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Decision Support

Designing interagency responses to wicked problems: A viable system model board game

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ABSTRACT

Government agencies struggle to address wicked problems because they are open-ended, highly interdependent issues that cross agency, stakeholder, jurisdictional, and geopolitical boundaries. While both quantitative modelling and qualitative problem structuring methodologies have been used to support interagency decision making in the past, co-designing an effective interagency organization to collaboratively tackle wicked problems is more challenging. Few approaches have been developed to enable such efforts. This paper explains how the viable system model (VSM) was implemented through a board game, which was employed to co-design an interagency meta-organization that would be capable of more effectively collaborating to jointly address a wicked problem: international organized drug crime and its interface with local gangs in Chicago, USA. The board game was developed to make the VSM easier for the participants to learn, given that the cybernetic language and engineering-influenced diagrams in the original literature can be off-putting to leaders and managers. The board game was used as the final stage of a multi-method, systemic approach, which involved boundary critique and problem structuring as well as deployment of the VSM. The research findings indicate that the VSM board game, used as part of a larger mixed-methods systemic intervention, contributes to building trust in the value of systems thinking amongst the participants, and sets up a rich context for collaboration on multi-agency co-design. The game therefore offers significant promise as part of the co-design of interagency responses to wicked problems because it creates an embodied process for stakeholders to learn about the VSM. It also reduces the work involved in this learning. Thus, the game enables an effective appropriation of the VSM language and criteria.

1. On the need to improve interagency responses to wicked problems

Since so many wicked problems cross agency, stakeholder, jurisdictional, political and geopolitical boundaries, they often confound government departments that are designed to address issues which align nicely within their bureaucratic boundaries. The term 'wicked problem', first proposed by Rittel and Webber (1973), refers to highly complex, unpredictable problems (in terms of how they evolve and generate impacts), which interact with other problems, entail stakeholder conflict, are often beyond the capacity of any one agency to address alone, and usually have to be managed rather than solved.

Wicked problems remain a significant challenge to government bodies that usually take a 'reductionist' approach: breaking issues down into a collection of separate problems and then attempting to solve each of them independently within silos, erroneously hoping that all these individual solutions will aggregate into a solution to the whole issue (Fuerth & Faber, 2012). Unfortunately, trying to solve wicked problems with reductionist approaches can

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lead to unintended negative consequences because interactions between the parts (and with other issues and decisions) are not well-enough accounted for (Friend & Hickling, 2005; Camillus, 2008). Also, government decision makers charged with addressing these problems can become frustrated with how things unexpectedly change.

While OR practitioners have made substantial contributions to analyzing large, complex problems, thereby informing public policy (e.g., Simonovic, 2002; Meadows, Randers & Meadows, 2005; Masys, 2016; Dodd, 2019; Wright, Cairns, O'Brien & Goodwin, 2019; Schickore, 2020), there is limited literature on how OR can be used to create interagency organizations that are co-designed by agents facing the challenges of collaboratively addressing wicked problems. A few authors (e.g., Ling, 2002; Warmington, Daniels, Edwards, Brown, Leadbetter et al., 2004; Davis and Tierney, 2012) have observed that governments struggle to address wicked problems systemically and bring the right resources to bear from across many agencies. A major criticism of usual approaches to interagency collaboration is that it can be time consuming to develop a shared understanding, build trust, agree on purposes, acquire the necessary new skills, and forge cross-cutting agendas (Pollitt, 2003; Huxham & Vangen, 2005; Christensen & Lægreid, 2007). Other complaints about collaboration include too many meetings, missed opportunities, inaction, poor synchronization, overlapping goals, and divergent expectations (Weiss, 1987; Pacanowsky, 1995).

Head and Alford (2015) argue that, when public sector organizations collaborate to address wicked problems, they are often impeded by inflexible everyday working mechanisms. Bjurstrøm (2021) looks at how inter-agency coordination is affected by the policy autonomy of agencies, and he concludes that those with more autonomy tend to view the coordination that comes with collaboration as a threat to their freedom, so they collaborate with others less often than organizations that do not expect to be working autonomously.

The present paper picks up on this theme of interagency collaboration to address wicked problems, and we offer a new methodological contribution to the co-design of interagency organizations using OR. The wicked problem chosen for our research was an extremely complex and dynamic one, with extensive interdependencies and multiple agencies involved in countering it: the illicit drug trade and trafficking into U.S. urban centers. A discussion of how this issue has been dealt with in recent years can be found in two other papers from the authors (Sydelko, Midgley & Espinosa, 2017, 2021).

The research reported in this paper was done as a PhD project (the first author is the student and the other two are her supervisors). There was no funding or authority from a government entity to launch a real interagency organization, but to get as close as possible to the real situation, actual agency personnel were recruited to voluntarily participate and reflect on the implications for action in the real world. Logistically, we could involve most of the relevant national agencies, but not every local one across the whole of the USA. Therefore, for the purposes of representing a specific locality, we chose the city of Chicago.

2. The choice of methods and tools

The overall project followed a systemic intervention approach (Midgley, 2000, 2023), incorporating action research (Bradbury, 2015), or what Franco, Hämäläinen, Rouwette and Leppanen (2021, p.403) call a "process methodology": a series of events that bring about a behavioural outcome – in this case, improved collaboration founded upon better mutual understanding cohering around the design of an interagency meta-organization. The systemic intervention was structured into three stages of inquiry:

(1) Facilitated boundary critique (e.g., Córdoba & Midgley, 2003, 2006; Foote, Baker, Gregor, Hepi, Houston et al., 2007; Midgley, Ahuriri-Driscoll, Baker, Foote, Hepi et al., 2007; Midgley & Pinzón, 2011) to support stakeholders in exploring the problematic situation as well as their purposes, values, boundary judgments and ascribed identities;
(2) Deployment of a new problem structuring method called 'systemic perspective mapping' to build up a common understanding of stakeholders' perceptions of the wicked problem (Sydelko et al., 2021); and
(3) Use of a viable system model (VSM) board game to co-design an interagency meta-organization.

The first two of these stages provided stakeholders with a deeper, more systemic and multi-perspective awareness of the illicit drug trade and the potential options for integrated interventions (see Sydelko et al., 2021, for details). However, while the stakeholders appreciated their development of this enhanced systemic awareness, they were aware that something more was needed: they operated in siloed structures, which would frustrate effective implementation of their new insights and intervention preferences, so this had to be addressed. The current paper summarises the third stage of the research, when we used the VSM (Beer, 1979) to co-design a collaborative interagency organization with the participants, employing an innovative board game to aid application of the model.

Below, we first of all discuss previous research on use of the VSM for interagency organizational diagnosis and design. We then identify our specific contribution to this body of literature: overcoming the communication challenges involved in using the VSM in a participative mode with stakeholders for co-designing a collaborative interagency organization. These challenges stem from the VSM being framed using cybernetic terminology and systems-engineering diagrams that are unfamiliar to most practicing leaders and managers. Identifying where our contribution lies then sets us up to explain the VSM in more depth, before we outline our development and use of the VSM board game to communicate and apply the model in our project. The paper then concludes with information from our evaluation of this use of the VSM, allowing us to draw conclusions about the utility of our innovation.

