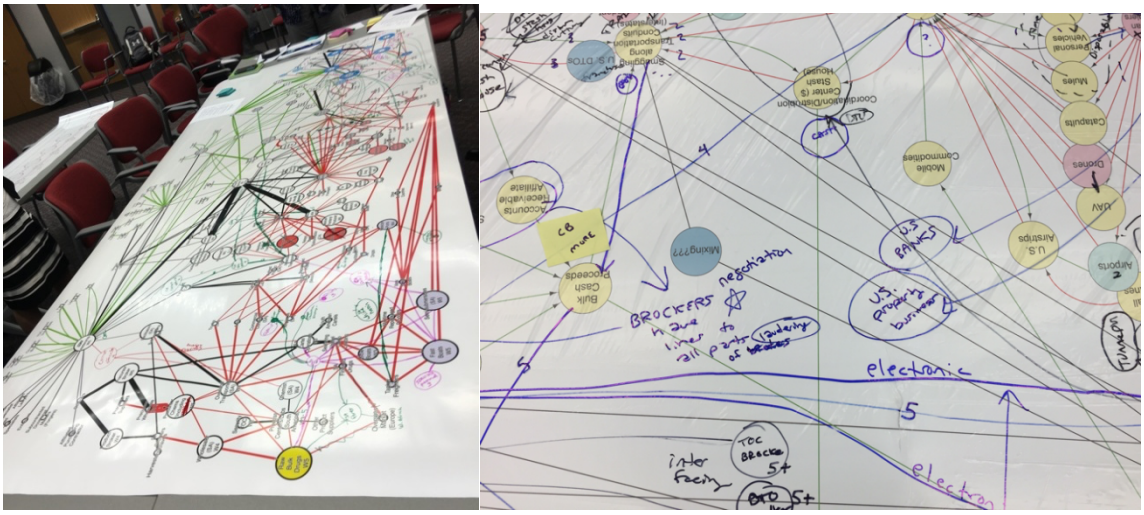

Figure 6.6: Photographs of the marked-up merged systemic perspective map after Boundary Critique

Within the common stakeholder map, the weights for the elements and interdependencies were carried over from the individual systemic perspective maps. Some elements or interdependencies were unanimously weighted with the same value; but in many cases, a range of weights were assigned by individuals. Stakeholders, who individually mapped the problem and put weights on the aspects of the problem they felt were most important, were able to clearly see that their perspectives differed from other stakeholders. Although they may have considered themselves experts, it became clear that they brought their own biases when describing how they perceived the problem. This was when the Boundary Critique became a particularly important part of structuring the problem, with stakeholders exploring and justifying their preferred weights through dialogue.

For some elements and relationships with just small differences in weightings (and hence small differences in values being brought to bear), quick consensus judgments were often made. Elements with wider ranges of weights/values typically required more discussion. For instance, one element had weights ranging from 1 to 5. The weight of 1 was given by a stakeholder with a national/international perspective. A stakeholder with a more local perspective had valued this element at 5, and said it was one of his top priorities. The other stakeholders were somewhere in

the middle. Although the local stakeholder initially began to ***acquiesce*** and agree to a weight of 5, further encouragement from me as facilitator and other stakeholders to give their reasoning for why that element was of low importance resulted in an engaged discussion about the differing perspectives. Through a relatively lengthy dialogue, these two stakeholders shared why they chose their weights and they ultimately agreed on a weight of 3. Without hearing the dialogue, it might be assumed that this was just a 'fudging' of the difference, but actually the weighting emerged from careful deliberation. The local stakeholder agreed that, when seen from a broader perspective, his high-value element was not as crucial as it appeared from his more narrowly bounded perspective. Similarly, the national/international stakeholder found the local perspective compelling and changed his position. This negotiation happened without much intervention by the facilitator.

In a minority of cases, the 'dialogue' was more one-sided. This appeared to be either because some stakeholders were much more vocal and extroverted, or because more junior stakeholders were intimidated by stakeholders with higher rank. Facilitation was necessary at times to make sure that all those who stepped back from engagement were asked for their opinions. Even when directly prompted by the facilitator, however, one stakeholder remained unwilling to engage in disagreements, and this had to be accepted as a limitation of the effectiveness of the Boundary Critique. In just a few cases, stakeholders remained so firm on their weights that the decision was made to assign more than one value to those elements, with notes added about the meanings of these differences.

The discussion of relationships brought up more questions than the weighting of elements did. It was obvious that stakeholders had not thought as deeply about all the interdependencies and relationships as they had about the elements in isolation, and it became very clear at this point just how important a systemic appreciation of these relationships is when dealing with a wicked problem.

Some of the interdependencies within the illicit drug trade were in the context of supply chains: the flow of drugs and the laundering of money. Because these logistical relationships were more familiar to the stakeholders than others, the weighting was relatively straight forward. However, other interdependencies represented relationships within the cartel operations. Because the cartels had evolved as very flat organizations, clear hierarchical relationships were not evident. Cartels have a vested interest in ensuring that drugs, money and criminal acts cannot easily be traced back to leaders, and the full extent of cartel operations are kept deliberately opaque to their members (let alone outsiders), to limit the damage that can be caused when individuals are

caught and co-operate with the Police. Because of this, the more obscure and non-direct relationships were difficult to define and weight. Not only were there a lot of good discussions about how to assign weights to the interdependencies, but stakeholders also found they had differing opinions on their nature. For example, one stakeholder would identify a relationship as one of employment, while another stakeholder understood it to be contracting. The difference between these two was very important in understanding the structure of these flat, covert, cartel organizations. Through the dialogue process, the group was able to work out these issues and come to agreements on most of them.

As the final exercise in this Boundary Critique workshop, stakeholders were told they had a budget that would cover eight to ten interventions, and they should collaboratively identify those that would most impact the illicit drug trade. Although this exercise could be seen as artificially framing intervention as a zero-sum game (under pressure, people often don't think that a priority for intervention might be finding ways to increase the resources available), it was done to illustrate that, when designing an interagency policy response, budget and resource issues may stimulate conflicts, and the Boundary Critique process can be used to work through them collaboratively. Indeed, resource constraints can drive innovation (Gibbert & Välikangas, 2004; Gibbert, 2005) as long as conflicts are approached constructively. Putting budget pressures on countering the problem resulted in good dialogue about priorities and possibilities, and helped the participants consolidate their emerging team identity.

Our first Boundary Critique workshop (discussed above) was facilitated to encourage full participation from all stakeholders, asking each to comment and reflect on any proposed change. This workshop ultimately generated a draft common perspective map, but it also resulted in suggestions for additional stakeholders who could help fill in some gaps they identified. Four new stakeholders were recruited, and individual systemic perspective maps were solicited from each. Subsequently, a second Boundary Critique workshop was needed to integrate their insights into the first collective map. Three of the stakeholders from the first workshop and three new stakeholders were able to attend this second workshop, and the process unfolded much as before. Importantly, those who had been in the first workshop were not defensive about their map being changed, as they were part of the group who had suggested the need for the new agencies to become involved.

In the second workshop, the budget constraints were pushed a bit further, and only five interventions were allowed. This was done to simulate how resource constraints can drive the need for further difficult boundary judgments about what stays in and what elements will not be

addressed. Discussions during this process centered primarily on negotiating between the values placed on the supply-side of the drug trade (a national and international focus) versus the demand side (primarily a regional and local focus). However, through much reflection and dialogue, five options for intervention were ultimately agreed upon. These five were:

(1) An enhanced shared intelligence environment;

(2) A concentration on finding and removing intermediaries (nodes and links that connect higher level transnational organized crime leaders to more tactical gang activities);

(3) Increased security clearance for local officers so national and international agencies can more easily share intelligence;

(4) More effort to be put into addressing the money laundering part of the wicked problem, where stakeholders felt they could most 'hurt' the overall drug trafficking enterprise; and

(5) Tapping into social media communications within gangs (an emerging important strategy at the local level that regional, national, and international stakeholders were not previously aware could be of value to them).

This Boundary Critique exercise illustrates how including multiple values not only shapes how the problem is structured, but also drives a better coordinated and more integrated approach to managing the problem.

6.3 Conclusion

The overall design for this study has been discussed in this chapter to help the reader understand the two-phase approach to the research. The first phase involved Boundary Critique and use of a newly developed method, which I have called Systemic Perspective Mapping. Systemic perspective mapping was deployed with the stakeholders to generate deeper understandings of the wicked problem of organized drug crime from their single-agency perspectives. Each agency representative had the opportunity, early on, to provide their perspectives without pressure from other stakeholders, reducing the potential for them to be marginalized from the beginning. Boundary Critique was then used to support the participants in moving toward a common understanding of the wicked problem, making sure that conflicts between perspectives and decisions on problem elements and interrelationships were thoroughly discussed. Priority options for intervention were also identified.

In the evaluation of this workshop, all the stakeholders rated this process as being 'very useful' (the highest grade) on their questionnaires (see Appendix 2). The feedback provided by the participants was overwhelming positive, indicating that Systemic Perspective Mapping, combined

with Boundary Critique, was highly effective in developing a subtle and well-justified common understanding of the drug trafficking problem. All felt that genuinely trusting relationships had been built, and there was a sense of teamwork with other agencies. They strongly emphasized the extensive mutual learning that came from working together through the process, but wished they could have spent more time really delving further into each part of the exercise.

The participants' most common qualitative statements related to how the process helped them to appreciate the wicked problem from other stakeholders' perspectives. Examples of these comments included: "My operational focus is small, this allowed for greater understanding not only of the problem, but other stakeholders' perspectives and focuses"; "The different perspectives were critical in properly framing the problem"; and "I gained critical insight and understanding, not just from fellow national level agencies, but all the way down to the local street cop and how one impacts the others".

Stakeholders also felt strongly that the process helped in giving them a more systemic perspective, and they gained a new appreciation of how their actions could affect others. Overwhelmingly, they believed that the process gave them confidence that the common systemic perspective map generated by the group could make a difference in countering the illicit drug trade. Here again, there was a desire to spend more time in dialogue, and the addition of more stakeholders was asked for. Conceivably, a continued process of iteratively adding stakeholders, folding in their perspectives, and including them in group Boundary Critique could have been pursued until the values and perspectives of all the stakeholders were reflected in the common perspective map. However, this was not possible within the time constraints of my PhD research.

If successfully implemented in real policy and practice projects, this research suggests that the approach could provide an effective way to develop a common interagency understanding of wicked problems, which is a crucial step needed before a coordinated organizational response can be designed. The organizational design aspect of this research will be covered in Chapter 7. Chapter 8 will reprise the Systemic Perspective Mapping method's contributions to knowledge and draw conclusions for the whole thesis.

Chapter 7: Phase Two -- A Viable System Model Board Game

In this research, I asked the participants to design an interagency organization that could specifically respond to their wicked problem, represented by the common systemic perspective map developed earlier (as discussed in Chapter 6 of this thesis and in Sydelko et al, 2017, 2021).

It was important to support the participants in gaining a more systemic understanding of their wicked problem through Systemic Perspective Mapping *before* designing this interagency response. Jumping straight to VSM design (the approach I selected for the interagency organizational work) would have risked the most lethal danger that Beer (1985) identifies: that attenuation is based on ignorance of the environment rather than accurate feedback from it. Therefore, most VSM methodologies (e.g., Espejo & Reyes, 2011; Espinosa & Walker, 2017; Espinosa et al, 2022; Martinez & Espinosa, 2022; Espinosa, 2023) suggest a preliminary stage to enrich the observer's understanding of the environment and clarify the system boundaries (as suggested originally by Beer, 1979, pp.8-9). This is the reason I chose to start the Systemic Intervention with Boundary Critique and problem structuring.

7.1 More Detail on the VSM

The VSM was introduced in Chapter 2 (section 2.1.5). But before describing the development and deployment of a VSM board game for designing a response to the wicked problem (now represented in the form of a common understanding expressed in a systemic perspective map), it is important to provide a more detailed discussion of the VSM. To begin, I'd like to introduce some of the important principles underpinning the VSM.

7.1.1 Ashby's Law of Requisite Variety (Attenuation and Amplification)

In creating the VSM, Beer was inspired by Ashby's (1947) law of requisite variety, which states that an organization, like a biological organism, must balance its own variety (which can be thought of as a measure of complexity) to the variety of its environment. Beer suggests that, in order to manage the complexity of a set of tasks, we need communication mechanisms to attenuate (reduce) the variety in the environment or amplify the variety in the organization so it can better respond to that environment (Beer, 1985). First, because wicked problems have a great deal of variety, the interagency needs to attenuate it in ways that make it more manageable. A law

enforcement example that Beer (1985) gives is public policy that reduces crime through surveillance, thus allowing the Police to focus their resources where they are most needed. Conversely, he says that amplification, in the law enforcement context, involves things like providing the Police with new communication technologies or weapons to enhance their effectiveness in action. Of course, which methods of attenuation and amplification are chosen, and the balance between them, is a moral as well as a practical concern (Ulrich, 1981).

Importantly, attenuation and amplification are influenced by the ways in which organizational participants *perceive* their relationship with their environment. For instance, attenuation can happen in two ways. First, action can be taken that successfully reduces the variety in the environment and/or the information the organization must manage concerning this environment, and this is generally considered a good thing as long as it doesn't contravene widely held ethical standards. Second, the organization may erroneously *think* it is in a low-variety environment because its methods of gaining or interpreting information about its environment are inadequate. This is why, when it came to our own project, it was so important to support the participants in gaining a more systemic understanding of their wicked problem before designing an interagency response. As mentioned earlier, jumping straight to VSM diagnosis would have risked the most lethal danger that Beer (1985) identifies: that attenuation is based on ignorance of the environment rather than accurate feedback from it. This is why most VSM methodologies suggest a preliminary stage to enrich the observer's understanding of the environment and clarify the system boundaries (as suggested originally by Beer, 1979, pp. 8-9). In our case, this is the reason we chose to start our Systemic Intervention with Boundary Critique and Systemic Perspective Mapping.

I would add that Boundary Critique and Systemic Perspective Mapping alone, without a proper organizational diagnosis (e.g., using the VSM), may bring with it a corresponding lethal danger of amplification: by ignoring weaknesses in the organization, participants may over-confidently believe that they have the variety in the environment under control, and they may remain unaware of where they are failing. With regard to both attenuation and amplification, the development of useful knowledge (of both the environment and the internal readiness of the organization to respond) is critically important. In this respect, Boundary Critique and Systemic Perspective Mapping on the one hand, and VSM diagnosis on the other, correct for each other's potential weaknesses.

7.1.2 Recursive Systems

The principle of recursion is also a key principle to Beer's development of the VSM. Recursion means that "every viable system contains and is contained in a viable system" (Beer, 1984, p.5). Recursion describes how there are subsystems within subsystems within subsystems, with any number of scales, all of which share the same structural patterns of organization. For instance, a government agency can be a viable system that contains departments that are themselves viable systems. In turn, the agency is part of a larger viable system of a whole government (which, in turn, could be part of an international alliance). Hoverstadt (2008) says that the VSM conceptualizes organizations as 'fractal', because of this recursion.

When modeling a specific organization, it is important to represent relevant levels of recursion (Beer, 1979, 1981, 1985). Typically, before starting a VSM diagnosis or design, a recursive analysis is undertaken to clearly define the system in focus (the level of recursion and the subsidiary organisations in which the analysis will be conducted), delineate its S1s, and identify the viable systems at the recursive levels above and below the system in focus. However, because my research purpose was to design a single interagency organization, I only aimed at analysis at the relevant level of recursion, which is the interagency. I did not progress into a next stage of redesigning each of the S1s (the individual agencies) in more detail. This was beyond what was possible in the time constraints my PhD was subject to, but I explained to the participants that, ideally, it would be advisable to do VSM analyses on their own organizations too. Indeed, I note that there were many discussions during breaks in our VSM workshops (to be introduced shortly) when participants spontaneously applied the insights they had gained to their individual agencies.

7.1.3 Homeostasis

The balance between an organization and its environment is called homeostasis. The VSM supports participants in exploring what is needed to maintain homeostasis in a socially desirable manner; i.e., in the case of organized crime, successfully reducing its negative impacts without significant side-effects. It offers several concepts and principles that enable the design of, or improvement to, an organization, focusing, in particular, on its ability to continuously adapt and *self-organize* in response to disturbances in its external environment. This important concept of self-organization (Ashby, 1947; Pask, 1961; Von Foerster, 1984, 2003) is enjoying renewed popularity (e.g., Espinosa & Duque, 2018; Herron & Mendiwelso-Bendek, 2018; Yearworth & White, 2018).

Beer's use of the term 'viable' refers to an organization's ability to maintain a separate existence (Beer, 1985). Therefore, a viable system is a system that keeps its identity while maintaining a co-evolutionary, but still balanced, relationship within its niche (Espinosa, 2008). In order to design and maintain a viable organization capable of tackling the complexity of a wicked problem, the organization must be closely attuned to its environment and must dynamically adjust to disruptions (Beer, 1985).

7.1.4 Five Subsystems of the VSM

In Beer's original depiction, there are five subsystems that represent the different functions needed in an organization. Figure 7.1 is a general diagram representing the VSM (note that the VSM diagram (Figure 7.1) and Table 7-1 previously presented in Chapter 2 are repeated here for easy reference).