2.1. Use of the viable system model (VSM) for interagency design

When dealing with a highly wicked problem, the goal should not necessarily be to solve it, but to design an interagency organization (or a voluntary collaboration, as discussed by Midgley, Munlo & Brown, 1997a, 1997b, 1998) so that it can be *adaptively managed*. 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 facilitated the participants' co-design of an interagency organization that could enhance collaboration among them, to better respond to their wicked problem, represented by the common systemic perspective map developed earlier in our project (Sydelko et al., 2021).

Midgley et al. (1998) originally influenced our approach, as they were the first to deploy the VSM in the context of multi-agency coordination following the explicit and extensive use of boundary critique and problem structuring. Also, Brocklesby (2012) discusses a very similar wicked problem to us: developing an interagency law

Table 1
VSM projects addressing multi-organizational problems.

Examples of Projects Addressing Multi-Organizational Problems	Authors
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 and 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 and Walker (2006)
Multi-agent systems simulation.	Jones, Rodriguez-Diaz, Hall, Castañón-Puga, Flores-Gutierrez et al. (2007)
Managing a complex supply network.	Chronéer and Mirijamdotter (2009)
Facilitating agreements on climate action in two Colombian ecoregions.	Guzman (2015), Espinosa and Walker (2017)
Designing a global natural disaster response system.	Munday (2015)
Handling the need for rapid communications during disaster response.	Preece, Shaw and Hayashi (2015)
Improving food security in turbulent political environments.	Velez (2016)
Enhancing the network design of a national program for cleaner production in Mexico.	Espinosa and Walker (2017)
Supporting self-governance in an indigenous community.	Espinosa and Duque (2018)

enforcement response to the problem of organized transnational crime in the United Kingdom. Brocklesby advocates using the VSM because it creates a 'big picture' approach that treats agencies as pieces in a much larger jigsaw puzzle.

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. Examples can be found in Table 1. Those listed in italics used the VSM within the context of systemic intervention and/or mixed-method OR projects.

2.2. Communication challenges with the VSM

Since Espejo and Harnden (1989) edited their seminal book of readings on the VSM, showing how the model can be used in a facilitative (as opposed to expert-led) manner, many applications have been highly participative: people from across the engaged organizations learn about the model and collaborate on diagnosing viability issues and/or they co-create a new organizational design using the VSM as a template (e.g., Franco & Montibeller, 2010; Espinosa & Walker, 2013; Tavella & Papadopoulos, 2014; Espinosa, Reficco, Martinez & Guzmán, 2015; Espinosa, Midgley, Vachkova & Walker, 2021). Indeed, Harwood (2019) goes so far as to claim that viable system diagnosis can be considered a problem structuring method. In a similar move, Lowe, Espinosa and Yearthworth (2020) offer a set of constitutive rules and an epistemology for VSM practice, which help to show how the VSM can be embedded into a practical method for engaging with broad organizational problems. This work addresses a recurring criticism of Beer's (1979, 1981, 1984, 1985) original writings on the VSM: that he did a good job of explicating his theory of organization, but didn't provide much guidance for its application in practice (e.g., Flood & Jackson, 1991).

As the emphasis in VSM practice has shifted over the years from expert-led to more participative applications, this puts an onus on OR practitioners to communicate the model to stakeholders and develop their capacity to apply it for themselves in organizational diagnoses and designs. Here, it is well known in the systems thinking and OR communities that there are still issues to be overcome. Checkland (1980), Ulrich (1981), Jackson (1988) and Lowe, Martingale and Yearworth (2016) have all discussed the highly technical visual representations influenced by the discipline of engineering, and the specialist language of cybernetics used by Beer (1979, 1981, 1984, 1985), which may create cognitive barriers to uptake by non-expert leaders and managers.

Uptake of the VSM by a leader or manager requires it to be perceived as relevant by that person. Drawing on Sperber and Wilson's (1995) relevance theory, Velez-Castiblanco, Midgley and Brocklesby (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 are 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 (Velez-Castiblanco et al., 2016). The problem with highly technical diagrams and specialist terminologies 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, non-expert stakeholders can be put off by the VSM in its original form. In summary, the contribution of this paper lies in addressing this challenge of communicating the VSM through use of a board game: our main goal for designing the game was to develop a more effective approach to explaining and applying the VSM, which enhances communication of the approach and eases the workload associated with learning it, so leaders and managers see its relevance to collaboration in the co-design of an interagency organization.

We actually offer two ways forward to support participants in engaging with the VSM. One of these is to employ the VSM after boundary critique and problem structuring, so some trust in the value of using a systems approach has already been built prior to introduction of the VSM. Trust can be developed by sucessfully agreeing on a systemic perspective map (Sydelko et al., 2021), which represents the issues being faced, how they are interconnected, and weightings of importance. The other means we offer to support participants in engaging with the VSM is the board game, which further contributes to building trust and increases the likelihood that the VSM will deliver significant, perceived cognitive inferences, even if the model is not fully understood at first glance. This is the case because moving counters around a board is a more fully 'embodied' experience than simply reading about the model or hearing the facilitator explain it: learning is enhanced by a range of sensory-motor experiences (Macedonia, 2019), so significant cognitive inferences become more possible.

The board game also makes learning the VSM fun rather than daunting. Talking about fun may sound trivial or simplistic, but the commitment that is built through fun activities has been noted before in OR (Cohen, 1994), and there is a serious point here: it is well established by both systems scientists (e.g., Maturana, 1988) and neuroscientists (e.g., Barrett, 2006, 2017) that thought, felt sense, emotion and behaviour are all entangled (completely interlinked), and a positive tone of felt sense (fun) is likely to create a more optimal learning experience, with higher levels of motivation linked to dopamine rewards, as well as more positive associations going forward. This positive felt sense reduces the perceived work involved, so our innovations address both sides of Sperber and Wilson's (1995) equation: increasing the perceived cognitive

inferences that are likely from the VSM and reducing the perceived cognitive effort that will be involved in realizing them.

Below, we first of all introduce the VSM in more detail for readers who are not familiar with it. We then explain our process of application, placing emphases on the interface with earlier problem structuring and use of the VSM board game.

2.3. The viable system model (VSM)

Originally, Beer (1979) modeled the VSM after the human nervous system that regulates internal systems to keep in balance with their environment. In his writings, he insists that the comparability of a human organism and an organization is based on isomorphic analysis (i.e., they both display the generic properties of all types of physical, biological and social system), and is not just vaguely analogical (Beer, 1984). The VSM was also 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. Another less technical way to say this is that, in order to thrive, the organization must be able to generate a sufficient variety of responses to match the variety of possible situations it might encounter (Ashby, 1947). Beer (1979) suggests that, in order to manage the complexity of a set of tasks, we either need to proactively attenuate (reduce) the variety in the environment, or we need to make changes to amplify the variety within the organization.

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, which deters many criminal acts and catches some of the remaining ones on camera. This allows 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 an ethical as well as a practical concern: Ulrich (1981) argues that the VSM shouldn't be used to pursue organizational effectiveness at the expense of vital community and societal values.

Importantly, attenuation and amplification are influenced by the ways in which organizational participants *perceive and interpret* their relationship with their environment. The relevance of perception and interpretation is made clear when we understand that two things could be happening when an organization says it has been successful in attenuation. First, action could have been taken that has successfully reduced the variety in the 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 that environment are inadequate* (i.e., these methods create bias in the attention paid to environmental variety, as discussed by Lilley, Whitehead and Midgley, 2022). Attenuation can be real or it can be an illusion. 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. Jumping straight to a VSM collaborative co-design of the multiagency organization would have risked the most lethal danger that Beer (1985) identifies: attenuation being based on ignorance of the environment rather than accurate feedback from it. Following Beer's (1979) suggestion of starting VSM applications by enriching people's understandings of the environment and clarifying the preferred system boundaries, we chose to begin our systemic intervention with boundary critique and systemic perspective mapping (Sydelko et al., 2017, 2021). Through retrospective reflection, we realized there was an additional benefit of taking this approach: it built trust and confidence in systems thinking, which made the participants more open to learning about the VSM than they might otherwise have been.

We would add that boundary critique and problem structuring alone, without a proper organizational diagnosis (e.g., using the VSM), may bring with it a lethal danger of amplification: participants may over-confidently believe that they have a high variety organization, and 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 problem structuring on the one hand, and VSM diagnosis on the other, are complementary.

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. The important concept of self-organization (Ashby, 1947; Pask, 1961; Von Foerster, 1979, 1984) is enjoying renewed popularity in OR (e.g., Espinosa & Walker, 2013; Jackson, 2015; Espinosa & Duque, 2018; Herron & Mendiwelso-Bendek, 2018; Yearworth & White, 2018; Soliman & Saurin, 2020).

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, Harnden & Walker, 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 has to dynamically adjust to disruptions (Beer, 1985). In Beer's original depiction of the VSM, there are five subsystems that represent the different types of function needed in an organization for it to be viable (see Fig. 1).

Table 2 helps explain Fig. 1. It contains descriptions of each of the VSM subsystems and the roles they play. In addition to the major subsystems, there are other important elements shown in Fig. 1 that are not in Table 2. First, there are communication channels (shown as thick red lines) that carry the information to and from the operational units (System 1s) and the management meta-system (Systems 2-5). These communication channels must be able to handle rapid knowledge flow; ideally, as fast as the rate at which variety is generated (Hilder, 1995). A second very important component of Fig. 1 is the outside environment in which the viable system is embedded. Each System 1 also has a local environment in which it is operating, and we will discuss later how System 4 is responsible for maintaining an understanding of the entire environment, as well as potential future environments.

The reader will notice that the System 1s in the VSM diagram (Fig. 1) contain another VSM diagram within them. This is because each System 1 should itself be a viable system: a viable system can be made up of many viable systems. Furthermore, although this is not shown in the diagram, it is also possible to look at a meta-level to the viable system in focus and see that the latter is actually part of a much larger system. There are subsystems within subsystems within subsystems, with any number of scales, all of which share the same structural patterns of organization. This principle of the VSM is called *recursion*, which essentially means that organizations are 'fractal' (Hoverstadt, 2008). 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

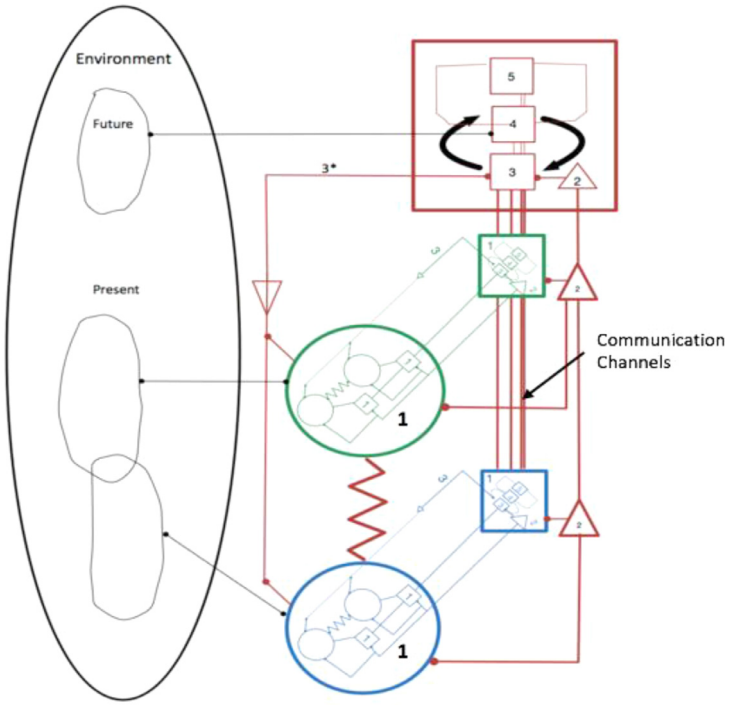

Fig. 1. Diagram of the viable system model (Beer, 1979).

Table 2
The VSM subsystems.

System 1 (S1):	S1 is the operations of the organization, where the production of products or services happens (Beer, 1985; Espinosa et al., 2015). Within an interagency viable system, the S1s can be the individual agencies that will provide the agreed operational functions within the interagency organization (Midgley et al., 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 focused on avoiding oscillations and providing conflict resolution when discord exists between the S1s (Espinosa & Walker, 2017). S2 is a set of coordinating mechanisms needed to prevent conflicts among the agencies. 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 System 1s, 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. S3 is an especially challenging function to design because it embodies the resource bargain 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.
System 4 (S4):	S4 supports organizational adaptation. 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 innovations and strategic development paths; and recommending the organisational changes needed to adapt to anticipated environmental changes. 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 facilitates effective interactions between S3 and S4 (creating an S3/S4/S5 homeostat) to foster adaptation capabilities. S5 provides an essential policy overview and is responsible for ensuring that there is a robust decision-making function. It does so by including S3 and S4 in policy and strategy decisions.

system of a whole government (which, in turn, could be part of an international alliance).

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, delineate its System 1s, and identify the viable systems at the recursive levels above and below the system in focus. However, because our research purpose was to design a single interagency organization, we only aimed at analysis at the highest relevant level of organization (known as 'recursion level 0' in the VSM literature). We did not progress into a next stage of redesigning each of the System 1s (the individual agencies) in more detail. This was beyond what was possible in the time constraints we were subject to, but we explained to the participants that, ideally, it would be advisable to do VSM analyses of their own organizations too. Indeed, we 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. We took this as evidence that the participants were quickly learning and understanding the VSM, transfering cognitive inferences from one level of recursion to another.