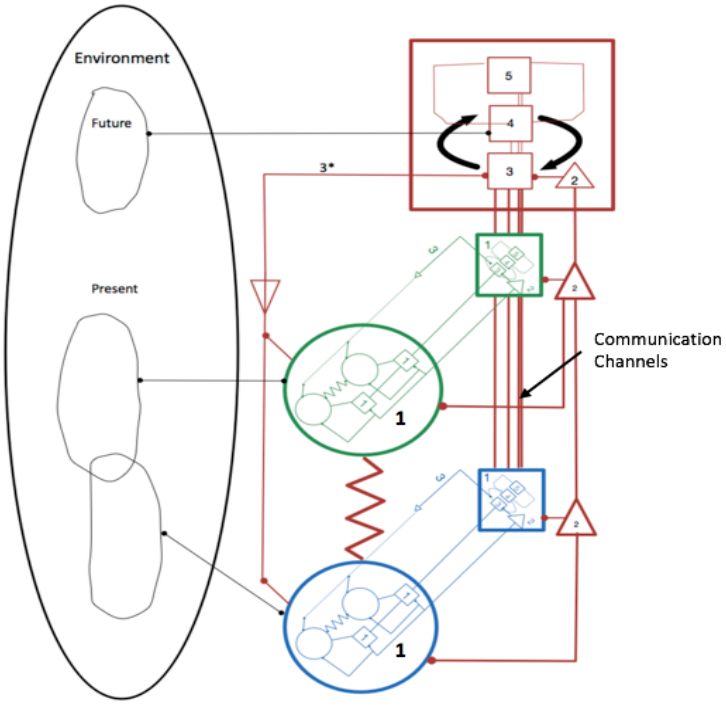

Figure 7.1:Diagram of the Viable System Model (Beer, 1979)

In the diagram in Figure 7.1, the VSM model is oriented vertically. This way of expressing the VSM might result in people (i.e., my participants as well as readers of this thesis) seeing the model (erroneously) as a hierarchy where the management functions (S3-S5) exert increasing amounts of top-down control the nearer they are to the top, with S5 at the apex of a command-and-control

structure. Rather, the VSM is heterarchical, with Systems 2-5 being support functions that enable the S1s to do their jobs (Beer, 1979).

In addition, because an organization is intimately involved in its environment, it can be misleading to depict it as separate from this environment, with arrows going to and from it (also depicted in Figure 7.1). Figure 7.2 shows the VSM diagram turned on its side, and the environment is wrapped around the viable system. I believe this depiction is a more intuitive depiction of a heterarchy and embeddedness.

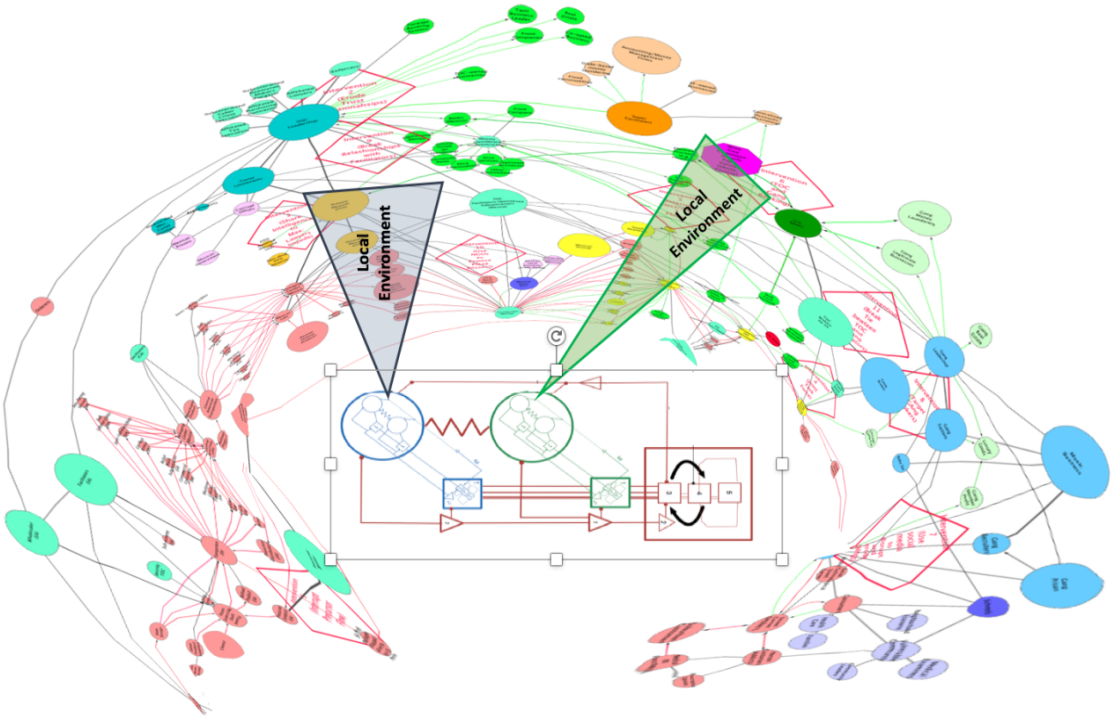

Figure 7.2:The VSM embedded in the environment

Again, a purely mechanical and hierarchical interpretation of the VSM, like the one described in Jackson and Keys (1984), would miss the important nuance that this view of the viable system brings. The representation in Figure 7.2 is especially important for interagency working because agencies highly value their autonomy and appreciate that, rather than designing a new level of hierarchy, a design with a set of mechanisms (all equally important) that allows the interagency to manage variety and behave like a networked whole could be developed.

But who gets to decide what is in or out of the environment for a viable system? Certainly, this can be guided by clarifying the organizational identity and the recursive analysis, but at some point, it is a judgement call where the boundaries are set. It might be that it is within the purview of Systems 3/4/5 to delineate the boundary and to make decisions about expanding it or

contracting it as circumstances change. But it seems critical that those boundaries are set appropriately and in consultation with others within the organization, or with stakeholders outside the organization that may be impacted. S5 represents all the stakeholders' points of view, and therefore the identity and policy decisions need to be agreed with the involvement of those stakeholders. However, the original theory doesn't recommend *how* to better involve all stakeholders to make collective identity and boundary decisions. The use of Boundary Critique (see Chapters 5 and 7) as a methodological device to help with VSM environment delineation may be a fruitful combination for making sure that power and conflict are addressed when setting these boundaries. Further research into this could be worthwhile.

I provided concise explanations of each of the five organizational functions within the VSM when I reviewed this approach in Chapter 2. This is repeated in Table 7-1 as a reminder for the reader who has not yet memorized the different aspects of the VSM.

Table 7-1: The VSM Subsystems (repeated from Chapter 2)

System 1 (S1):	S1 is the operations of the organization, where the production of products or services happens (Beer, 1985; Espinosa, Reficco, Martínez & Guzmán, 2015). Within an interagency viable system, the S1s can be the individual agencies that will provide the operational functions within the interagency organization (Midgley, Munlo & Brown, 1997, 1998). S1s remain autonomous individual agencies, but within constraints set by S3, S4 and S5 (see later in this table), and because the VSM is elegantly recursive, each agency is a viable organization in itself.
System 2 (S2):	S2 deals with support for day-to-day operations, providing shared languages, protocols, procedures and information. It is also involved in avoiding oscillations and providing conflict resolution when discord exists between the S1s (Espinosa & Walker, 2017). S2 is a set of coordinating mechanisms needed to keep the agencies in homeostasis. It can include already existing mechanisms that can be leveraged, and it can help to identify when new mechanisms are needed to keep the interagency operations running smoothly.
System 3 (S3):	S3 is responsible for generating synergies among the S1s, and for regulatory issues, such as resource distribution, accountability and legal requirements (Espinosa & Walker, 2017). S3 also handles resource bargaining to ensure that all parts are running in the best interests of the whole organization (as defined by the strategic S5 subsystem discussed below). S3 is an especially challenging function to design because it embodies the resource bargain that all stakeholders must agree to, as well as the performance management of each of the autonomous units (S1s). Working with S2, S3 facilitates the continued operations of the interagency. S3 also uses a sporadic and informal auditing system (called S3*) that monitors the activities of the S1s (Hilder, 1995). It offers an alternative channel to generate unstructured information to complement the more formal S3 accountability information. It can probe the details of the operations without taking over and micromanaging.
System 4 (S4)	S4 is the adaptation function of the organization. It is responsible for understanding the total relevant environment in which the organization is embedded (Hilder, 1995), appreciating that what counts as 'relevant' requires a values-informed boundary judgment (Ulrich, 1981). Whereas S3 is concerned with management of the operations of the organization, S4 is concerned with the outside environment in which the organization sits (Beer, 1979). It is responsible for scanning the outside environment; anticipating potential disruptions to this environment (either in terms of threats or opportunities); suggesting strategic development paths; and recommending the internal operational changes needed to adapt to anticipated environmental and organizational changes, working closely with S3. Through these mechanisms, S4 (in

	conjunction with S3) creates the space in the organization for thinking strategically about the balance between maintaining current operations and responding to the need for change (Hayward, 2004).
System 5 (S5):	S5 defines the identity of the organization and provides its ethos, purpose and policy (Leonard, 2009). S5 works with S3 and S4 (creating an S3/S4/S5 homeostat) in monitoring the adaptation capability. S5 may be called in to make decisions on the recommended adaptive changes S4 recommends if any conflict exists between S3 and S4, and in this sense, it provides an essential strategic overview and decision-making function.

7.1.5 Coordination among S1s

Although the S1s can remain generally autonomous, their relationship with S4 and S5 is established through 3 different channels: (1) bargaining to negotiate resources in each given period of time, as S4 and S5 will have an overview of the resource needs of the whole organization, taking account of what investments are needed for the future; (2) the accountability channel, so the S1s make themselves responsible for the way they use these resources; and (3) a channel for systems 3-5 to intervene if and when a S1 behaves in ways counter to organizational viability or reputation).

S1s can also be highly interdependent (perhaps they exchange personnel, compete for the same funding, or have connected information systems). These connections are depicted as squiggly red lines on the diagram (Beer, 1985). Although there are single squiggly lines connecting S1s, they represent two-way flows. These connections might also be very informal, built on personal relationships or hallway conversations. Because these connections can be loose or strong, they can be drawn as thin or thick lines.

In addition, the local environments connected to each S1 may overlap. Because of the interdependences among S1s and their overlapping local environments, there is potential for S1s to 'step on each other's toes.' Beer calls these tensions and disagreements that can arise "oscillations" that need to be dampened, or the viability of the SIF will be in jeopardy (Beer, 1985, p.14). Yolles (1997) argues that, although conflicts are tensions in the system and are necessary to drive the ability of the system to change, an overload of tension will reduce homeostasis.

Within a viable system, accurate and timely communication among the subsystems is essential. In the VSM diagram, the red lines between the S1s, S3, S4, and S5 represent these lines of communication, and it is this continuous loop of information-sharing that is the basis of Beer's Second Principle of Organizations (Beer, 1985, p.40):

> "The four directional channels carrying information between the management unit, the operation, and the environment must each have a higher capacity to transmit a given

amount of information relevant to variety selection in a given time than the originating subsystem has to generate it in that time."

This principle conveys the need for all four channels to work together and deal with the total variety generated by the interaction between S1 and its environment at any given time, and between S1s and the meta-system.

S2 is the anti-oscillatory mechanism. It coordinates shared activities and resources among the S1s and provides conflict resolution when agreements are not reached or discord exists between them. S2 is often implemented through processes and communication mechanisms that are mutually agreed upon among S1s. It is only when disagreements cannot be resolved by S1 workers themselves that operational or general management might get involved (Hilder, 1995). S3 has a very close relationship with S2. S3 provides a broader profile, dealing with overall budgets, resource allocation, and other general issues. S2 deals with the day-to-day operations and is involved in providing cohesion. S3 and S2 must work very closely together, to ensure S1s are working synergistically. The variety required by the interactions between S1 and the general management through the six vertical channels (environmental channel, S2, S3 accountability & resource negotiation, S3-normative channel, and S3*) is expressed in Beer's first Axiom of Management (Beer, 1985, p.65):

> "The sum of vertical variety disposed on the six vertical components of corporate cohesion **EQUALS** the sum of horizontal variety disposed by all the operational elements."

This axiom is central to achieving effective interagency/whole-of-government cohesion. The challenge to designing an interagency meta-organization is to ensure that it balances the complexity of the interactions of each agency with their niche and the interactions among them all through robust meta-systemic mechanisms to manage variety. This is the key to self-organization and providing agencies with rich and varied contexts for inter-communications and joint action. Here again, Systemic Intervention can be weaved into the organization to ensure that all S1s' values are considered in managing these complex relationships.

7.1.6 Auditing

Another aspect of the resource bargain is that the operational management (S1 management) agrees to be accountable for their actions to systems 3/4/5. This agreement to be accountable is a powerful attenuator of their variety (Hilder, 1995). S3 has the responsibility to guarantee that the S1 gets access to the required resources and information to self-manage its own operations;

it also monitors the activities of S1s through sporadic and occasional auditing procedures (S3*), represented by the red line running from S3 to each of the S1s.

7.1.7 System 4: 'Knowing the Environment'

S4 has been already covered in relationship to how it interacts with the entire environment for the viable system. S4 is also the generative mechanism by which the organization learns the best ways to adapt; in conjunction with S3, it creates the strategic decision-making space of the organization (Hayward, 2004)**.** Beer (1979) laments that System 4, which is very important, is many times either missing or short on resources and power to perform its functions. Beer says this is because of the need to 'put out fires' today and keeping the operation moving often means people put a much higher priority on S3 than S4. Also, Beer reasons that a fully functioning S4 might be very powerful (even threatening to S5 or S3), because it has the most complete knowledge of the environment and is responsible for anticipating future ones.

However, the role of S4 is obviously enormously important for the system to remain viable. S4 is the innovator (i.e., research and development, market research) and is the only subsystem with responsibility for continuous environmental intelligence and strategic foresight of what the future might bring (Beer, 1979).

This challenge of 'knowing the environment' when the environment in question contains a wicked problem that an interagency is collectively responsible for, is a challenging task. S4 certainly must rely on the knowledge and experience of the S1s to participatively (1) explore the elements of their own local environment, (2) identify the interdependencies between those elements, (3) define the boundaries of the problem, and (4) anticipate how Systemic Interventions might alter the structure and behavior of the system. This is why the Systemic Perspective Mapping, described in Chapter 6, is so important before the organizational design around a wicked problem begins.

Because System 4 is responsible for anticipating potential environmental disruptions, it can utilize the intelligence information that is likely already being collected by each of the S1s. S4 needs to pull S1 intelligence functions out of the S1s but can exist as a distributed function that dynamically coordinates intelligence information for the whole system in focus. In addition, S4 can augment that distributed information with other intelligence methods, such as Scenario Planning (e.g., Ramírez, Selsky & van der Heijden, 2008) and foresight methods (Fuerth, et al., 2009; Fuerth & Faber, 2012; Ronis, 2007).

7.1.8 The 3/4 Homeostat

While there are many homeostatic mechanisms within the VSM, the S3/S4 Homeostat is worth exploring more closely, as it's pivotal to the whole functioning of an organization. The intelligence function of the SIF (S4) looks 'outside-and-then' (i.e., 'and then' means anticipating what is coming) and must understand the environment in which the SIF is embedded (Beer, 1985). For the SIF to adapt to any changes in the environment, S4 must be intimately connected to S3, which provides the current understanding of the SIF (inside-and-now). S3 'inside-and-now' is in a powerful position and may very well resist making any changes in operations based on information and recommendations from S4. If S4 is well-developed, it too holds power, in that it is responsible for 'outside-and-then' and strategic foresight, creating a sort of 'yin and yang' between the two systems. Beer designed the S3/S4 homeostat (represented in Figure 7.1) as the thin black lines connecting the two systems, so the variety in S3 and the variety in S4 are equal, as stated in Beer's Second Axiom of Management (Beer, 1985, p.87):

> "The variety disposed by System Three resulting from the operation of the first axiom **EQUALS** the variety disposed by System Four".

This Axiom is at the core of organizational adaptation. Mechanisms for adaptation need to be present in all the sub-systems and sub-sub-systems of the organization (Hoverstadt & Bowling, 2008). For an interagency (especially one facing wicked problems) to be viable within a highly complex and adaptive environment, it must be flexible, adaptable, and be able to make joint decisions on the same intelligence.

The important function of the S3/S4 homeostat reinforces the need for a strong S4. As mentioned above, when an organization does not have a S4, or has one that is weak, there is little or no attenuation of variety from S3 to S5 (Beer, 1979). There would be no S3/S4 homeostat to resolve issues and conflicts, filtering them before they move on to S5. Essentially, S5 would have to take on the S4 role and be solely responsible for knowing the 'Outside and Then' and for recommending operational adjustments to S3. It is easy, therefore, to understand the threats to viability this would bring. In a working viable system, it is only when the homeostat is unable to find resolution to conflicts between the two systems that S5 will need to come in to facilitate a final decision. But if a working S3/S4 homeostat is in place, the discussions that have taken place will enable them to clearly articulate their positions to support policy and strategy positioning.