Because the VSM diagram (Fig. 1) is oriented vertically, it is tempting to see it (erroneously) as a hierarchy where the man-

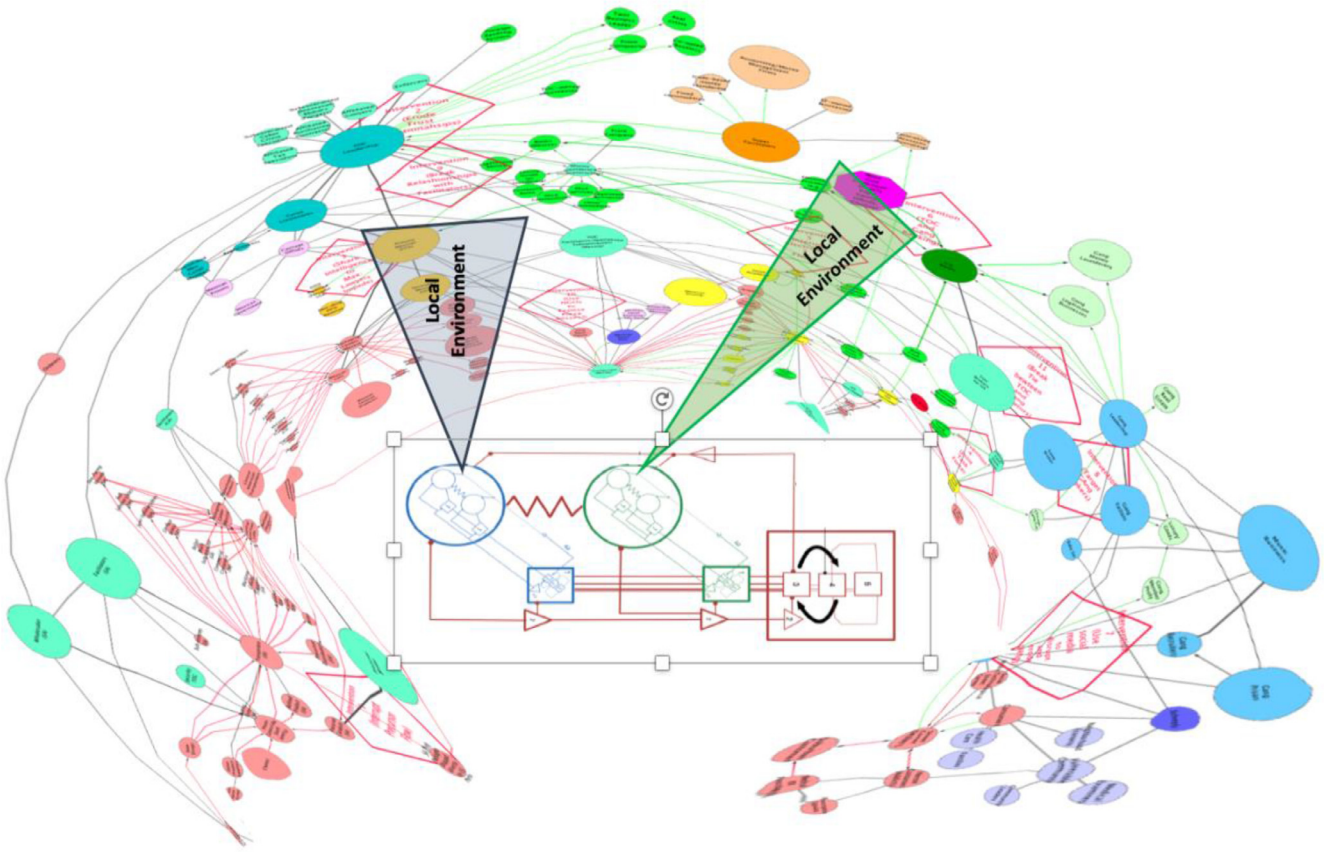

Fig. 2. The VSM embedded in the environment.

agement functions (Systems 3-5) exert increasing amounts of top-down control the nearer they are to the top, with System 5 at the apex of a command and control structure. Rather, the VSM is heterarchical, with Systems 2-5 being *support functions* that enable the System 1s 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 Fig. 1). Fig. 2 shows the VSM diagram turned on its side (as recommended by Midgley et al., 1998), which we believe is a more intuitive depiction of a heterarchy. This diagram also shows the environment surrounding the interagency to reinforce the fact that they are intimately entwined.

2.4. Boundary critique and problem structuring

As described in more detail in Sydelko et al. (2021), the process of identifying agencies from which to recruit an interagency design team started with a boundary critique workshop held at the National Defense University in May 2016, to which an initial set of stakeholders and other subject matter experts were invited. This workshop involved a stakeholder analysis, leading to the identification of a wider set of agencies that would need to be represented in subsequent problem structuring and design work on interagency co-ordination. It also involved an initial scoping of the issues involved in the interface between international organized crime and local gang violence, so we could begin to make judgements on the kind of methodological approach that would be of most value to the agencies.

Following the stakeholder analysis, the agencies represented in the problem structuring and design workshops during the rest of the project were the Drug Enforcement Agency and the Chicago High Intensity Drug Trafficking Area (both part of the Department of Justice); Customs and Border Protection and the Coast Guard (both part of the Department of Homeland Security); the Federal Bureau of Investigation; the Chicago Police Department; the Department of Defense (including various transnational counter-crime entities within it); and the Department of the Treasury. It did not prove possible to recruit participants from the Department of State, some local partners, federal public health departments and agencies, a couple of relevant non-governmental organizations, and international agencies from beyond the USA.

As explained in Sydelko et al. (2021), we first used boundary critique and problem structuring for two purposes: to reveal to the participants the degree to which their partial perspectives could create miscommunications; and to gradually build a common, richly textured understanding of the wicked problem that could inform interagency collaboration and the co-design of a meta-organization using the VSM. We detailed in that 2021 paper how the boundary critique and problem structuring provided an in-depth understanding of the differing perspectives and goals of the involved stakeholders, and allowed them to generate a common understanding of the wicked problem. Our new problem structuring method, called 'systemic perspective mapping', involved exploring with each individual stakeholder the elements of the wicked problem, the interconnections between the elements, and the weightings of both the elements and interconnections. All the individual maps were then merged into a composite one, discussed by stakeholders as the basis for moving towards a shared understanding and a single, collective representation of the issues they faced. This helped build awareness of how limited and partial individual understandings may be, and induced a level of humility

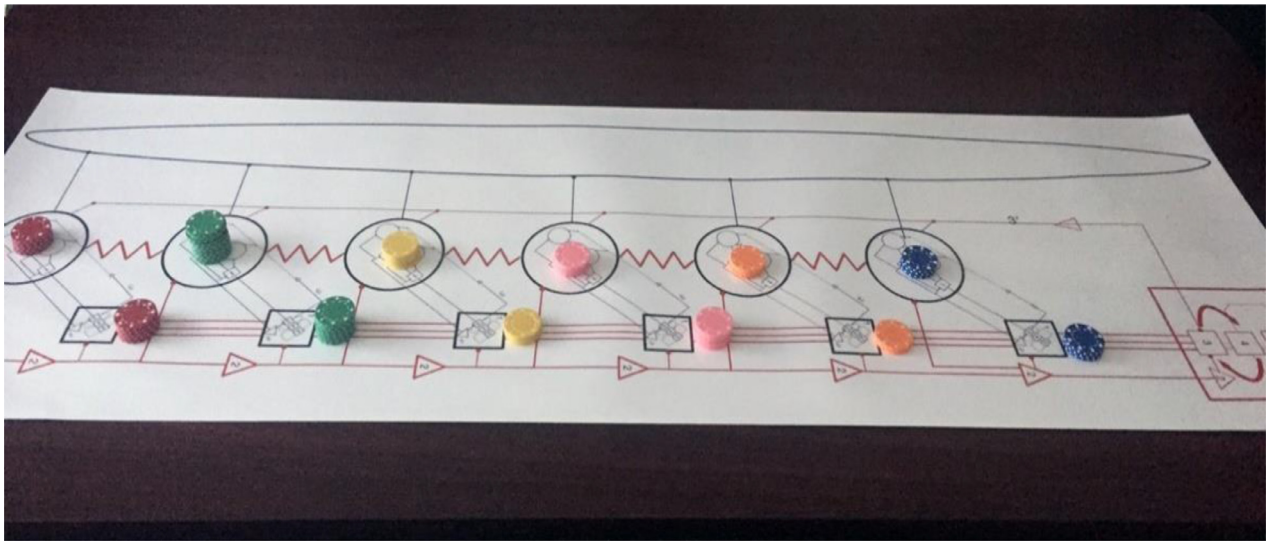

Fig. 3. Photograph of the VSM board game.

and openness to other perspectives that allowed the group to start to build their collective representation of the wicked problem. The latter was more nuanced than any of their previous individual understandings, and could be used to more clearly agree on identifying current and potential agency responsibilities, which is essential to using the VSM to co-design an interagency organization.