7.1.9 Transduction

As information passes back and forth from the environment and between the subsystems within the SIF, it passes through organizational boundaries. Because of the differing cultures and languages used from one system to another, and between the environments, information crossing these boundaries will often need to be translated or variety might be lost. Beer calls the translation of information across these boundaries 'transducers', and he offers a Third Principle of Organization (Beer, 1985, p.41) to address them:

> "Wherever the information on a channel capable of distinguishing a given variety crosses a boundary, it undergoes transduction; the variety of the transducer must be at least equivalent to the variety of the channel."

Transducers are very important when a government faces wicked problems. Every agency has their own mission, budgetary constraints, and culture that create their own unique perception of the environment, and that sets up preconceptions and misunderstandings of what other parts of the SIF are doing. Because of the communication challenges facing an interagency, attention needs to be paid to designing transducers that bring all agencies into a common understanding. As will be discussed later, the ability to bring agencies together to structure their common understanding of the wicked problem provides an excellent transduction method that helps to (1) identify where these differences and perspectives, syntaxes and assumptions exist, and (2) provide for conflict resolution that separates mere language differences from real conceptual differences.

7.1.10 Continuous Management of Variety

All the processes within the SIF are designed to manage variety so that the SIF is not overcome by the variety of its environment. Managing variety is continuous: because external environments are dynamic and constantly changing, an organization must keep on adapting. Beer's Fourth (and final) Principle of Organization addresses this crucial concept (Beer, 1985, p.46):

> "The operation of the first three principles must be cyclically maintained through time without hiatus or lags."

For an interagency that is responding to a wicked problem, there needs to be a clear understanding that they are not 'solving' the problem but managing it. A wicked problem can change and morph in response to disruptions outside of the purview of the viable system. S4 must be continuously monitoring for those changes. In addition, an interagency is likely to be

intervening in the wicked problem constantly and causing direct and reverberating effects. The S3/S4 homeostat is crucial to making sure that the S4 is aware of the operational interventions of S3 and their effects on the environment.

7.1.11 S5 and the Metasystem

S5 supplies logical closure to the SIF (Beer, 1979). This closure is important, because the buck must stop somewhere. It is also responsible for monitoring the S3/S4 homeostat: S5 receives any variety that is left over from the S3/S4 homeostat, which is described by Beer's Third Axiom for Management (Beer, 1985, p.96):

> "The variety disposed by System Five **EQUALS** the residual variety generated by the operation of the Second Axiom".

When the S3/S4 Homeostat is working well, there will not be much residual variety for S5 to deal with. If the variety passed on to S5 is not absorbed, it will pass up to the next level of recursion. S5 is often seen as the 'boss' (especially in a vertically aligned model orientation) and responsible for arbitration when the S3/S4 homeostat cannot come to agreement. In organizations with weak or non-existent S4s, the S3s become very powerful. The other important role for S5, related to closure, is that it provides identity. It holds the purpose and mission of the viable system. I will discuss later how this S5 identity and allegiance was necessary and important in designing the interagency.

The combination of S2, S3, S3*, S4, and S5 is referred to as the Metasystem, which exists to perform any function needed to maintain coherence of the viable system (Beer, 1979). Beer dislikes the term 'senior management' that is sometimes used to refer to these functions, because it connotes a control role. Beer maintains that the Metasystem has a logical relationship with the operational elements, and it 'looks after' and supports them (Beer, 1979). As discussed before, this is the reason that the VSM diagram might be turned on its side (Midgley et al, 1998).

7.2 Use of the VSM for Interagency Design

When dealing with highly wicked problems, the goal should not necessarily be to solve the problem, but to design an interagency organization (or a voluntary collaboration, as discussed by Midgley et al., 1997, 1998) so that it can be *adaptively manage*d. This is because one of the most frustrating features of wicked problems is that they cannot simply be eliminated – instead, the task of agencies is to intervene in ways that make it more manageable and that tackle, minimize

or mitigate its worst effects (Rittel & Webber, 1973). The VSM can help with adaptive management. It is a cybernetic model, first developed by Beer (1979, 1981, 1984, 1985), which offers a conceptual framework for diagnosing and designing flexible and adaptive organizations and communication flows that are closely responsive to the relevant aspects of the outside environment. In this research, we asked the participants to design an interagency organization that could specifically respond to their wicked problem, represented by the common 'systemic perspective map' developed earlier in our project (Sydelko et al., 2021).

Even before the term 'interagency' was as widely used as it is today, there were examples in the literature of using the VSM for addressing multi-organizational problems: e.g., organizing industry in Chile and then supporting national policy-making in that country (Beer, 1981, 1989); using the VSM to improve commercial broadcasting in the USA (Leonard, 1989); designing a training network in New Zealand (Britton & McCallon, 1989); strategic information management of the Colombian President's Office (Espinosa, 1995); integrating user involvement and multi-agency working to improve housing for older people (Midgley et al., 1997, 1998); monitoring a national program to fight poverty (Espinosa, 1998, 2006); designing a national environmental information network (Espinosa & Walker, 2006); multi-agent systems simulation (Jones, Rodriguez-Diaz, Hall, Castañón-Puga, Flores-Gutierrez et al., 2007); managing a complex supply network (Chronéer & Mirijamdotter, 2009); facilitating agreements on climate action in two Colombian ecoregions (Guzman, 2015, Espinosa & Walker, 2017); responding to natural disasters (Munday, 2015; Preece, Shaw & Hayashi, 2015); improving food security in turbulent political environments (Velez-Castiblanco, Midgley and Brocklesby, 2016), 2016); and enhancing the network design of a national program for cleaner production in Mexico (Espinosa & Walker, 2017).

Out of these examples, it was Midgley et al (1998) who originally influenced our own approach, as they were the first to deploy the VSM in the context of multi-agency co-ordination following the explicit and extensive use of Boundary Critique and problem structuring (the latter was undertaken using a method called 'problem mapping'). Additionally, Brocklesby (2012) was an influence, as he worked on a very similar wicked problem to the one addressed in this study: developing an interagency law enforcement response to the problem of organized transnational crime in New Zealand. Brocklesby advocates using the VSM because it creates a 'big picture' approach that treats agencies as pieces in a much larger jigsaw puzzle.

7.3 The VSM Board Game

Drawing on Sperber and Wilson's (1995) relevance theory, Velez-Castiblanco et al. (2016) explain that the relevance to a manager of any OR theory or methodology is a function of the perceived

cognitive inferences that he or she can gain from it (i.e., how useful it appears to be) minus the cognitive effort (amount of work) involved in assimilating it. If the value of the cognitive inferences is perceived as high, and the work to be done to realize them is not considered excessive in light of that value, then the theory or methodology will be perceived as relevant (Sperber & Wilson, 1995; Wilson & Sperber, 2002). The problem with highly technical diagrams and specialist terminology (such as the engineering terms and icons used by Beer in describing and diagramming the VSM) is that the cognitive inferences (value) that can be derived from them is not obvious at first glance, but the amount of work involved in learning them looks daunting. Thus, I worried that non-expert stakeholders would be put off by the VSM in its original form.

Therefore, to make it easier and more intuitive for stakeholders to produce their VSM design, a visual layout of the VSM on a table, inspired by a board game, was developed. I have called this way of engaging the stakeholders the 'VSM Board Game' (Figure 7.3), even though it is not a game in the classic sense. The layout requires stakeholders to directly interact with the wicked problem, collect game pieces, and move these pieces through the VSM. It is in this sense that it is a game, not in the sense of anybody winning.

The board game was deployed in a one-day workshop using the game layout to guide stakeholders through the VSM design. A large VSM template was spread out on a table, so stakeholders could seat themselves next to their S1 circles. By posting the common systemic perspective map on the wall in front of them, stakeholders could directly interact with the representation of their wicked problem environment while designing the interagency to respond to it.

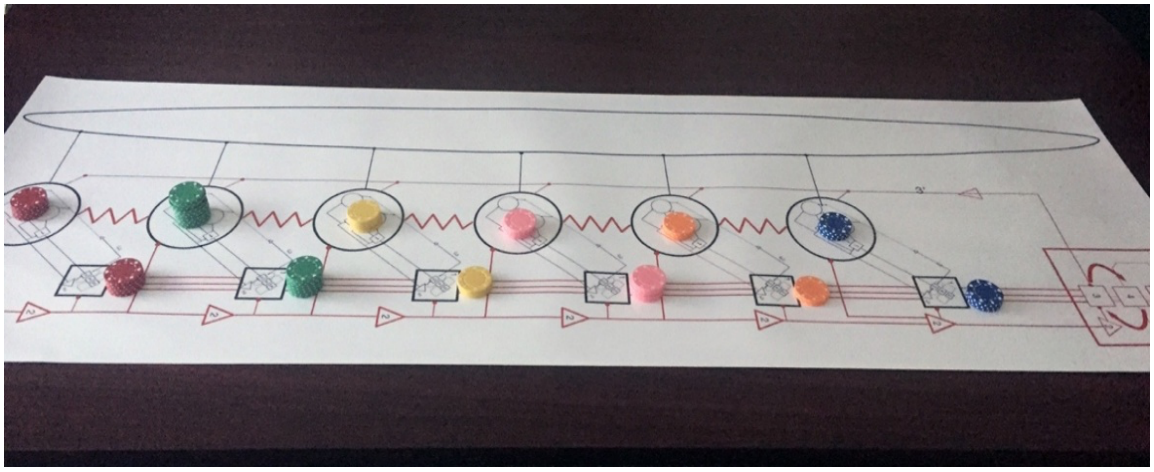

Figure 7.3: Photograph of the VSM Board Game

7.3.1 Designing S5: Mission and Essence of the Interagency

The game started with the S5 because it establishes the identity, ethos and purpose for the new interagency organization. S5 was thought to be some sort of strategic board or committee made up of the top leadership of the various agencies who could work together to define the remit of the interagency organization. Because our project did not have access to chief executives and other highest-level leaders, our participants (mostly senior managers of one kind or another) took on the task of creating an identity and mission for the interagency themselves.

Stakeholders huddled in a circle and were given thirty minutes to agree on a name for their interagency and to generate a mission statement describing the ethos of what they thought the group could organize around. At first no one wanted to throw out an idea. Everyone looked to other people until eventually one stakeholder said, "What would people fear?" What conveys power? Like we are 'super cops'". Another added that since "we are all law enforcement [….] we should do 'blue' and then 'net' because the system looks like a web". The group immediately agreed, and people commented, in various ways, that they loved 'BlueNet' as a name, and decided that its mission/essence should be to:

1. Identify networks and nodes within those networks that are most impactful and/or fall into the blind spots of agencies.
2. Understand relationships between problem elements.
3. Identify the significant parts of the criminal networks that correspond to more than one agency's mission and responsibility.
4. Find areas where group resources are lacking.
5. Identify network probabilities using interagency efforts.
6. Have the most positive community impact possible.
7. Refuse to be just another taskforce, but be the 'navy seals' of law enforcement, not distracted by home agency issues.
8. Have a mission that is overarching the missions of the individual agencies.
9. Allow each agency to bring its resources to the joint effort.

During a workshop break, I (as the facilitator) crafted a mission statement from the above list, also keeping in mind the substantial previous dialogue between the participants that I had facilitated (reported in Chapter 6). After the break, the group then read the mission statement, edited it following some deliberations, and agreed a final version (Figure 7.4).

The group fully embraced the name BlueNet for their interagency organization, and all agreed that it was important to be equally loyal to BlueNet as to their home agency. They were also enthusiastic about how BlueNet would be overarching, and they said that they would love to be able to bring their home agency resources to this joint effort. Following the workshop, one of the stakeholders commented, "I like the mission statement and everyone taking the larger picture into mind at all times – bringing forth your own agency's perspective, but in a holistic, mission-above-all-else way".

BlueNet

BlueNet is an elite law enforcement squad that spans across and unifies the agencies dedicated to countering illicit drug trafficking organizations that threaten our communities, impact the health of our citizens, and pose a real national security threat to the nation. Joining forces and leveraging from our collective knowledge, experience, and resources, BlueNet will unravel the complexities of drug trafficking operations while protecting personal rights. We pledge to relentlessly counter their illicit activities from source to street corner.

Figure 7.4: Mission statement developed for BlueNet

7.3.2 BlueNet S1: Delineating Local Environments

Each agency stakeholder represents a S1 of BlueNet on the VSM board. They were asked to sit at the board table aligned to one of the S1 circles. The first task in the game was for each stakeholder to delineate their own local agency environments within the overall VSM environment, which was represented by the large printout of the common systemic perspective map hung on the wall. Each stakeholder was assigned a unique color and given masking tape of that color to use to identify all the elements and interdependencies on the systemic perspective map that their agency actively engaged with. Often, overlap is seen as a negative (a waste of resources); but, when viewed more holistically, overlapping areas were mainly seen in our exercise as opportunities, where pooled efforts could result in bigger, synergistic impacts. In addition, overlaps provide the potential for interagency agility, as subgroups with the necessary

information can cover for each other when the variety in any given agency is insufficient to take control of a situation alone.

This concept is captured by McCulloch (1965) in his principle of “redundancy of potential command’, which emphasizes distributed information flow so that any sub-system can assume command when required to do so. This allows the potential for control to be spread throughout the system (Beer, 1981). Low, Ostrom, Simon and Wilson (2003) also argue that overlapping functions across organizational networks may play a central role in maintaining resilience.

In addition to delineating their local environments, stakeholders were asked to use sticky notes of their assigned color to identify their existing activities that attenuate and amplify variety (Ashby, 1968), making visible how they currently impact on their local environments. A schematic of this stage of the game is shown in Figure 7.5. In addition, photographs of a participant delineating their agency’s local environment and of the completed delineation exercise are provided in Figure 7.6.

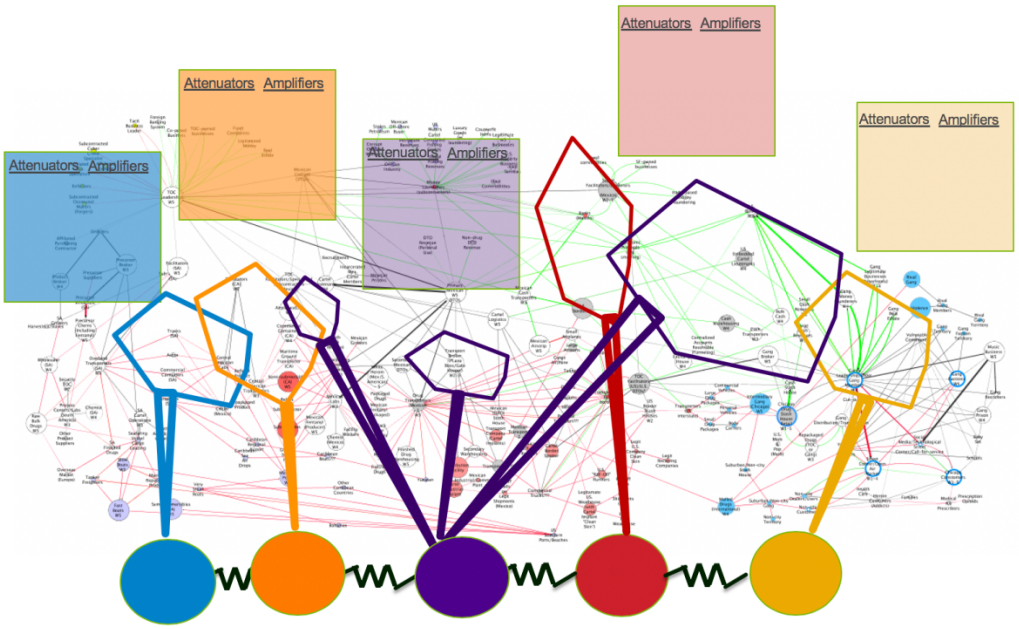

Figure 7.5: Schematic of the delineation of local environments and attenuation/amplification activities

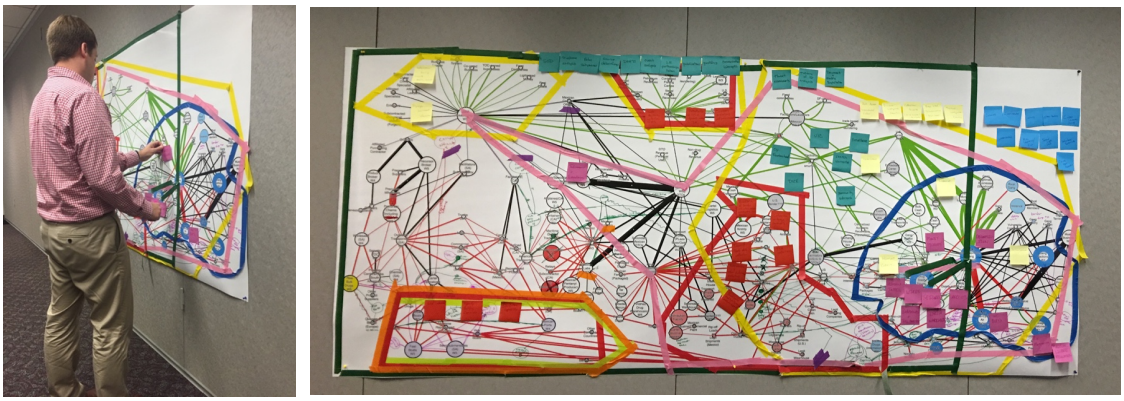

Figure 7.6: Agency stakeholder delineate their local environments on the common systemic perspective map

The playing pieces for the VSM game were poker chips, and stakeholders were given a chip of their assigned color for every attenuation/amplification activity they identified. The sticky notes related to each activity were placed in front of the relevant stakeholder for reference, so they could keep in mind what the different chips represented. For instance, if an agency identified the gathering of suspected boat locations from drone operations in the Caribbean, they would take that sticky note off the map and receive a poker chip to represent it. Or if another agency identified gathering intelligence on the flow of laundered money, they would receive a chip for that. They were then asked to read to the rest of the group what each chip represented before placing them within their S1 circles (see Figure 7.7). Many of these chips represented data collected about their local environments. Other chips represented operations being conducted to amplify their effects on the illicit drug trade. These activities were later used for discussion of S3. Non-participating S1s were represented by writing them down next to the game board.