We realized in retrospect that this problem structuring also built trust in the value of the systems approach, *and this extended to the VSM*, thereby mitigating the communication difficulties stemming from the specialist, technical language and diagramming used for VSM modelling. Far from being defensive about learning a 'difficult looking' model, our participants very much welcomed it. As Franco et al. (2021, pp. 412) say, "by using holistic judgements people can reconcile the discrepancies between their pre-method judgements [in our case coming from the boundary critique and systemic perspective mapping] and those produced by the methods [i.e., the VSM], which in turn increases their confidence in the results" (text in square brackets added to clarify how Franco et al.'s, 2021, observation applies to our intervention).

In terms of relevance theory (Sperber & Wilson, 1995; Wilson & Sperber, 2002), the participants' experiences of the boundary critique and systemic perspective mapping told them that our systems approach was able to deliver strong cognitive inferences (value for understanding their wicked problem) that outweighed the work involved in learning new methods, and they trusted that this would also be the case for the VSM, so its relevance was accepted straight away.

Having explained how trust in the systems approach increased the participants' anticipation of worthwhile cognitive inferences, we can now look at how playing the board game likewise increased cognitive inferences while simultaneously reducing the perceived cognitive effort involved in learning the VSM.

3. The VSM board game

To make it easier and more engaging for stakeholders to produce their VSM design, a VSM board game (Fig. 3) was developed and used as a facilitated model-building process to co-design a collaborative interagency organization. Serious games (i.e., those used to support learning in relation to purposes beyond play) are receiving increasing attention from social and political scientists, futurists, medical researchers and computer scientists, amongst others (e.g., Mayer, 2009; Hamari, Koivisto & Sarsa, 2014; Seaborn & Fels, 2015; Dias, Tibes, Fonseca & Zem-Mascarenhas, 2017; Vervoort, 2019). Their value has not escaped the attention of OR practitioners too (e.g., Cleophas, 2012; Savic, Morley & Khoury, 2016; Aubert, Bauer & Lienert, 2018), including the specific use of board games (Maliphant & Smith, 1990). Our own board game was designed to counter erroneous and/or inefficient modelling behaviours, by making it easier and more enjoyable for the participants to learn about the VSM from the OR practitioner who was facilitating the workshop. Facilitators and novice participants need to have different attentional behaviours in workshops, with the former attending to the learning requirements of the latter (Tan, Wei & Lee-Partridge, 1999; Taket, 2002; Papamichail, Alves, French, Yang & Snowdon,2007; Franco & Montibeller, 2010; Bell & Morse, 2013): the board game not only enhanced participants' learning through a more 'embodied' experience than reading or listening to a lecture (hence the potential for more significant cognitive inferences), but it also freed the facilitator to focus more fully on 'active listening' to the participants, and on asking them the right questions (e.g., about the functions needed for a viable interagency organization).

The board game was deployed in a one day workshop using the game to structure a complex, non-linear sequence of stages (as in Franco et al, 2021, pp 409-411) required to learn the VSM in relation to the roles and structures of the interagency organization that was to be designed. We laid out a large VSM template on a table, so stakeholders could seat themselves next to their System 1 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.

Because these stakeholders had previously collaborated to create their own common understanding of the problem, they entered the VSM board game workshop with already-built relationships and a greater level of trust than they had had when they started out. We observed camaradery and a sense of fun during the game that kept them engaged throughout. We also perceived a good deal of learning from one another, and mutual learning is very important when operational success relies on high quality co-ordination between agencies (Daniels, Leadbetter, Warmington, Edwards, Martin et al., 2007). The learning we saw suggests that our design process, based on the VSM board game, compares favourably with many other interagency design excercises that, ac-

cording to Warmington et al. (2004), fail to make learning a priority. Indeed, in their evaluation feedback to us, our participants strongly emphasized the value of the extensive mutual learning that came from working together through the process.

3.1. Designing system 5: the mission and identity of the new interagency

The game started with the System 5 because it establishes the identity, ethos and purpose for the new interagency organization. System 5 was created as a strategic board or committee made up of top leadership representatives 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. They were also asked to generate a mission statement describing the ethos of what they thought the group could organize around. At first, nobody 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. People commented that they loved "BlueNet" as a name, and described the essential characteristics and activities of BlueNet as:

- Identifying networks (and nodes within those networks) that are most impactful, and/or fall into the blind spots of agencies.
- Understanding relationships between problem elements.
- Identifying the significant parts of the criminal networks that correspond to more than one agency's mission and responsibility.
- Finding areas where group resources are lacking.
- Identifying network probabilities using interagency efforts.
- Having the most positive community impact possible.
- Refusing to be just another taskforce, but be the 'navy seals' of law enforcement, not distracted by home agency issues.
- Having a mission that is overarching the missions of the individual agencies.
- Allowing each agency to bring its resources to the joint effort.

During a workshop break, the first author crafted a mission statement from the above list, also keeping in mind the substantial previous dialogue between the participants that she had facilitated (see Sydelko et al., 2021). After the break, the group then read the mission statement, edited it following some deliberations, and agreed a final version (Fig. 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". This is evidence that, through the initial systemic perspective mapping (Sydelko et al., 2021) and then playing the board game, the participants managed to integrate their various understandings in a way that motivated them to collaborate, and resulted in an effective co-design of System 5, employing VSM criteria.

3.2. The BlueNet system 1s: delineating local environments

Each agency stakeholder represented a System 1 of BlueNet on the VSM board. They were asked to sit at the board table aligned to one of the System 1 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 colour and given masking tape of that colour to use to identify all the elements and interdependencies that their agency actively engaged with (see Figs. 5 and 6). They were also encouraged to use sticky notes of their assigned color to identify their activities for attenuating and amplifying variety (see Ashby, 1968, for a discussion of variety), making visible how they impacted on their local environments. This is where the participants began to understand how the systemic perspective mapping undertaken in the first phase of the research, which enabled them to develop a shared understanding of the issues around the interface between international organized crime and local gang violence (Sydelko et al., 2021), would be useful for designing mechanisms for interagency collaboration: it highlighted a real need for improved coordination between the System 1s (discussed in more detail in section 3.3).

By directly placing their agencies into the systemic perspective map that they themselves had collaboratively structured, the stakeholders were able to connect the visualization of their local environments with the aspects of the VSM environment relevant to their organizations, while at the same time gaining a greater understanding of those aspects of the wicked problem that they were not directly addressing. Thus, they came to the VSM with a heightened awareness of how their actions (or inactions) could play out in the wider system, potentially affecting aspects of the problem that other agencies would have to react to.

Fig. 6 makes clear that there were many overlaps in the jurisdictions of the different agencies, as well as aspects of the problem that none of them were dealing with. Initially, overlaps in local environments were seen as negative: a waste of resources. However, as the participants began to discuss this further, they started to see overlaps as opportunities for collaboration, where pooled efforts could result in larger, synergistic impacts. In addition, the stakeholders observed that overlaps offer 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 action in a situation alone. McCulloch (1965) calls this *redundancy of potential command*, and 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.

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 System 1 circles (see Fig. 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 a discussion of

Fig. 4. Mission statement developed for BlueNet.

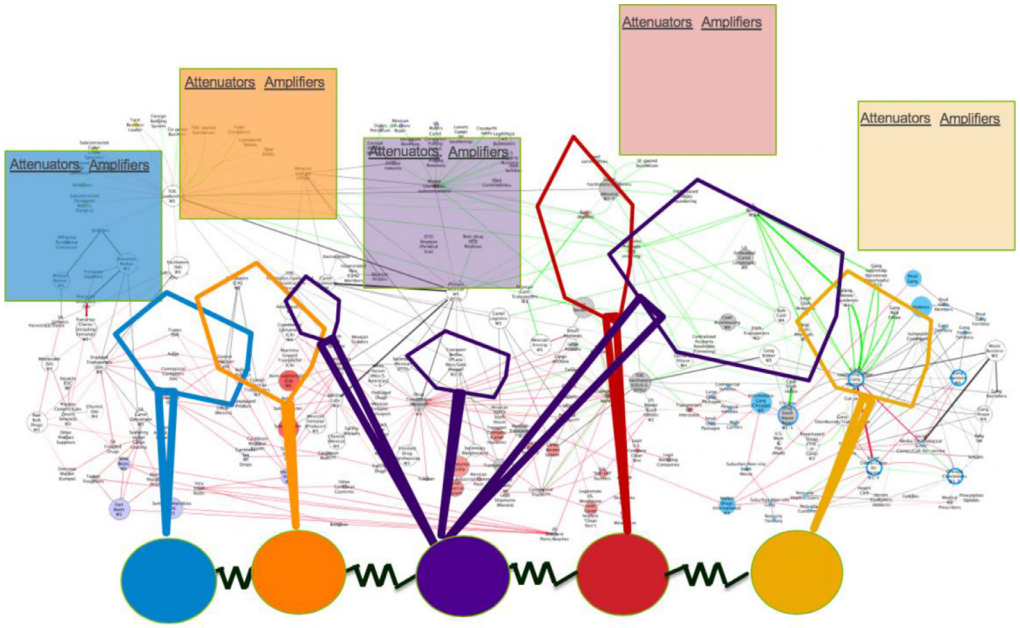

Fig. 5. Schematic of the delineation of local environments and attenuation/amplification activities.

System 3. Non-participating System 1s were represented by writing them down next to the game board.

As the rules of the game were clear and explicit, there wasn't that much need for the facilitator to intervene in the group dynamics. The game acted as a 'boundary object' (Star & Griesemer, 1989; Star, 2010) to support negotiation: Franco (2013) explains that, in the context of an OR project, a boundary object is a model that each stakeholder can read their own different meanings into. In effect, the game became a rules-based vehicle to enable each person to have his or her voice heard and concerns taken into account as the participants collectively reached agreements about the nature and shape of the emerging interagency organization. Throughout this exercise, stakeholders continually exclaimed surprise about what other agencies were doing in terms of attenuation and amplification: the modeling was clearly stimulating improved mutual understanding. In addition, there were many animated conversations about how one agency could acquire information from another. These conversations set the stage for designing System 2.

3.3. BlueNet system 2: 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 System 1. It also begins the dialogue between participants responsible for System 2 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

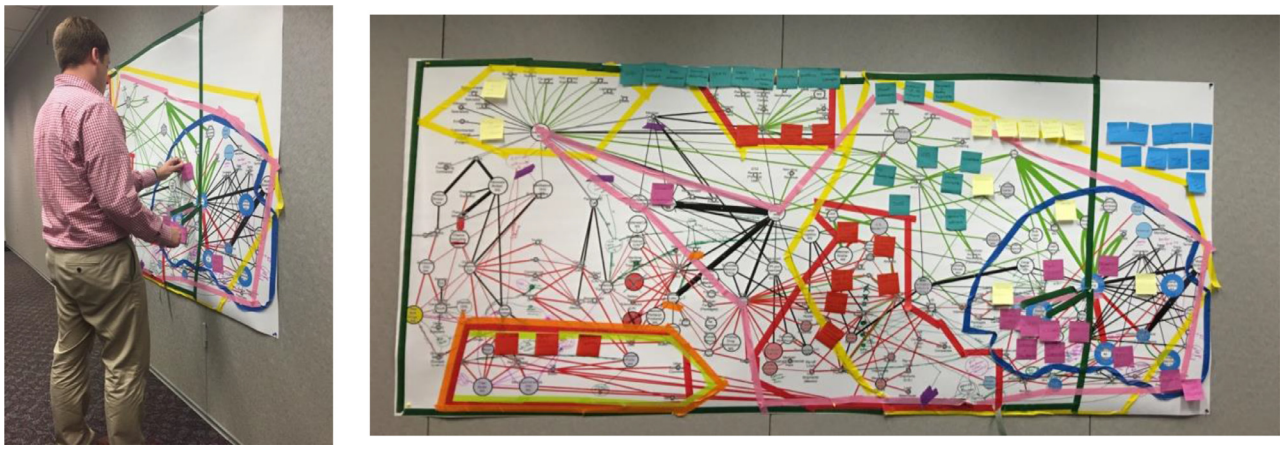

Fig. 6. Agency stakeholders delineate their local environments on the common systemic perspective map.

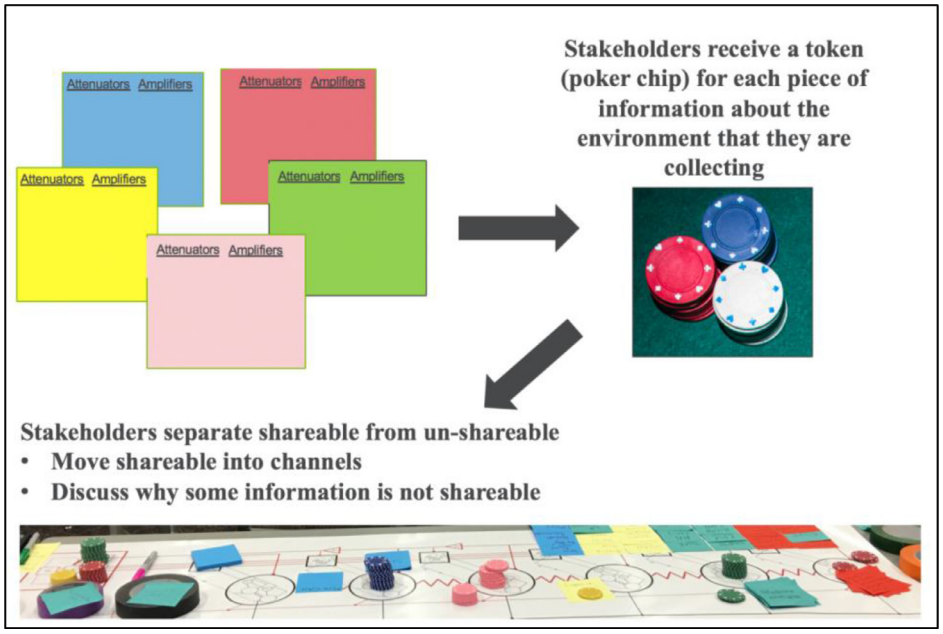

Fig. 7. Poker chips to represent data/knowledge obtained through attenuation and amplification (written on sticky notes that were used by stakeholders for reference).

to know' culture are barriers (Givens, 2012). So, it is not surprising that the participants 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, Taylor, Carswell, Nicholas, Wood, et al., 2014). Brocklesby (2012) says that other commonly-encountered problems include empire-building, elitism, inter-agency rivalries, lack of IT integration, and conflicting objectives.