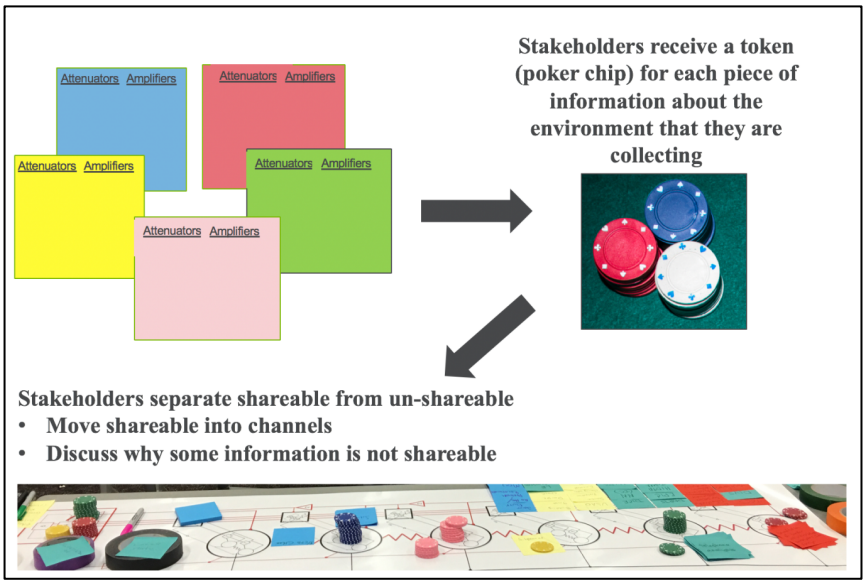

Figure 7.7: Poker chips to represent data/knowledge obtained through attenuation and amplification (written on sticky notes that were used by stakeholders for reference)

7.3.3 BlueNet S2: Knowledge/Information Channels and Mechanisms

As the board game continues, receiving a token for each of the amplification/attenuation activities creates a concrete link between the local environments and each S1. It also begins the dialogue around S2 functions. Stakeholders expressed frustration with the current lack of information sharing, which can be especially challenging in national security contexts where the classification of information and a 'need to know' culture are barriers (Givens, 2012). Therefore, it is not surprising that stakeholders considered information and knowledge sharing to be a major priority for change, to address current obstacles to collaboration and teamwork. The identification of this priority is reflected in the literature on multi-organizational collaboration (e.g., Weber & Khademian, 2008; Foote et al., 2014ab). Brocklesby (2012) says that other commonly encountered problems include empire-building, elitism, inter-agency rivalries, lack of IT integration, and conflicting objectives.

Interestingly, the participants in our study found that many of the obstacles they initially identified were only *perceived* obstacles, and their perspectives were often based on invalid assumptions. Simply checking their assumptions with others was enough to stimulate learning that collaboration would be easier than they had anticipated. In some cases, the group was able to identify new, relatively low budget, practical solutions to improve sharing and situational awareness. For example, simply giving a few Chicago law enforcement officers higher level clearances would make a significant difference and was possible to implement without having to undertake a major change initiative. Likewise, one agency representative identified the value of giving another the ability to log into the databases he worked with and said that IT access could be granted with only minimal extra administration.

In other cases, security policies or trust issues among agencies were identified as problems, and these would be more difficult (but not impossible) to address. Finally, it was recognized that some solutions would require fundamental changes to policy or substantial additional funding to redesign information system configurations to enable easier sharing. But even with these challenges identified, stakeholders were not demoralized: they commented that they had never before had this level of conversation about the importance of information sharing, and their deliberations could drive justifications for changing policies or requesting further funding.

In designing the S2 function for BlueNet, mechanisms and channels for sharing knowledge/information between agencies were particularly relevant. For instance, the Drug Enforcement Agency might pass along to Customs and Border Protection crop monitoring

information that shows significant increases in cocaine production in Latin America, so rises in cross-border trafficking can be anticipated. Or perhaps information obtained from placing US police officers into local Mexican law enforcement could help the Drug Enforcement Agency and Department of Defense become more aware of changes in the environment beyond the US border. Because some communication channels already existed, chips representing the information being communicated were placed into the channels on the game board and descriptions of what was happening were noted (Figure 7.8). With the chips that remained in S1 circles, stakeholders were asked 'what information/knowledge about the environment, or other S1 operational activities, would be beneficial to your agency?' This generated a lot of discussion, resulting in a stated desire by all stakeholders that they would 'take what they could get'.

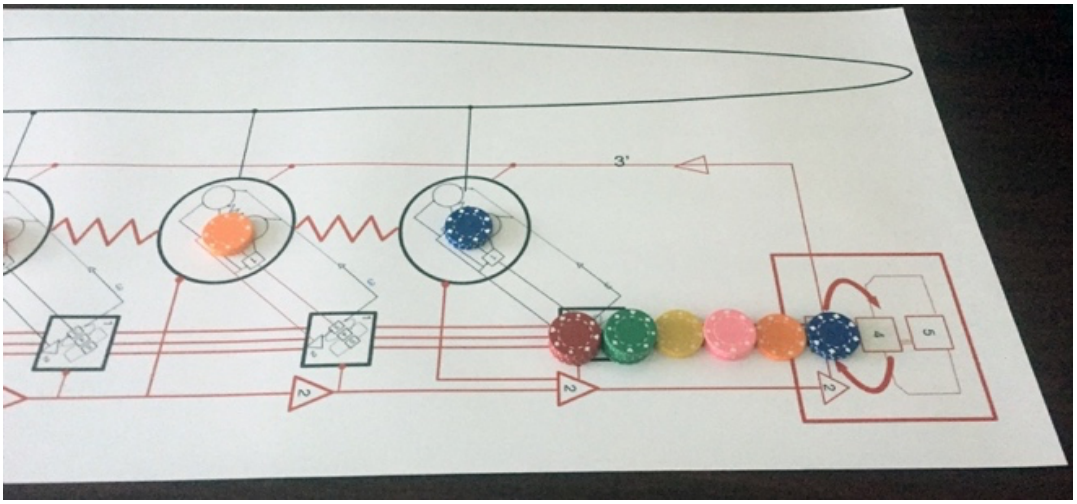

Figure 7.8: Photograph showing sharable knowledge/data being pushed through communication channels to the metasystem (Systems 3-5)

For BlueNet, S2 has two roles. It is the infrastructure that enables knowledge flows through the channels (information systems, interagency meetings and informal communications among agency staff). It could also have the role of flagging any incompatible information generated by multiple S1 operations co-occurring in space and time, which will need to be de-conflicted by S3 (see section 7.4.4 below).

Stakeholders recommended options for S2 that ranged from low difficulty and relatively low-cost solutions to those that were more challenging and more expensive. For some, it was simply a matter of including cross-agency access to existing mechanisms of information provision. For others, where no existing mechanisms existed, ideas were put forward on how those information-providing mechanisms might be developed.

One significant barrier was identified: existing data often contains personally identifiable information (***PII***), and the agency representatives recognized that sharing it would require effort and/or technologies that could strip out the PII. For sensitive or classified information, all recipients would need to hold appropriate security clearances and specialized secure information systems would need to be in place in order to facilitate sharing.

For those S1 chips that represented amplification mechanisms, the discussion centered around the S2 activities for cross-agency teaming that were already in place. Some of the amplifiers identified in the local environment exercise included existing targeted task forces, cross-agency investigations or collaborations with overseas partners. Recommendations were generated on how these existing amplification mechanisms could be leveraged in a more integrated and more systemically managed manner.

7.3.4 BlueNet S3: Managing Operations

The VSM design then turned to the S3: the role that would service the immediate BlueNet activities of the S1s (in coordination with S2) through managing tasks and resource allocations from an interagency budget. Stakeholders initially worried that creating S3 would result in building a new level of hierarchy: "bureaucratization—trying to spur efficiency, but you end up slowing down the organization because people are trapped in ritual conformity". But as stakeholders further explored S3 as a support function, they began to envisage it as an enabler and not a hierarchical dictating function. They clearly recognized the need for a S3 function for facilitating successful whole-system interventions. One stakeholder felt that "there is a psychological component too for scaring bad guys for them to know that everyone, or multiple groups, are working against them".

Through the discussions about what the S3 might look like for BlueNet, two major options emerged. One was to take an existing fusion center, task force or other coordinating vehicle and build on it so it becomes a S3 that can cover the entire problem space. However, the challenge to this was that these vehicles typically facilitate coordination around only certain parts of the wicked problem and are often led by just one agency, giving that agency a perceived higher status and greater control over the operations than 'partner' agencies enjoyed. Therefore, stakeholders were uncomfortable with this option. The other (and preferred) option was to develop a wider-scope, committee-based S3 that is made up of operational representatives from all the agencies. They suggested that the committee assignments should be full time and last at least a year, but no more than two years. This would give committee members time to focus on BlueNet, but not

so long as to lose touch with their original agencies. This S3 committee would be responsible for having current awareness of the entire BlueNet internal operational environment, and would provide BlueNet-level resource management, budgetary and legal support.

As the group began to discuss the design of S3, they described five major issues the design should address:

1) All stakeholders clearly expressed the desire to collaborate with other agencies, but they agreed that most current collaboration is done using their own personal networks and by using what they called 'I know a guy' methods. They felt strongly that any S3 function should not disrupt those networks, but perhaps there was a need to more formally capture the information flows.
2) Another major issue was who gets recognition in a collaborative setting. For instance, if Agency A is the only name on the report that was actually written in partnership with Agency B, then why would Agency B share information again in the future? Agency employees are rewarded on metrics that are collected in their silos, and not necessarily for their work on joint missions. It was recognized that using only numerical metrics to show impacts on wildly complex wicked problems is difficult. Nevertheless, without some form of recognition, there would be less incentive to act in a coordinated fashion.
3) Current experience has been that coordinating functions, such as fusion centers, take in information, but do not communicate back out in a timely fashion. One stakeholder said that "fusion centers are probably the worst because they become gatekeepers instead of pipe fitters. It's their job to disseminate, not to hoard information". Another stakeholder insisted that the agencies be seen as "customers of fusion centers". In addition, there was frustration with the information in fusion center databases being "so static". The group saw the need for two-way information channels and a willingness to "reach down for the information to the people who are actually doing the work". Also, S3, having a fuller awareness of the overall operations, should be able to "reach out to us and say, 'hey, I know you have this investigation, you should know this'".
4) Stakeholders agreed that "case coordination is difficult because we don't have feedback on when we should hit targets, and if us hitting a target will negatively impact a larger investigation". There was a very strong desire to prevent 'piggy-backing' on sources. By piggybacking, they meant a situation where Agency A identifies a source or piece of information, shares it, and then Agency B swoops in independently to act on that source. All the stakeholders had examples of this taking place, and they commented on how it erodes trust and is a strong deterrent to collaboration. The stakeholders unanimously

insisted that S2 should be designed to minimize the potential for piggybacking, and S3 should play an auditing role in curtailing these activities.

5) One challenge the group faced was that they sometimes blurred S2 and S3 functions. Many of the existing databases that they identified (mostly managed by fusion centers) also included capabilities for tagging conflicting information and for granting access to participating federal, state, local, and tribal law enforcement agencies. The ability to deconflict information is highly important because it keeps law enforcement activities from interfering with each other and makes positive synergies more likely. However, deliberation, negotiation, and resolution of the conflicts needs to include the agencies generating them, and this must happen much more quickly than the stakeholders said was currently possible. There were two different views about whether de-confliction and analysis is part of S2 or S3: those placing it in S2 were keen on making information management more automated, while those viewing it as in S3 emphasized the importance of interagency dialogue, human judgement and the auditing of piggybacking. Lowe, Martingale and Yearworth (2016) likewise found that stakeholders in their study had difficulty in differentiating between S2s and S3s, and they therefore decided to combine them into one subsystem called the 'operational management function'. In this study, we endeavored to assign the collation of information generated by the S1s to S2, but the further analysis of this to deconflict the information and generate knowledge of wider relevance was regarded as a S3 function.

7.3.5 BlueNet System 4: Anticipation and Adaptation

Stakeholders were then asked to focus on System 4 as the facilitating mechanism responsible for BlueNet's adaptive behavior. For an organization to remain viable over time, a strong System 4 is enormously important, especially for an interagency collaboration fighting a wicked problem that is as dynamic as organized crime. System 4 is responsible for scanning and interpreting the outside environment in which BlueNet is embedded (often called 'maintaining situational awareness' in law enforcement and national security communities). At the BlueNet System 4 level, the participants said that the common systemic perspective map could facilitate a good situational awareness of the wicked problem because the map reflects the current understanding and integrated perspectives of all the identified S1 stakeholders. The point was made that it could be augmented with the information provided through the attenuation/amplification mechanisms (largely analytical products) to provide more detailed data on parts of the problem. In considering how BlueNet would be able to sustain this systemic situational awareness, stakeholders wondered if the final systemic perspective map could be more dynamically incorporated within

BlueNet. They first proposed that *S3* should 'own' the common systemic perspective map because it represents the collective knowledge of the existing BlueNet environment. But although S3 must know the existing state of the *internal* operational environment (also provided by the S1s), it is System 4 that has the responsibility for continuous scanning of the existing *outside* environment (wicked problem).

Stakeholders saw the need for continued problem structuring and Boundary Critique exercises to provide updated BlueNet systemic perspective maps. This was viewed as important because the process ensures that all the relevant stakeholder values and perspectives are taken into consideration, and it gives stakeholders the chance to generate dialogue and resolve conflicts. Stakeholders stressed that the updated systemic perspective map should be shared back to the S3 and S1s, with alerts when changes have been made.

However, because BlueNet's System 4 needs to receive new information as soon as possible after it first becomes relevant, it is impractical to rely solely on periodic problem structuring exercises. Therefore, it was suggested that System 4 supplement systemic perspective maps with the information shared by S1s as they perform surveillance on, intervene in, and develop knowledge about the wicked problem environment. The stakeholders believed that a continual cycle of information flow between the S1s, S2, S3 and System 4 provided the potential for an exciting and extremely powerful new mechanism to create systemic situational awareness of a rapidly evolving environment.

Stakeholders realized that System 4 would not need to be created from scratch in order to provide the anticipatory function for BlueNet: the individual BlueNet agencies (S1s) already had a rich set of methods and technologies for anticipating what might happen in their local environments (a recursive level below BlueNet). Many of these methods are highly analytical and use OR techniques such as data analytics, trend analysis, forecasting, modeling and simulation. Most often, both the input data and the outputs are not widely disseminated among all the agencies (for reasons covered in the discussion of S2). Stakeholders explored how the BlueNet System 4 could leverage the anticipatory information already being generated by the S1s. This leveraging concept is very important for the design of an interagency because it maintains S1 autonomy while still providing an interagency anticipatory capability. Of course, the stakeholders agreed that it would take a high level of trust among the S1s, and with the S4, for this mechanism to work.

However, it is important to realize that System 4 needs to be more than just a collection of S1 forecasting outputs (Beer, 1979). A truly systemic understanding of the future environment must

be more than the aggregate of existing information. It was recognized by the participants that System 4 might need additional capability beyond what the S1s currently provide in order to adequately cover the entire relevant environment. S4 should also look for potential changes (e.g., of a geopolitical, economic, and social nature) outside the current representation of the BlueNet wicked problem that might impact on the evolution of that problem. Therefore, they recommended that System 4 should be able to employ its own anticipatory methods that interface with anticipatory analyses conducted elsewhere in government to expand the understanding of the wicked problem. Systemic analytical tools, like System Dynamics, have been used in previous projects as part of the VSM design for System 4 (Schwaninger, 2004; Schwaninger & Perez-Rios, 2008), so there is precedence for building in these kinds of analytical approaches. As part of the overall research project that this PhD is contributing to, an experimental model using genetic algorithms and System Dynamics modeling was developed (North, Sydelko & Martinez-Moyano, 2015ab). More details of this model development are provided in Appendix 4.

Because S4 is responsible for communicating projected environmental disruptions to S3 and S1, S4 would also benefit from developing 'alternative future' systemic perspective maps, drawing upon scenario planning (e.g., Ramírez et al., 2008) and foresight methods (Fuerth et al., 2009; Fuerth & Faber, 2012; Ronis, 2007). These maps could be developed with complementary written scenario descriptions for context. All stakeholders agreed that being able to compare current and future system maps in a common format would create a unique mechanism to better visualize and understand anticipated changes and how they might affect the operating environment.

System 4 also has the responsibility for making recommendations for operational adjustments it deems necessary to adapt to anticipated environmental disruptions. To do this, the participants insisted that System 4 would need to have a continuous interplay with S3, which would hold the knowledge of the up-to-date BlueNet operational state and its current resource capabilities. A tightly coupled and trusted S3/S4 relationship could ensure that the requisite resources, budget and variety needed to adapt would not exceed the internal capacity to provide it.

Some stakeholders wondered if this S3/S4 process could be 'automated' in some way. However, this 'solution' would reduce the S3/S4 tension between current and future requirements and is necessary for human beings to reflect on those requirements if they are to make sound strategic decisions. S3 may be reluctant to make adaptive changes because of cost or risk. People with System 4 roles are needed to present counterarguments for why internal changes may be necessary in order to maintain viability in the face of anticipated external events. These external events could either be threats to the viability of BlueNet or potential opportunities that could be

missed if the interagency fails to internally adapt. It is through negotiations between S3 and S4, with S5 oversight and intervention, when necessary, that the interagency can adapt to rapid changes and sustain viability over time.

The participative engagement of S4, S3, S2 and S1 personnel in workshops using PSMs (e.g., those represented in Rosenhead and Mingers, 2001, and elsewhere) can build a collective understanding of the need for change and commitment to making it happen, thereby freeing resources for System 4 that are conventionally tied up with fighting resistance to change (the Systemic Perspective Mapping presented in Sydelko et al., 2021, had this aim). Ultimately, when conflict exists between S4 and S3, S5 must decide to implement or not implement S4 recommendations, taking into consideration the potential disruption to the existing operational environment and ensuring any changes are aligned with the overall BlueNet identity and ethos.

7.4 Reflections on the Use of the VSM Board Game

By placing the systemic perspective map of the wicked problem on the wall in front of the stakeholders, and seating each of them behind a S1 circle on the VSM board (laid out on a table), I simulated the experience of dealing with the variety coming from the wicked problem to inspire the interagency design. While Beer (1994, 1995) and other researchers (e.g., Espejo, Bowling & Hoverstadt, 1999) have also proposed methodologies and methods to aid the application of the VSM, I aimed to develop a tool (the VSM Board Game) to provide a physical and intimate interaction between agency stakeholders and their collaboratively developed systems perspective on the wicked problem. This kind of interaction within a group setting brings a great deal of dialogue and enhanced mutual understanding to the task.

In their feedback to us, collected through post-workshop debriefings and a questionnaire informed by the approach to evaluating systemic methods developed by Midgley et al. (2013), the stakeholders said that they very much appreciated how the VSM Board Game helped them to explicitly identify overlaps in the work of the various agencies, and it encouraged serious thought on how a whole-of-government interagency organization should align itself to help address the threat of organized crime.

Stakeholders commented on how they valued the ability to design BlueNet themselves through use of the board game and not have a structure imposed on them. They liked the way that no one agency was seen as the lead and said that they could freely voice their opinions and agree on the rules and protocols they should all follow. Before starting the VSM workshop, the stakeholders

lamented that they seldom have sufficient time to make a strategic assessment of what other agencies do to anticipate alternative future environments (System 4), so they felt that using the VSM was a welcome exercise. They were especially intrigued by how organizational adaptation could be achieved through the S3/S4 collaboration. However, there was some concern about the cost of hiring sufficient staff to adequately equip S3 with the ability to maintain coordination, and for System 4 to generate maps of alternative futures.

During this study, stakeholders began to see their own agencies as recursive VSMs that could potentially be embedded in the interagency organization. Similar results were reported by Brocklesby (2012) in a study conducted to illustrate the value of the VSM in diagnosing an existing multi-agency organization, the UK's Serious Organized Crime Agency. Interesting conversations emerged around which sub-system they each saw themselves in within their own organizations. Some said that they were in two sub-systems simultaneously, sometimes being part of a S1 and other times a S3. They also discussed how some sub-systems were not working well within their agencies, or in some cases were missing altogether.

Study participants also lamented the missing key stakeholders who did not participate in the study. Sydelko et al. (2021), in a discussion of the Boundary Critique for this study, listed the missing stakeholders as the Department of State; local, state, and federal public health departments and agencies; others from the intelligence community; additional local government partners; non-governmental organizations; and international agencies from beyond the USA. Those who did participate hoped that, in the future, the participation of these other organizations would improve their ability to design an effective interagency system. Clearly, bringing in new agencies could potentially introduce more conflict and create a bigger challenge for the VSM design, but one that could produce huge benefits.

7.5 Summary

This chapter began with a more detailed discussion of the VSM than was provided in Chapter 2, and a review of literature describing the use of the VSM for interagency design. This was followed by a description of the VSM board game, developed and deployed to make the VSM more accessible to the participants. A reflection on the use of the board game was also provided. Chapter 8 will reprise my contributions to knowledge and draw conclusions for the whole thesis.

Chapter 8: Thesis Summary and Conclusions

The desired outcome of the overall research, articulated in Chapter 1, was to establish the potential value of a synthesis of systems approaches that could address any specific wicked problem when two things are required: facilitating a common understanding of that problem, and then creating an interagency organization with the capacity to respond in a coordinated manner. Systemic Intervention (Midgley, 2000) was chosen as the overarching approach; and within this, Boundary Critique, Systemic Perspective Mapping and the VSM (with an associated board game) were deployed. This approach was developed specifically to include multiple systems methods that address many concerns about achieving interagency success head-on. This chapter explains my findings for both phases of the research, and for the entire Systemic Intervention. It also provides insights into how this research deals with some of the challenges of interagency collaboration.

8.1 Discussion of Phase 1 of the Action Research

Research Purpose for Phase One: Develop, implement, and assess a participatory Problem Structuring Method, underpinned with Boundary Critique, to create a common interagency understanding of a wicked problem among multiple agencies.

Forging a cross-agency understanding of the wicked problem is vital to any successful design of an interagency response. A lack of agreement on the problem definition is often cited as one of the major challenges to designing interagencies(Roberts, 2000). Indeed, such disagreement is one of the key characteristics of wicked problems identified by Rittle and Webber (1973). As I have observed through my own experiences, and from what has been reported in the literature (Bakvis & Juillet, 2004; Gerassi, Nichols, & Michelson, 2017; Parker, Hartley, Beashel & Vo, 2021), interagency resentments and competition can make it difficult to generate a common understanding of the problem, even when the agencies know it would be helpful (Bakvis & Juillet, 2004). This thesis has discussed how I used Boundary Critique and Systemic Perspective Mapping to overcome some of the differences between the agency representatives involved in my research in order to generate a common interagency understanding, which was the first part of a larger multi-method intervention to design a new interagency approach.

Warmington et al. (2004) argue that many interagency approaches lack mechanisms to counter social exclusion. Therefore, respecting and appreciating various, and sometimes conflicting,

stakeholder perspectives and values is crucial – if formulating an understanding of the wicked problem is done without reference to multiple perspectives, that understanding is likely to be impoverished (Churchman, 1979a).

My use of Systemic Perspective Mapping, incorporating Boundary Critique, was specifically designed to address the potential for exclusion in three ways. First, a stakeholder identification process was undertaken through engagements with an initial interagency group at the National Defense University. By asking already-known stakeholders who else needed to be included, I mitigated the risk of missing important voices who I personally was not aware of. Second, I initiated a discussion with my supervisors (Gerald Midgley and Angela Espinosa) about whether drug users and dealers should be considered stakeholders. This showed up a real dilemma around the issue of exclusion: including those engaged in unlawful pursuits would have resulted in disengagement by the agencies, and I had to make the judgement that more harm than good would be done by opening the boundaries of participation to criminal elements. Ulrich (1983) says that the most justifiable boundary of participation is not necessarily the widest possible one, and my project is a good example of that principle in action. Third, and finally, inclusion was addressed by capturing each of the agency perspectives individually first, before bringing those perspectives together for dialogue in the multi-agency group. Systemic Perspective Mapping was initially deployed with the agency representatives to generate deeper understandings of the wicked problem of organized drug crime from their single-agency perspectives. Each person had an early opportunity to provide their perspectives without pressure from other stakeholders, reducing the potential for them to be marginalized later.

In addition to Systemic Perspective Mapping, Boundary Critique enabled continued dialogue around stakeholder values and perspectives. This supported participants in moving toward a common understanding of the wicked problem, making sure that conflicts between perspectives and decisions on problem elements and interrelationships were thoroughly discussed. Priority options for intervention were also identified.

The observations made during the intervention and the formal feedback provided by the participants (adapting the evaluation approach of Midgley et al., 2013) indicate that Systemic Perspective Mapping, combined with Boundary Critique, was highly effective in developing a subtle and well-justified common understanding of the drug trafficking problem. The stakeholders expressed their appreciation that illicit drug trafficking is a wicked problem that exhibits many interdependencies: e.g., “it was the first time that I had a visual depiction of the interconnectivity of each element.” Also, they said that the approach enhanced mutual understanding amongst the agency representatives: e.g., “my operational focus is small; this [Systemic Perspective Mapping] allowed for greater understanding, not only of the problem, but stakeholders’ perceptions and

focuses" and "the different perspectives were critical in properly framing the problem". They also realized that the problem of drug trafficking will never be totally solved, but needs an interagency that can act like "a counter-system towards the wicked problem."

Despite the limitations of the data, I was able to collect on the effectiveness of the intervention (as explained in Section 6.1.5, the participants refused to allow sessions to be recorded due to confidentiality concerns), it was nevertheless clear that the stakeholder feedback on the exercise was overwhelming positive, with everybody saying that it was 'very useful' (the top grade out of the five options available). They strongly emphasized the extensive mutual learning that came from working together through the process but wished they could have spent more time really delving further into each part of the exercise.

Although this research was not intended to produce an 'official' formulation of the wicked problem, it was conducted with real stakeholders from key agencies and resulted in a useful systemic perspective map of the illicit drug trafficking problem. The observations made during the intervention, and the feedback provided by the participants throughout the study, suggest that the Systemic Perspective Mapping increased their knowledge of the interconnectedness of the problem. It also provided opportunities for a great deal of collaborative learning, particularly during the Boundary Critique workshops. In addition, the dialogue generated around the weightings of elements and interdependencies created a greater appreciation of the factors (missions, budgets, scales of operation, policies, etc.) that drove the differences in perspectives between the agencies. This resulted in improved levels of mutual respect among the stakeholders, as reported by them in their feedback to me. Indeed, several participants requested copies of the final map for further use within their own organizations, stating that a clearer systemic understanding of the problem, integrating multiple perspectives, can be useful even to inform a single agency's mission.

8.1.1 Systemic Perspective Mapping: Contribution to Systems Thinking

I believe that the Systemic Perspective Mapping method developed as part of this study, and its implementation process, provides a contribution to the literature on systems thinking. I have explained how my method compares with other methods for mapping the system (i.e., causal loop diagramming, rich picturing, etc.) in section 6.2.1 of this thesis.

I have also argued for the need to address issues of interagency trust, protecting/guarding mission/budgets, and fear of being marginalized by other more powerful (or perceived as powerful) agency stakeholders. The Systemic Perspective Mapping method emphasizes structuring the problem with individual agency representatives first, giving them the freedom to

express their perspectives in a non-competitive environment. By then merging all the perspectives together, a more inclusive capture of perspectives is provided before group Boundary Critique begins. I believe this is highly effective in breaking some of the barriers that have been observed in fostering collaborative relationships.

8.2 Discussion of Phase 2 of the Systemic Intervention

Research Purpose for Phase Two: Building on the results of phase one, develop, implement, and assess a VSM (Beer, 1979, 1981, 1984, 1985) board game for designing an interagency meta-organization that is 1) tailored to the representation (that stakeholders themselves created) of the wicked problem and 2) capable of effectively addressing the problem at multiple scales and across boundaries.

One defining feature of super-wicked problems is having weak or non-existent institutions at the appropriate scale to enable co-ordination and take effective action (Levin et al., 2012). It is for this reason that, after the common interagency understanding had been developed in my Systemic Intervention, I went on to use the VSM (Beer, 1984) to address this issue.

The VSM has been criticized by some researchers for being difficult to understand and use, and the cybernetic language has been identified as a 'cognitive barrier' to uptake (Ulrich,1981; Jackson, 2001; Hildbrand & Bodhanya, 2015). This can be a particular problem in situations where there are real-time constraints on the stakeholders' engagement, and few opportunities for one-to-one coaching (Espinosa and Walker, 2013). To overcome the cybernetic language barrier, I focused on the development of a VSM Board Game to make getting to grips with the model more 'fun'. I therefore researched how the VSM Board Game could be used as part of the overall Systemic Intervention approach for collectively designing a tailored interagency organization. Others have developed software tools and new implementation methods to facilitate learning around the VSM (Espejo et al., 1999). An example of a new method is offered by Lowe, Espinosa and Yearworth (2020), who developed a set of guiding questions to facilitate a VSM assessment of an existing organization.

Researchers have suggested that blurred lines of accountability are a major challenge to successful interagency design (Pollitt, 2003; Christensen & Lægreid, 2007). My approach addresses this by placing the systemic perspective map of the wicked problem on the wall in front of the stakeholders. Seating each of them behind a S1 circle on the VSM board (laid out on a table), I effectively simulated the experience of dealing with the variety coming from the wicked problem

to inspire the interagency design. While Beer (1994, 1995) and other researchers (e.g., Espejo & Reyes, 2011; Espinosa & Walker, 2011, 2017) have also proposed methodologies and methods to aid the application of the VSM, I aimed to develop a tool (the VSM Board Game) to provide a physical and intimate interaction between agency stakeholders and their collaboratively developed systems perspective on the wicked problem. This kind of interaction within a group setting brings a great deal of dialogue and enhanced mutual understanding to the task.

Figure 8.1 provides a diagram of the entire VSM analysis developed using the board game. In their feedback to us (collected through post-workshop debriefings and a questionnaire, described in Chapter 6 and Appendix 3, informed by the approach to evaluating systemic methods developed by Midgley et al., 2013), the stakeholders said that they very much appreciated how the VSM Board Game helped them to explicitly identify overlaps in the work of the various agencies, and it encouraged serious thought on how a whole-of-government interagency organization should align itself to help address the threat of organized crime.

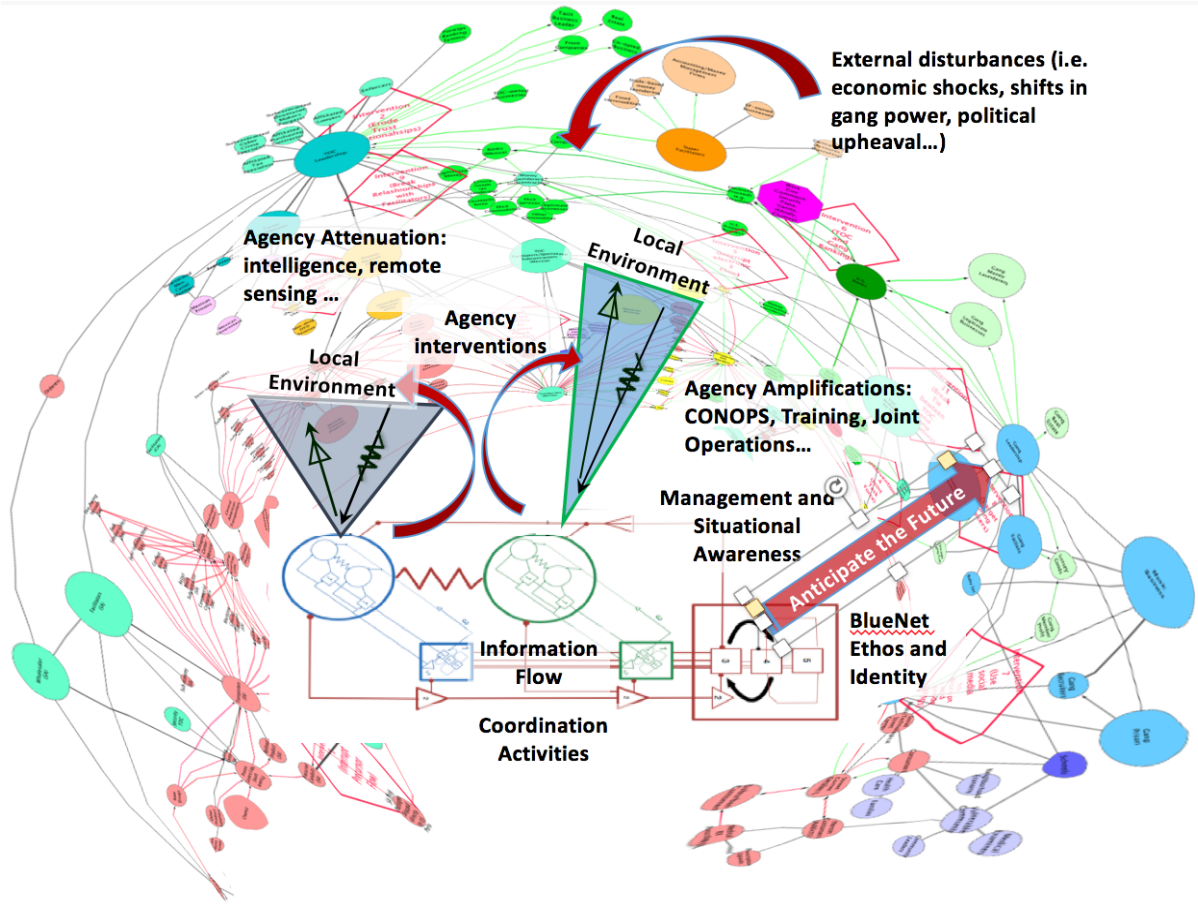

Figure 8.1: Diagram of the total VSM BlueNet inter-agency design

The VSM can be used in different ways. Sometimes practitioners act in an expert mode, consulting members of the organization, but doing the analysis themselves. Jackson (2000) argues that this approach is based in the functionalist paradigm, because the analyst is assuming it is possible for him or her to develop a reasonably objective representation of how each aspect of the organization functions in relation to the whole. In contrast, other practitioners seek to facilitate the stakeholders in doing their own VSM analysis (e.g., Espejo & Harnden, 1989; Franco & Montibeller, 2010; Golinelli, Pastore, Gatti, Massaroni & Vagnani, 2011; Brocklesby, 2012; Espinosa & Walker, 2013; Espinosa et al., 2015; Tavella & Papadopoulos, 2015). Jackson (2019) calls this an interpretive use, as the practitioner is assuming that the 'building blocks' of social reality are people's perspectives and interpretations, so bringing these together to forge a common understanding of the organization (rather than aiming for objectivity) is most appropriate. My own approach to using the VSM was in line with the latter work, supporting the agency stakeholders to design their own viable system, yet I would situate it in a critical-systems (rather than interpretive) paradigm because, in common with other writers on Critical Systems Thinking (e.g., Flood and Jackson, 1991b; Flood and Romm, 1996; Midgley, 2000; Jackson, 2019), I advocate the integrated use of methods and models drawn from other paradigms (e.g., the bringing together of Boundary Critique, Systemic Perspective Mapping and the VSM), reinterpreted through the Systemic Intervention approach (Midgley, 2000, 2006a, 2015, 2018, 2022b; Midgley & Rajagopalan, 2021).