At the start of the discussion of System 2, there seemed to be a 'yes, but' attitude amongst some (but not all) of the stakeholders, summed up by the frustrated words of one participant: "that just can't be done". Those focusing most on barriers complained about how regulations, security concerns, data provinence, and trust issues were insurmountably difficult challenges. However, as the dialogue unfolded with others who felt less constrained, people began to realize that many of the obstacles they initially identified were actually only *perceived* obstacles, and their perceptions were often based on invalid assumptions. The process dynamics facilitated by use of the VSM board game encouraged the participants to reveal their perceptions to others, and in turn hear challenges to those perceptions, which resulted in easing the negotiations on issues that would otherwise have been more controversial (also see Gardiner, 2022, for another systems/OR modelling approach that enables distinctions to be made between facts and fictions in a non-threatening manner). Simply checking their assumptions with others was enough to stimulate learning that collaboration would actually 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, giving a few Chicago law enforcement officers higher-level clearances would make a significant difference, and the participants said that it would be possible to implement this 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 some cases, security policies or trust issues among agencies were identified as problems, and these would be more difficult (but not impossible) to address. Even when real obstacles remained, stakeholders were not demoralized: they commented that

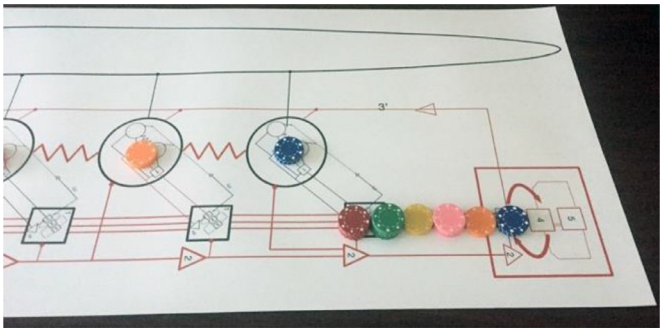

Fig. 8. Photograph showing sharable knowledge/data being pushed through communication channels to the metasystem (Systems 3-5).

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 inform requests for further funding to build sharing capabilites.

In designing the System 2 function for BlueNet, mechanisms and channels for sharing knowledge/information between agencies were particularly relevant. For instance, the Drug Enforcement Agency might pass crop-monitoring information to Customs and Border Protection 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 U.S. 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 U.S. 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 (Fig. 8). With the chips that remained in System 1 circles, stakeholders were asked "what information/knowledge about the environment, or other System 1 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".

For BlueNet, System 2 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 System 1 operations co-occurring in space and time, which will need to be de-conflicted by System 3 (see below).

Stakeholders recommended options for System 2 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 have to be in place in order to facilitate sharing. For those System 1 chips that represented amplification mechanisms, the discussion centered around the System 2 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 and 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.

3.4. BlueNet system 3: managing operations

The VSM design then turned to the System 3: the role that would service the immediate BlueNet activities of the System 1s (in coordination with System 2) through managing tasks and resource allocations from an interagency budget. Stakeholders initially worried that creating System 3 would result in building a new level of hierarchy: one person described this as "bureaucratization—trying to spur efficiency, but you end up slowing down the organization because people are trapped in ritual conformity". However, as stakeholders further explored System 3 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 System 3 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 System 3 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 System 3 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 enjoy. Therefore, stakeholders were uncomfortable with this option. The other (and preferred) option was to develop a wider-scope committee-based System 3 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 System 3 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 System 3, they described five major issues that 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 System 3 function should not disrupt those networks, but perhaps there was a need to more formally capture the information flow.
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 agen-

cies 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, System 3, 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 piggy-backing, 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 System 2 should be designed to minimize the potential for piggy-backing, and System 3 should play an auditing role in curtailing these activities.
5) One challenge the group faced was that they sometimes blurred System 2 and System 3 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 has to 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 System 2 or 3: those placing it in System 2 were keen on making information management more automated, while those viewing it as in System 3 emphasised the importance of interagency dialogue, human judgement and the auditing of piggy-backing. Lowe et al. (2016) likewise found that stakeholders in their study had difficulty in differentiating between Systems 2 and 3, 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 System 1s to System 2, but the further analysis of this to deconflict the information and generate knowledge of wider relevance was regarded as a System 3 function.

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 System 1 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 perception map could be more dynamically incorporated within BlueNet. They first proposed that *System 3* should 'own' the common systemic perspective map because it represents their collective knowledge of the existing BlueNet environment. However, although System 3 must know the existing state of the *internal* operational environment (also provided by the System 1s), 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 perception maps. This was viewed as important because the process ensures that all the relevant stakeholder values and perceptions 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 System 3 and System 1s, 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 System 1s 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 System 1s, System 2, System 3 and System 4 provided the potential for an exciting and extremely powerful new mechanism to create systemic situational awareness of a rapidly evolving environment.

People 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 (System 1s) 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 System 2). Stakeholders explored how the BlueNet System 4 could leverage the anticipatory information already being generated by the System 1s. This leveraging concept is very important for the design of an interagency organization because it maintains System 1 autonomy while still providing an interagency anticipatory capability. Of course, the stakeholders agreed that it would take a high level of trust among the System 1s, and with the System 4, for this mechanism to work.

However, it is important to realize that System 4 needs to be more than just a collection of System 1 forecasting outputs (Beer, 1979). A truly systemic understanding of the future environment has to be more than the aggregate of existing information. It was recognized by the participants that System 4 might need additional capability beyond what the System 1s currently provide in order to adequately cover the entire relevant environment. System 4 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, North, Sydelko & Martinez-Moyano, 2015), so there is precedence for building in these kinds of analytical approaches.

While discussing how System 4 would communicate projected environmental disruptions to System 3 and System 1, stakeholders proposed that System 4 should also develop '*alternative future* systemic perspective maps', drawing upon scenario planning (e.g., Ramírez, Selsky & van der Heijden, 2008; Helfgott, 2018; Gregory, Atkins, Midgley & Hodgson, 2020) and foresight methods (Fuerth, 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 alternative 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 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 System 3, 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, others countered that this 'solution' would reduce the S3/S4 tension between current and future requirements that is necessary for human beings to reflect on in order for them to make sound strategic decisions. It was notable that, although there was an initial disagreement on this point, the dialogue unfolded in an open and engaged manner, with no attempts to silence people with different perspectives (see Boston and Ellis, 2019, for a discussion of how constructively engaging with different perspectives aids leadership in the midst of complexity): through the process of our intervention, the participants had established trust and were able to work with opposing perspectives without leaping to judgement, which is a capability that we noted was not evident at the beginning of the project when we ran our first workshop at the National Defense University – hence the need, during the systemic perspective mapping, for us to support individuals to become aware that *everyone* had a limited understanding of the wicked problem as a whole, based on their single-agency purposes, values and boundary judgements (Sydelko et al., 2021).