The VSM-generated interagency design produced through my research encouraged adaptation to the environment, so the interagency could keep in homeostasis with the wicked problem over time. As problem elements change, either through intentional interventions or other external disturbances, the systemic perspective map can and should be updated and the design should be recalibrated. Likewise, as agency missions, responsibilities, and power relationships change, the design can be re-visited to make sure that BlueNet stays aligned. Within the timescale of a PhD project, it wasn't possible to follow up and facilitate this kind of adaptation, but the stakeholders themselves remarked on its necessity.

Stakeholders commented on how they valued the ability to design BlueNet themselves through using the board game, and not have a structure imposed on them. They liked the way that no one agency was seen as the lead and said they could freely voice their opinions and agree on the rules and protocols they should all follow. Because interagencies must contend with real communication challenges, participants appreciated how starting the design process with the common understanding (systemic perspective map) meant that they were not bogged down with

having to contend with differing perspectives, or even syntax or terminology issues. Those issues had already been addressed.

Before starting the VSM workshop, the stakeholders lamented that they seldom had sufficient time to make a strategic assessment of what other agencies did to anticipate alternative future environments (System 4), so they felt that using the VSM was a welcome exercise. They were especially intrigued by how organizational adaptation could be achieved through the S3/S4 collaboration. However, there was some concern about the cost of hiring sufficient staff to adequately equip S3 with the ability to maintain coordination, and for S4 to generate maps of alternative futures.

During this study, stakeholders began to see their own agencies as recursive viable systems that could potentially be embedded in the interagency organization. Similar results were reported by Brocklesby (2012) in a study conducted to illustrate the value of the VSM in diagnosing an existing multi-agency organization, the UK's Serious Organized Crime Agency. Interesting conversations emerged around which subsystem they each saw themselves in within their organizations at the recursive level below. Some said that they were in two subsystems simultaneously, sometimes being part of a S1 and other times a S3. They also discussed how some subsystems were not working well within their agencies, or in some cases were missing altogether.

Study participants also lamented the missing stakeholders who did not participate in the study (listed in the Chapter 7). Those who did participate hoped that, in the future, the participation of these other organizations would improve their ability to design an effective interagency system. Clearly, bringing in new agencies could potentially introduce more conflict and create a bigger challenge for the VSM design, but one that could produce huge benefits – albeit not within the scope of a single PhD project.

8.2.1 VSM Board-game Contributions to Systems Thinking

The successful implementation of the board game demonstrates how an interagency organization can be quickly co-designed, once the right context for generating a common understanding of the wicked problem among multiple agencies has been agreed upon. By first structuring perspectives of the problem with participation from local, regional, and federal agencies, I was able to begin the VSM Board Game with stakeholders directly delineating on the systemic perspective map where they had responsibilities, and documenting what activities (surveilling, interdicting, data

analysis, etc.) their agency was currently involved in. This created a robust foundation for the VSM Board Game.

In Chapter 7, I conceptualized the problem of accessibility using Sperber and Wilson's (1995) relevance theory (first introduced into the systems literature by Velez-Castiblanco, 2012, and Velez-Castiblanco et al., 2016). This explains that the relevance of a model or idea to any given person (e.g., a participant in an organizational design project) is a function of the perceived cognitive inferences it generates (i.e., how useful it appears to be) minus the amount of work that it takes to assimilate it. At first sight, a project stakeholder who is new to the VSM will be uncertain of its potential cognitive inferences but will see straight away that its language and diagrams are dauntingly complicated. I will explain below how the innovations described in this paper addressed both problems, and I will then extend relevance theory by adding a third dimension to it (in addition to perceived cognitive inferences and the amount of work to realize them). I will demonstrate that my approach (in common with other participative approaches to the VSM, and indeed other collaborative systems thinking and OR methodologies) addresses this third dimension too.

To reduce the work (or cognitive load) that the stakeholders would have been anticipating when I first introduced the VSM, the board game was developed and used to be more highly engaging for the stakeholders, as it introduced a bit of fun into the proceedings and helped structure the process of identifying and addressing viability issues in a step-by-step manner. Increasing the perceived potential cognitive inferences of the VSM (via the step-by-step approach to aid clarification) and reducing the work involved in learning it (by making it more fun) addresses both sides of Sperber and Wilson's (1995) equation, thus making the VSM appear more relevant to the stakeholders in this study so they would want to engage with it.

However, earlier I mentioned that there is the potential to enhance relevance theory by introducing a third dimension. Midgley (2022a) discussed with me the concern he has had for some years that relevance theory only talks about an *individual's* calculation of potential relevance: Sperber and Wilson (1995) do not account for the social context. If this context is introduced as a third dimension, then a *social* relevance theory can be proposed. The social context includes all the peer expectations placed on an individual by others in their family, friendship groups, work team, line management, professional societies and communities of practice, etc. Some such expectations will be hard for an individual to counter if they want to remain within a given organization or institution, or benefit from rewards being offered for conformity: e.g., think of a student faced with studying a mandatory module they would prefer

to opt out of because it doesn't look very useful or appears to involve a lot of work – if they want to remain on the course, studying with their friends, and they want to graduate with a degree, they are likely to do the necessary work despite their misgivings, and they may even discover beneficial cognitive inferences that they did not anticipate. Other social expectations may be less consequential, but nevertheless also act as motivators, such as discovering that colleagues in their own organization and/or external collaborating organizations are volunteering their time for a VSM diagnosis and design exercise – there may be minimal consequences for the individual if they don't volunteer as well, but their respect for and identification with their colleagues makes them take the risk and join in.

My use of both the Systemic Intervention approach in general, and the VSM, in particular, addressed the social context in order to motivate engagement. First and most obviously, it did so by making the approach participatory right from the initial collective engagement with stakeholders at the Boundary Critique workshop in the National Defense University. Here, I was taking them out of their day-to-day peer communities and putting them with a new community of practice. In this new social context, norms of engagement could be quickly established. Thus, seeing the collective engagement of others set up peer expectations of individual engagement. Once this peer community was established, the effects of their expectations also influenced the participants who joined the study later.

It is important to acknowledge that this approach is by no means unique in harnessing peer expectations: it is a benefit of all participatory approaches, once successfully initiated, that peer expectations of engagement are established. This is the case for most PSMs (e.g., Rosenhead, 1989; Rosenhead & Mingers, 2001; Mingers & Rosenhead, 2004) and dialogical systems approaches (e.g., Checkland, 1981; Mason & Mitroff, 1981; Christakis, Warfield & Keever, 1988; Ackoff et al., 2006), as well as use of the VSM in a participatory mode (e.g., Espejo & Harnden, 1989; Franco & Montibeller, 2010; Espinosa & Walker, 2013; Espinosa et al, 2015; Tavella & Franco, 2015; Tavella & Papadopoulos, 2015, 2017; Tavella, 2018; Harwood, 2019). However, this is not the benefit of participation that is most mentioned in the literature: usually, emphasis is placed on the value of mutual learning (e.g., Checkland & Scholes, 1990) and/or buy-in to emergent solutions (e.g., Flood, 1995), rather than the acceptance of methodologies that, in the absence of peer expectations for engagement, might not appear so relevant to individual stakeholders.

So, I have now explained how my approach to using the VSM board game addressed all three aspects of social relevance theory: belief in significant potential cognitive inferences was

enhanced by establishing trust in the overall systems approach through prior Boundary Critique and problem structuring; the perceived work involved in learning the VSM was reduced by use of an innovative board game; and participation in interagency workshops set up peer expectations of individual engagement, thus addressing the need for a propitious social context.

8.3 The Entire Systemic Intervention: Summary and Discussion

There are three fundamental aspects of systemic intervention: Boundary Critique (e.g., Ulrich, 1983; Midgley et al., 1998; Midgley & Pinzón, 2011; Foote et al., 2007), which involves exploring different possible boundaries for the inclusion or exclusion of stakeholders and the issues that concern them, as well as checking for issues of power, conflict and marginalization that might have to be accounted for in the project design; Methodological Pluralism (e.g., Jackson, 1987; Midgley, 1989a,b, 1990, 1997a, 1997b, 2000; Midgley et al., 2017), sometimes called 'multi-methodology' in the OR literature (following Mingers and Gill, 1997), which involves drawing methods from other methodologies and paradigms and mixing them to create a bespoke project design; and improvement (Midgley, 1996b, 2000), which has to be defined locally and temporarily, but in a widely-informed manner, in relation to the Boundary Critique.

8.3.1 Discussion of Mixing Methods

Figure 8.2 revisits the diagram of the entire Systemic Intervention approach for this research. For this study, I embraced the concept of the 'creative design of methods' (Midgley, 1997c, 2000). I chose some existing methods (e.g., use of the VSM and questionnaires), but reinterpreted them through my Systemic Intervention approach and my analysis of the context of the project to address the interdependent complexities of the wicked problem and the practical challenges of organizing an interagency response. I also designed new methods (Systemic Perspective Mapping and the VSM Board Game) when existing ones did not seem adequate. As described in Chapter 6 (and in more detail in Sydelko et al., 2021), the whole project was prefaced by extensive and interwoven Boundary Critique, empowering stakeholders to identify others who would need to be involved.

The Systemic Perspective Mapping (a new PSM), which first engages with each agency representative individually, and then with the whole group, helped the stakeholders make two significant cognitive inferences: they realized that they each had only a partial understanding of the wicked problem, so insights could be gained from listening to other perspectives; and they came to appreciate that it was actually possible to generate a common interagency understanding

(i.e., an improvement) by doing the difficult work of integrating their perspectives into a single visual map. These insights were so powerful for the stakeholders (see Chapter 6 and Sydelko et al., 2021, for their feedback) that trust in the next steps was significantly built. Indeed, as the problem structuring phase ended, the stakeholders were raising the issue themselves of how they could build a collaborative interagency organization, and were asking us to help them with it, making the VSM the obvious next step in the project.

The two phases together (problem structuring followed by use of the VSM) represent a larger Systemic Intervention approach (influenced by earlier authors, such as Midgley et al., 1998, Espinosa and Duque, 2018, and Brocklesby, 2012, who all prefaced use of the VSM with Boundary Critique and/or problem structuring) that contributes to the emerging field of interagency design.

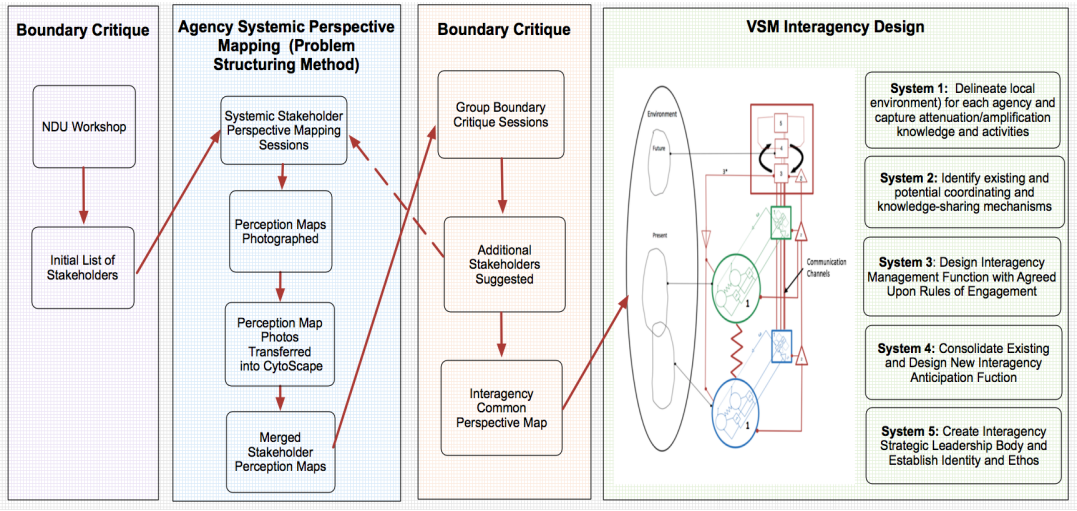

Figure 8.2: Systemic Intervention Approach to Designing an Interagency (revisited from Figure 6.1)

The Systemic Intervention approach is not only functionally useful (in the sense of providing a larger set of methods to do a wider variety of things than methodologies that prescribe only a narrow range of methods), but it also builds trust in systems thinking, giving stakeholders confidence that some of the more complicated aspects of the work, like use of the VSM, will indeed generate significant cognitive inferences.

8.3.2 Stakeholder reflections on the Systemic Intervention

This research was not intended to create actual U.S. policy change but was conducted with real stakeholders from key agencies battling illicit drug trafficking. Their experience with the approach, and the feedback they provided throughout (and after completion of the study), suggests that Systemic Intervention provides a powerful approach for improving interagency design that can be

taiored to specific wicked problems. The participants particularly felt that the Systemic Intervention approach enabled:

- Inclusiveness of all necessary agency perspectives, provided that those agencies chose to participate (some declined the invitation to join the project, or just failed to respond).
- Cross-agency learning and a much deeper multi-stakeholder understanding of their wicked problem.
- Rich dialogue about conflicting perspectives and the ability to work transparently to resolve conflicts.
- Reduced marginalization of stakeholders with less positional authority and influence than others.
- The joint participatory creation of a non-hierarchical interagency design that aligns directly with the wicked problem they were collaboratively tasked to tackle.

Many study participants expressed the wish that they could have dedicated more time to the study (as volunteers, they were also fully engaged in doing their jobs). Their feedback also contained questions about whether the approach would work with the agency chief executives and a much larger set of stakeholders involved. Following Midgley (2000), I suggest that these challenges would probably necessitate adaptations to the process of implementation (e.g., involving stakeholders who might not feel comfortable speaking in front of chief executives in separate workshops).

As mentioned above, stakeholders were quick to understand how this approach could be applied to their home agencies. In fact, I was asked to brief top officials from two of the agencies in a joint meeting to summarize the study and help them understand the potential of the approach within their own agencies. A briefing was also given to a group of managers within one of the agencies. Both briefings were well received. In a response to a question about how the knowledge gained from participating in the study had influenced their approach to organized drug crime, one stakeholder responded:

> "The Systems Analysis-based methodology is still influencing us heavily in helping us understand the operational environment regarding this wicked problem. As we experience variance and increase in velocity of the evolution of the threat, the methodology assists us greatly in looking up and out at problems; identifying, not just the threat network and its nodes of influence, but also who are the partners that potentially

hold information or intelligence that help complete the picture, as well as hold authorities that, if executed, would complement our strategies to mitigate the threat".

8.3.3 Potential to Address Interagency Challenges

There has been an increasing interest in finding mechanisms for improved interagency, multi-agency, or joined-up government collaboration to address problems that cross agency, stakeholder, jurisdictional, and geopolitical boundaries. My review of research conducted on interagency collaboration mechanisms (section 3.4.1) has identified some successes, but many authors have discussed challenges and limitations. However, not many have offered clear ways forward for the collaborative and systemic co-design of interagency organizations, and my research offers clear methodological guidance to achieve this. Below, I discuss some of the more specific ways this research contributes to the literature describing interagency collaboration.

8.3.3.1 Autonomy

There was an element of unease among stakeholders in this study about the approach's ability to respect and retain the autonomy of the agencies and protect their budgets, despite me stressing that the S1s should maintain autonomy within the necessary constraints set to achieve the overarching mission of the interagency organization. Nonetheless, the participants still indicated a desire to see the approach used "for real", and they said they understood that a "perfect system" would not be possible, but an improved one could be. This finding is significant, as a perceived loss of autonomy is a major barrier to interagency working (Mullin & Daley, 2009; Bjurstrøm,2021.

8.3.3.2 Resource and Time Constraints

Another common complaint about creating interagency collaborative mechanisms is that it is expensive in terms of both resources and time (Weiss, 1987; Christensen & Lægreid, 2007). Indeed, one of the most time-consuming challenges is building trust (Pollitt, 2003; Vangen & Huxham, 2003; Atkinson, Jones & Lamont, 2007; Ansell & Gash, 2008; Bianchi, 2015; Curnin, Owen, Paton, Trist & Parsons, 2015). Stakeholders in my study expressed concern over the time requirements needed for their involvement, although I suspect that this was because all the individuals were being asked to participate *in addition* to their regular jobs. In a 'real life' interagency organization, the collaboration would be *part of* their regular work, and actually there was a strongly-expressed view from the participants that they would have liked to have taken *more* time to engage in the action research.

I argue that this study offers a new approach to enabling agency stakeholders to structure a common understanding of the wicked problem and collaboratively design a response to it within a reasonable timeframe. Overall, the estimated time that stakeholders dedicated to participating in the entire Systemic Intervention (including the filling out of evaluative questionnaires, which wouldn't necessarily be required outside the context of a research project) was about 30 hours each. Of course, my time to collect perspectives, create digital systemic maps in Cytoscape, and facilitate workshops should be included; but even that did not constitute a full-time role, as I was undertaking this research alongside my paid job of leading the Systems Science Team at Argonne Research Laboratories in Chicago, USA. I would estimate, on average, the fieldwork portion of the study took 3-4 hours per week for 2 years (including individual stakeholder engagements, workshops, and the Cytoscape Systemic Perspective Mapping effort).

It seems reasonable to believe that scaling up this approach would not require an inordinate amount of time, especially as 'quick wins' could no doubt be obtained through information sharing and improved coordination. The ability to formulate an interagency perspective under time constraints addresses the sense of urgency described by Levin et al. (2012), who define the features of 'super-wicked' problems. The time investment needed for an interagency design is a reasonable concern, given that most agencies are under pressure to demonstrate delivery against targets within their own organizations. This study was conducted using volunteers who had limited time to devote to engaging fully in the Systemic Intervention process. Support, encouragement, and the permission to allocate time to the process from upper levels of agency management is key to getting full engagement on a Systemic Intervention such as this. Those who volunteered were able to secure support from their managers, and this would be necessary for a 'real' application outside the context of a research project.

8.3.3.3 Leveraging Existing Organizational Constructs

Not surprisingly, to mitigate the perceived time and expense of designing a stand-alone BlueNet, the stakeholders suggested leveraging existing organizational constructs, such as fusion centers and task forces. However, they understood, through participating in the VSM design, that these constructs could not just be 'plugged in': rather, their functions would have to be changed and improved before they could be leveraged to work within BlueNet. While it is easy to conceptualize fusion centers as being part of (but not the entire) S2, there remains a lot of potentially useful, sharable information held within individual agencies (S1s), and mechanisms are needed for

facilitating that sharing. Additionally, fusion centers are often aligned to parts of the problem only, creating inconsistencies and a lack of integration and coherence across the whole wicked problem.

As discussed by Agranoff (2006), interagency bodies rarely have formal powers. As with task forces and fusion centers, the role is almost always one of studying issues and making recommendations for actions to be taken. The goal of this study was to design an interagency response that, if implemented for real, would be able to direct action, not just advise. This would mean that BlueNet would have its own mission and budget, even if the budget consisted of contributions by individual agencies. The authority given to BlueNet to conduct operations would have to come from the recursive level above it: perhaps the Executive Branch of the US Government. To create a true interagency, even if it is directed through czars or task forces, requires the granting of authority. Even though stakeholders thought that their agencies might provide support, they expressed doubt that the Executive Branch would adapt to an interagency approach and move away from funding siloed agencies. This is clearly a real challenge to successful, high-level interagency coordination. Although the time and budget constraints of this study did not allow for a detailed exploration of how fusion centers and task forces could be incorporated into BlueNet, it seems further work on how they could be redesigned to operate more effectively and efficiently in support of an interagency organization would be warranted.

8.4 Transferability

Although the Systemic Intervention described in this thesis and in Sydelko et al (2021) was conducted to design a specific interagency response to illicit drug trafficking, I suggest that this approach would be promising for governments to use to improve interagency design for other challenging wicked problems.

There is nothing in the systemic design that is specific to illicit drug trafficking. For instance, Boundary Critique interwoven with Systemic Perspective Mapping can be used for building trust and creating a common interagency understanding of any given wicked problem, starting from the multiple viewpoints of agency representatives and moving towards an integration and harmonization of their systemic perspective maps. Likewise, the VSM has been used in a wide variety of interventions, as explained in Chapter 7. It seems to me that there is no reason why the whole design (incorporating Boundary Critique, Systemic Perspective Papping and use of the VSM Board Game) couldn't be replicated in an equally diverse array of projects when a common understanding and a coordinated interagency response are required.

Having said this, it is important for me to acknowledge that there are limitations to what should be claimed based on a single case study (Checkland, 1981; Rowe & Frewer, 2004; Midgley et al., 2013). Within the context of time-limited PhD research, only one case study was possible, but since my fieldwork has concluded (while I was writing up this thesis), I have actually undertaken a second study (dubbed 'Project SYSTEMIC'), trialling the same mixed-methods design to address a different wicked problem: supporting community planning in the context of improving access to science, technology, engineering and mathematics (STEM) education for black and minority ethnic school students. This new project is completed, and a client report, in the form of an Austin community strategic plan, has been produced (Sydelko, 2021), but it has not yet been written up for publication in the peer-reviewed literature. I am therefore accumulating evidence that this particular combination of methods could be a relatively stable and transferable one and could have wider utility in relation to a diversity of wicked problems and interagency contexts. While my PhD research is based on just one case study, so my claim to transferability here needs to remain quite modest, it will not be long (assuming a peer-reviewed journal accepts the write-up of my new project) before a further example will be in the public domain.

I understand that every wicked problem is unique, and that the agencies, personalities, and politics involved in each can be very different. Nevertheless, I contend that the process should be transferable to other situations requiring a common understanding of the wicked problem and an interagency response to it, as long as it is possible to bring the right people together. Sometimes, engaging the right people can be very difficult, and this is perhaps especially so for super-wicked problems. Clearly, getting buy-in from champions at senior manager levels within the agencies can greatly help with this issue, and when there is also a champion at a higher level of recursion than any of the agencies (e.g., when national and/or international executives sponsor the work) it can also motivate 'lower-level' engagements, as long as the agencies are not alienated from the 'higher-level' authority. However, even when senior champions are absent, the project described in this thesis indicates that beginning the process at lower levels with just some stakeholders who are willing and able to participate, will uncover where there are missing perspectives. Inviting additional stakeholders can be aided by presenting them with the incomplete Systemic Perspective Mapping of the problem, so they can see where their valuable inputs are missing. This happened for both the drug trafficking study and for Project SYSTEMIC.

8.5 Future Research

Now that my PhD research is concluding, I am interested in developing an article reporting on the work done with Project SYSTEMIC. In addition, borrowing from other researchers who have

discussed evaluating methods across interventions (e.g., McAllister, 1999; White, 2006; Yearly, 2006), I would like to explore engaging with other systems practitioners to test how they might use this Systemic Intervention approach, and how easy it might be for others to take up. This would also assess whether success is dependent on my personal characteristics, or whether other competent systems practitioners could make progress using the same approach. Perhaps once additional applications are undertaken by four or five different practitioners, reflections across their case studies could be useful to reveal patterns – i.e., critical success factors and/or regularly-encountered barriers.

In addition, as this study focused only on the systemic *design* of an adaptive, viable interagency, and not on the *implementation* of the design, further research into assessing the implementation would provide additional evaluation of the effectiveness of the design. I will be looking for an opportunity where there is a need for the full design and implementation of an interagency approach to address a wicked problem. I would also be interested in researching how mixing design thinking methods (e.g., Kleinsmann, Valkenburg & Sluijis, 2017) into the systemic intervention might further enhance the creation of an organizational design. Perhaps incorporating design thinking into the problem structuring could bring the use of narratives into formulating the problem.

As mentioned in Chapter 7, the anticipatory system (S4) is often the most undeveloped of all the VSM functions, and for organizations (especially those that represent collaborations across autonomous agencies) to be nimble and adaptive, S4 must be robust and well connected to S3. Therefore, an area of interest is to further collaborate with other researchers interested in expanding the multi-methodological basis of this Systemic Intervention by including first-wave systems approaches (e.g. System Dynamics, Agent-based Modeling, Systemic Visualization, Data Analytics, Predictive Physical Modeling) to explore how this approach can better anticipate systemic changes to both wicked problems and to the organizations designed to address them.

I am also very interested in exploring how to include the natural environment as a stakeholder in the process of sustainability interventions. This could entail inviting subject matter experts (e.g., soil scientists, forest ecologists, hydrologists, atmospheric scientists) to participate as representatives for various components of the natural world during Systemic Perspective Mapping. The natural world stakeholders could also participate during the VSM Board Game in offering critical challenges to the designers of S1 and S4 (the two VSM systems that engage directly with the environment).

Additionally, it could be instructive to bring indigenous worldviews into the analysis, given the fact that many indigenous cultures embody sustainability principles (e.g., Romm, 2017; Morgan & Fa'aui, 2018). A community-level study using my Systemic Intervention approach could contribute to understanding how systems approaches can more fully embrace human diversity and understandings of the natural world as part of systemic planning.

8.6 Summary

In this chapter, I have summarized the entire Systemic Intervention and discussed the contributions of this research to both the field of systems thinking and to the practice of designing an interagency response to wicked problems.

One of the original contributions of this research is the creation of the new, participatory-dialogue method of Systemic Perspective Mapping. While this reflects the learning obtained through a review of existing literature, it also contributes to system thinking by providing a method to:

1) Be used when time and space is needed for individual stakeholders to develop their thinking prior to group problem structuring.
2) Allow individual stakeholders to express their understandings of problem interdependencies without forcing them to develop cause and effect relationships;
3) Capture stakeholder perspectives in a way that could be understandable by others outside the stakeholders that create the maps, and that could be merged with other stakeholder mapping outputs (unlike pen-and-paper rich pictures);
4) Create an appreciation of stakeholders' value judgements about the problem, expressed through weightings of elements and relationships; and
5) Create a more inclusive initial perspective that can be used when the group of stakeholders come together to reconcile their differences through Boundary Critique.

My research on the VSM board game contributes to the quest for "more process studies to identify modelling and interaction procedures that would follow paths on which individual differences would not matter" (Franco et al, 2021, pp. 412). I suggest that I have demonstrated the value of the game as a boundary object (Star & Griesemer, 1989; Star, 2010; Franco, 2013), which enables negotiations and agreements between people who read different meanings into the organizational design. The board game is rules-based, so it structures the negotiations with turn-taking and other devices that help people to clarify their understandings and receive constructive feedback on them.

It is also worth noting that the design of the whole Systemic Intervention, but in particular the board game, helped to overcome some of the significant barriers to co-production (McCabe, Parker, Osegowitsch & Cox, 2022) that can arise when academics and non-academic decision makers collaborate: not only was the entire intervention process constructed to facilitate the learning of the agency representatives, in ways they would perceive as relevant to their practical concerns, but the board game was specifically designed to overcome resistance to the highly-technical language of the VSM. In this sense, my research contributes to the literature on the VSM by addressing criticisms (e.g., by Checkland, 1980; Ulrich, 1981; Jackson, 1988; and Lowe et al., 2016) of the inaccessibility of the visual representations and the language of cybernetics originally used by Beer (1979, 1981, 1984, 1985). These criticisms are important because, with the turn to a more participatory approach to using the VSM (e.g., Espejo & Harnden, 1989; Franco & Montibeller, 2010; Espinosa & Walker, 2013; Tavella and Papadopoulos, 2014; Espinosa et al, 2015), and the corresponding rethinking of the philosophy underpinning its use in systems practice (e.g., White & Taket, 1996; Espejo & Reyes, 2011; Espinosa & Walker, 2017; Lowe et al., 2020), if stakeholders in projects find the theory and visual models off-putting, it could seriously undermine the usefulness of the VSM. With the "death of the expert" (White & Taket, 1994, p.733), or perhaps more accurately the idea that stakeholders in projects (including the public) bring in significant expertise of their own by virtue of their contextually-relevant knowledge and experience (Churchman, 1968, 1979; Ulrich, 1983), it is no longer enough for the systems practitioner alone to understand the VSM if he or she expects participants to use it.

While I believe that the Systemic Perspective Mapping and VSM Board Game each provide their own contributions, I argue that a mixed-methods design like this Systemic Intervention is more than the sum of its parts (Midgley, 1997a), in that each aspect of the intervention is strengthened by the other aspects. The Boundary Critique and Systemic Perspective Mapping that I have presented in this thesis helped the stakeholders develop a common, interagency understanding of the wicked problem, but it was using the VSM to design an organizational response that helped them see how they could move from an improved understanding to coordinated action. Better understanding of the current situation alone is often insufficient to enable beneficial change. However, if I had gone straight into a VSM analysis, it would have been weakened by an inadequate appreciation amongst the participants of the complexity they were facing. A high-quality organizational design on its own can likewise be insufficient to address a wicked problem: it is important to exploit the *synergies* that can be obtained from mixing methods to support intervention (Midgley, 1997a, 2000).

It should be noted that the final stages of my Systemic Intervention for designing a response to illicit drug trafficking were conducted just as the U.S. transitioned to the Trump administration and a Republican government. Many of my stakeholders were either reassigned to other duties or retired. Clearly, continuity of the interagency from one administration to another is a concern. Between then and now, an election has once again brought in a new Democratic government under President Biden. It remains to be seen whether he will continue the same approach to siloed funding and authorization of agencies or will be willing to experiment with new ideas.

My hope is that my research will offer an approach that can be taken up by the new administration to systemically design interagency organizations that are more capable than previous approaches of adequately responding to the many wicked and super-wicked problems that we are either experiencing now or are on the horizon. The signs are promising: just before submitting this thesis in September 2022, I was invited to participate as a subject matter expert in a US General Accounting Office (GAO) consultation on interagency collaboration practices. The GAO is an independent, professional, nonpartisan agency in the legislative branch of US Government, which is commonly referred to as 'the investigative arm of Congress'. The approach came as a result of GAO staff reading Sydelko et al (2021).

Throughout my career, I have consistently worked on very large problems that cross agency boundaries. It has been my anecdotal experience that trust and transparency present very difficult challenges when designing interagencies. This has also been documented by other researchers, as discussed in Chapter 3. However, from a very practical perspective, the new mix of methods that I have produced and tested in my research shows a lot of promise in breaking through trust barriers; providing for learning and increased awareness of the problem; respecting agency autonomy (within interagency constraints); and designing a response that is broad and adaptable.

I will continue to engage with this research agenda.

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Appendix 1: Stakeholder Invitation to Participate

Pamela Sydelko

Director: Systems Science Center

Global Security Sciences Division

Argonne National Laboratory

Lemont, IL 60439

Date: June 20, 2016

Dear _____,

This letter is an invitation to consider participating in a study we are conducting at Argonne National Laboratory. We would like to provide you with more information about this project and what your involvement would entail if you decided to take part.

The project focuses on the development of systems thinking and anticipatory systems methods that can aid in designing trans-agency meta-organizational structures that align with the "*wicked problems*" they are collectively addressing. Wicked problem is a term used by systems researchers to describe complex problems that exhibit a very high degree of interdependence, have a great number of stakeholders, and defy the notion of a single final solution.

The case study we are developing, entitled "*Crime on the Urban Edge*", will use the convergence between transnational organized crime and U.S. domestic gang crime as the complex problem that is being addressed. We believe that because of your knowledge and active involvement in addressing aspects of this problem, you would be able to provide a valuable perspective. Therefore, we would like to include your expertise and knowledge of these systems as one of several stakeholders to be involved in our study.

Participation in this study is voluntary. First, it will involve an interview of approximately 1 hour in length. You may decline to answer any of the interview questions if you so wish. In addition to the interview, a workshop will be held in Chicago to conduct systemic problem structuring and interagency team systemic design for a possible meta-organizational construct/strategy for improving the adaptability and viability in the face of this wicked problem.

Furthermore, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher(s). After the interview has been completed, we will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered strictly confidential. Your name affiliated with your organization's name will not appear in any thesis or report resulting from this study; however, with your permission anonymous quotations may be used. Data collected during this study will be retained for 10 years (as required for Department of Energy National Laboratories) in a locked office and on encrypted drives at Argonne National Laboratory. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

Should you have any concerns about the conduct of this research project, please contact Dr. Keith Bradley, Director, Global Security Sciences Division, Argonne National Laboratory, (630) 252-4685, ksbradley@anl.gov.

We hope that the results of our study will be of benefit to the individuals directly involved in the study, as well as to the broader research and national security community.

We very much look forward to speaking with you and thank you in advance for your assistance in this project.

Yours Sincerely,

Pamela J. Sydelko
Director: Systems Science Center
Global Security Sciences Division
Argonne National Laboratory
9700 S. Cass Avenue
Argonne, IL 60439
Phone: 630-252-6727
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Appendix 2: Stakeholder Problem Structuring and Boundary Critique Questionnaire

Answers to this questionnaire will be used to evaluate the strengths and weaknesses of the Problem Structuring Methods (PSM) we have used as part of the "Crime on the Urban Edge" study. As a project stakeholder and participant in the individual PSM sessions and the group PSM workshop(s), I would greatly appreciate your feedback in the form of this questionnaire. As has been mentioned at our workshops, your responses are entirely confidential, and your name and affiliation will not be mentioned or attributed to any feedback or comments you provide.

I want to thank you very much for your contribution to this study.

Section 1 – Stakeholder Interagency Experience

- How long have you worked in an area related to countering drug trafficking?
    - At what level(s) have you worked

□	□	□	□	□
Local	State	Regional	National	International

- Were you familiar with the term "wicked (tangled or messy) problem" before this study?
    - In what context?

- Have you previously used or been involved in the use of systems thinking approaches or methods (if known)?
    - Which ones?
    - In what context?
    - What were the outcomes?
    - What did you like most about the systems thinking approach(es)?
    - What did you like least about the systems thinking approach(es)?

- Have you participated in organized interagency efforts (task forces, joint operations…)?
    - How many other agencies participated?
    - How was the interagency effort organized?
    - What were the outcomes?

Section 2: Individual Problem Structuring Questionnaire

Individual problem structuring took place with you individually and consisted of facilitated system mapping from your perspective (index cards and sticky notes).

- How useful was the individual PSM session (individual session where you used cards to represent system elements and their relationships to construct your system map)? *Please tick appropriate box.*

☐	☐	☐	☐	☐
Not at All	Not so	Neutral	Fairly	Very

    - In what ways?
    - What is the thing you liked best about the individual PSM session?
    - What is the thing you liked least about individual PSM session?
    - What could have been done differently?

Purposes Achieved by the Individual Problem Structuring Session

The Individual PSM session can achieve a number of different purposes. Please help us to understand what purposes were achieved in your individual PSM session by answering the following questions:

- To what extent do you agree or disagree that the Individual problem structuring session has (*Please tick appropriate box):*
    - Helped you to identify the key elements of the wicked problem?

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Not given you an understanding of the interdependencies between elements of the wicked problem?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Failed to help you visualize your perception of the problem holistically?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Provided insight on the boundaries you have placed on the wicked problem?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Allowed you to focus on what was really important

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not provide insights into potential gaps in your understanding of the problem?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Made it difficult to focus on what elements of the problem were really important

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Gave me the ability to identify new and different intervention options?

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

Section 3: Group Problem Structuring Questionnaire

Group problem structuring took place in 2 different sessions, one on May 17, 2016, and the other on September 8, 2016. Some stakeholders attended just one session, while others may have attended both. These sessions consisted of facilitated group discussion regarding the common system map created by merging individual and group decisions about necessary changes to the common system map.

- How useful was the group problem structuring methods (session(s) where multiple stakeholders jointly made decisions on (1) names for system map elements and links, (2) additions/subtractions of elements and links, and (3) final weights for elements and links? *Please tick appropriate box.*

☐	☐	☐	☐	☐
Not at All	Not so	Neutral	Fairly	Very

  - In what ways?
  -
  - What is the thing you liked best about the group PSM session?
  -
  - What is the thing you liked least about group PSM session?
  -
  - What could have been done differently?
  -
  - Do you think the group PSM session helped you to?
  -

Purposes Achieved by the Group Problem Structuring Session

The Group PSM session can achieve a number of different purposes. Please help us to understand what purposes were achieved in your individual PSM session by answering the following questions:

To what extent do you agree or disagree that the group problem structuring (please tick appropriate box).

- Gave you the ability to visualize the entire wicked problem holistically and systemically

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Failed to put the wicked problem into a larger more holistic context

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not allow you to voice your opinion on what parts of the wicked problem are most important?

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Provided you an understanding of how your values influence your perspective on the wicked problem

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Challenged your previous way of thinking about the wicked problem

☐	☐	☐	☐	☐	☐
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Made you feel overwhelmed by the complexity of the problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Helped you to appreciate the wicked problem from the other stakeholder's perspective

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not changed your mind about what are the most important elements of the wicked problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Provided an appreciation of how actions taken by other stakeholders could affect you

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Not helped you to understand how your actions could affect other stakeholders

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Helped you recognize that there are many different points of view on the wicked problem

□	□	□	□	□	□
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A

- Provided a better understanding of how people's values relate to their views on the wicked problem

□	□	□	□	□	□

Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Not provided insights on how the values others put on wicked problem may come in conflict with your values

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Not helped you learn more about the issues surrounding the wicked problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Helped you think more creatively about the possible systemic options for tackling the wicked problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Not changed your mind on what ought to be done about the wicked problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Given you confidence that the common system map generated by the group PSM session(s) could make a difference in countering the wicked problem

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Is there anything else you would like to share in terms of your views on the processes we have used?

Appendix 3: Stakeholder Viable System ModelQuestionnaire

The Viable System Modelsession took place on September 9, 2016. Using a VSM game board to discuss each of the 5 VSM subsystems for an example of an interagency meta-organization.

Answers to this questionnaire will be used to evaluate the strengths and weaknesses of the VSM as it was used in the Crime on the Urban Edge (CUE) research study. When the question refers to "the problem", take this to mean the wicked problem of countering illicit drug trafficking by transnational organized crime and urban gangs. The term "Interagency" refers to the meta-organization system design produced by the VSM.

- How useful was the Viable System Model/Organizational Design Session (*please tick appropriate box*)?

☐	☐	☐	☐	☐
Not at All	Not so	Neutral	Fairly	Very

  - In what ways?

- What is the thing you liked best about the VSM session?

- What is the thing you liked least about VSM session?

- What could have been done differently?

Purposes Achieved by the Individual Problem Structuring Session

The VSM can achieve a number of different purposes. Please help us to understand what purposes were achieved in VSM session by answering the following questions:

To what extent do you agree or disagree that the viable system model/organizational design session has (please tick appropriate box):

- Helped you to envision the Interagency as a complex adaptive system

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not make clear the role of each agency (system 1s) within a larger interagency context

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Raised concerns about how operating as Interagency member could negatively impact your agency's funding

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Emphasized how the Interagency needs its own identity, ethos, and set of stated values

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Helped you to voice your concerns and opinions on what rules each agency should follow to be part of the Interagency

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Illustrated the dynamic and continuous nature of the VSM

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not provide transparency on what information and knowledge other agencies were collecting to better understand their local environments?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Gave you the ability to see your own agency as a recursive viable system model?

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Demonstrated the importance of establishing an Interagency entity that manages the here and now of the Interagency and ensure all agencies are abiding by agree-upon rules.

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not explain how anticipation of future changes to the environment is important to organizational adaptability

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Generated new ideas for what information and knowledge about the problem can be shared through information channels

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Made you feel more overwhelmed about managing the complexity of the problem

□ Strongly	□ Agree	□ Neutral	□ Disagree	□ Strongly	□ N/A

- Resulted in concerns about your agency's autonomy when operating within the Interagency

□ Strongly	□ Agree	□ Neutral	□ Disagree	□ Strongly	□ N/A

- Challenged your previous way of thinking about interagency organization

□ Strongly	□ Agree	□ Neutral	□ Disagree	□ Strongly	□ N/A

- Did not make clear how existing coordination and collaboration methods could be leveraged to provide better information flow within the Interagency

□ Strongly	□ Agree	□ Neutral	□ Disagree	□ Strongly	□ N/A

- Generate ideas for what new System 2 mechanisms could be established to improve coordination among S1s

□ Strongly	□ Agree	□ Neutral	□ Disagree	□ Strongly	□ N/A

- Caused concern about the amount of additional time needed to be part of the Interagency

□ Strongly Agree	□ Agree	□ Neutral	□ Disagree	□ Strongly Disagree	□ N/A

- Demonstrated how to design adaptation into the interagency

□	□	□	□	□	□
Strongly	Agree	Neutral	Disagree	Strongly	N/A

- Did not show how the Interagency would provide direct benefit to my agency

□	□	□	□	□	□
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A

- Helped you to build a better trust relationship and a sense of "teamwork" with other S1s

□	□	□	□	□	□
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A

- Is there anything else you would like to share in terms of your views on the processes we have used?

Appendix 4: Augmented Research

In addition to the funding that supported this PhD research, Argonne National Laboratory funded some experimental work associated with the (1) 3D visualization of complex wicked problems and (2) anticipatory modeling of supply chains developed in this ancillary research was done in collaboration with Argonne colleagues (North, Sydelko, Martinez-Moyano, 2016a b). I summarize this work here, as it represents the types of additional methods that can be included as part of this Systemic Intervention.

Visualization of Systemic Perspective Maps

The systemic perspective maps generated during this PhD research represent depictions of a highly complex wicked problem in a 2D form. Understanding and communicating the structure of complex abstractions like these maps is known to be very challenging (Sequin 2005). A better way to visualize wicked problems may be to manually work with three dimensions. As part of the ancillary research on illicit drug trafficking as a wicked problem, we experimented with 3D printing to create physical models from the individual systemic perspective maps.

3D printouts of the Cytoscape-generated systemic perspective maps were produced through a multiple step process (Figure A4.1 and A4.2):

1) The map is rendered in 3D using a special 3D version of Cytoscape.
2) The map is stored in an Extensible Markup Language (XML) version of Graph Modeling Language (GML) format called XGML.
3) The XGML is compiled into the solid computer aided design (SCAD) file format.
4) The SCAD file is then converted into the stereo lithography or standard tessellation language (STL) file format via the free and open source OpenSCAD application (OpenSCAD 2015).
5) The STL file is loaded into common 3D printer drivers to determine the required temporary overhang supports
6) The 3D map is printed
7) The temporary overhang supports that are needed for long horizontal spans are manually removed.

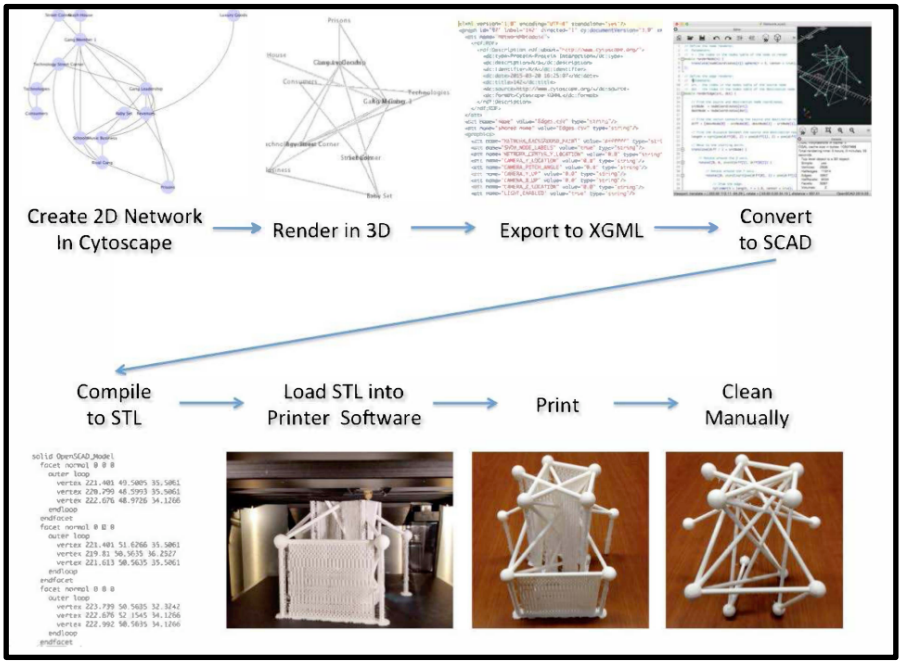

Figure A4.1: A 3D printing workflow diagram from North, Sydelko, Martinez-Moyano, 2016a)

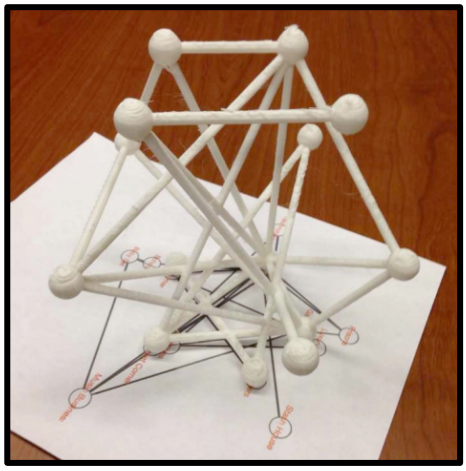

Figure A4.2: 3D printout atop a properly aligned 2D printout of the systemic perspective map.

Although funding did not permit a full evaluation of how 3D printing of systemic perspective maps improved the understanding of and engagement in the complex structure of wicked problems, early discussions with stakeholders indicate that they did improve their understanding, at least for networks small enough to print.

Anticipatory Modeling

Not surprisingly, when trying to better understand the wicked problem of illicit drug trafficking, it became clear that many elements and interdependencies are part of large supply chains, both for moving the illicit drugs and for the money laundering mechanisms. As we have described in the discussion on the VSM S4 design, many of the individual agencies responding to this wicked problem employ various methods for trying to anticipate how this wicked problem is changing and evolving - either due to forces outside the agency's involvement or those due to direct agency interventions. But as also discussed, these agencies are working primarily within their own local environments. Although sharing of anticipated changes to the local environments is important for the designed S4 function, projected changes to the overall environment would have to pieced together from all these individual projections.

A more holistic and efficient BlueNet anticipatory approach that crosses over agency mission boundaries would be to model potential adaption to the entire supply chains under various intervention scenarios. For this reason, an anticipatory modeling method was developed to automatically generate System Dynamics models using a kind of genetic algorithm known as a genetic program (North, Sydelko, Martinez-Moyano, 2016b). This modeling technique was especially developed for sparse data domains, such as the illicit drug trafficking problem.

Genetic algorithms are a category of biologically inspired search methods that implement some of the central features of natural selection (Holland, 1992). They (1) evolve a population of individuals, each representing a potential solution to a problem and (2) use a fitness function to rank each individual's effectiveness as a solution. Based on the biological concept of natural selection, populations are modified over a series of generations. Like in the biologic world, events occur during the evolutionary process that include the deaths of uncompetitive members of the population, the reproduction of competitive individuals, and random mutations among survivors. New individuals are produced by crossover events where children gain a mixture of the traits from their two parents.

Genetic algorithms have been widely used for a wide range of search and optimization tasks with substantial success (Goldberg 1989, Mitchel 1996). It should be noted, however, that for many problems, genetic algorithms are usually heuristics that do not guarantee optimal results. Genetic algorithms have been used with System Dynamics modeling to (1) construct System Dynamics models that match selected times series data (Koza **et al.,** 2001; Chen, Tu, and Jeng, 2011; Pawlas and Zall, 209; Abdelbari, Elsawah, and Shafi, 2015), (2) calibrate existing System Dynamics models

(Shuhong, 2008; Jeng, Chen, and Liang, 2006; Yu & Wei, 209) , and (3) optimize the parameters of existing System Dynamics models relative to an objective function (Linard, 2000; Alborazi, 2008; Eksin, 2008; Chen, Tu, and Jeng, 2011).

For this study, the goal was to see if a genetic algorithm technique known as genetic programming could help to anticipate the potential adaptions crime organizations would make to their supply chains in response to a BlueNet intervention. The genetic program would start with a user selectively altering aspects of the currently understood supply chain (extracted from the systemic perspective map). For example, a user might remove a stash house, take out a drug processing laboratory, and/or increase interdiction rates at a check point. Each 'individual' System Dynamics model created by the program has an associated set of output variables each (including a time series of values and an associated unit). These output variables were chosen by stakeholders and subject matter experts to represent organized crime desired aspects of the supply chain (i.e. producing high throughput, exhibiting low risk for interdiction). The fitness function uses the rising values for these variables to represent increasingly preferred candidates. Once the fitness levels become high enough, the resulting system dynamic models will be considered as possible future configuration of the supply chain.

For example, overall systemic output variables might have been high for a systems dynamic model that reroutes drug packages to remaining stash houses, or increasing the use of marine transport, or avoids routes through high-risk checkpoints. Of course, having a high fitness level for user-specified variables does not necessarily produce a realistic supply chain now or in the future, because unspecified or subtle output variables chose. Nonetheless, novel supply chains with high fitness values may offer interesting anticipatory windows into possible futures. The program shows promise as a potential S4 tool to be used by BlueNet to gain further insights into the dynamic nature of the supply chains within their wicked problem.