Those disagreeing with the use of automation to resolve S3/S4 conflicts, whose view ended up being accepted by everyone in the dialogue, disussed how System 3 may be reluctant to make adaptive changes because of cost or risk. Therefore, people with System 4 roles are needed to present counter-arguments 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 in-person negotiations between System 3 and System 4, with System 5 oversight and intervention when necessary, that the interagency can adapt to rapid changes and sustain viability over time.

We add that the participative engagement of Systems 4, 3, 2 and 1 personnel in workshops using problem structuring methods (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 between System 4 and System 3 becomes entrenched, System 5 must decide to implement or not implement System 4 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.

4. Stakeholder feedback

By placing the systemic perspective map of the wicked problem (Sydelko et al., 2021) on the wall in front of the stakeholders, and seating each of them behind a System 1 circle on the VSM board (laid out on a table), we simulated the experience of dealing with the variety coming from the wicked problem to inspire the interagency design. While Beer (1994), Espejo, Bowling and Hoverstadt (1999) and others have also proposed methodologies and methods to aid application of the VSM, we 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, which is essential for effective co-design.

Fig. 9 provides a diagram of the entire VSM analysis developed through the use of the board game. In their feedback to us (collected through post-workshop debriefings and a questionnaire informed by the approach to evaluating systemic methods developed by Midgley, Cavana, Brocklesby, Foote, Ahuriri-Driscoll 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. This demonstrates the value of the board game to the facilitation of negotiations and agreements on interagency co-design. 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 System 3 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 VSM study of the UK's Serious Organised 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 System 1 and other times a System 3. 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 stakeholders who did not participate in the study (listed in Section 2 of this paper). Those who did participate hoped that the future engagement 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.

While this research was not intended to create actual U.S. policy change, it was conducted with real agency stakeholders from

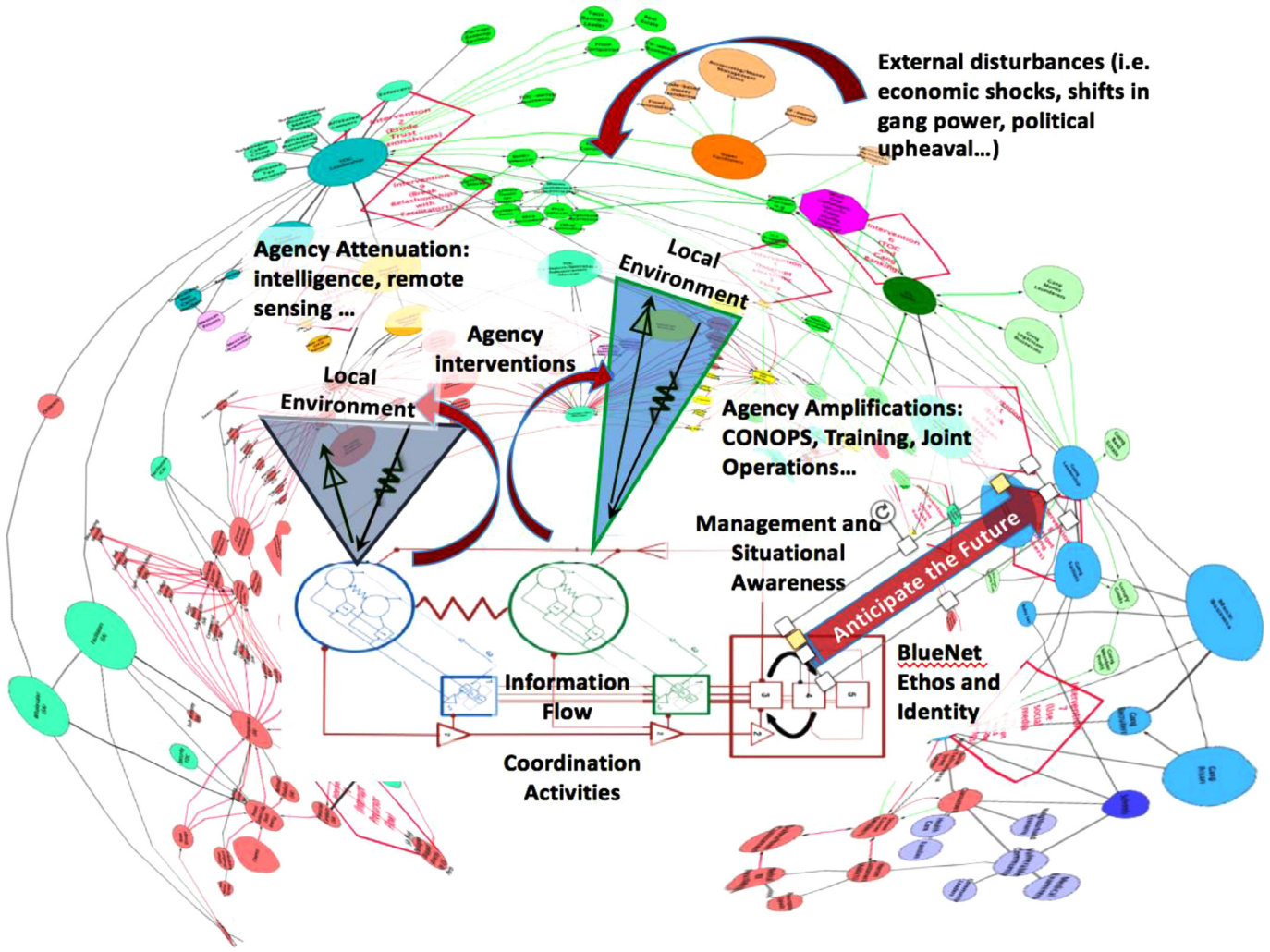

Fig. 9. Diagram of the total VSM BlueNet inter-agency design.

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 the VSM board game provides a powerful approach for improving interagency responses to wicked problems. The participants particularly felt that the approach enabled:

1. Inclusiveness of all necessary agency perspectives (providing they choose to participate).
2. Cross-agency learning and a much deeper shared understanding of their wicked problem.
3. Rich dialogue about clashes of perspective, and the ability to work transparently and constructively to resolve conflicts.
4. Reduced marginalization of stakeholders with less positional authority and influence than others.
5. The joint participatory creation of a non-hierarchical interagency response that is designed to align directly with the wicked problem that people are collaboratively tasked to tackle.

The feedback from participants included some expressions of concern about how well the approach would work with the agency chief executives and a much larger set of stakeholders involved. Following Midgley (1997, 2000), we suggest that these challenges would probably necessitate adaptations to the process of implementation (e.g., involving some categories of stakeholder in separate workshops if they do not feel comfortable speaking in front of chief executives). There was also an element of unease about the ability of the approach to retain agency autonomy (especially regarding budgets), despite us stressing that the System 1s 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.

Overall, the participants felt that their involvement in this study substantially changed their thinking about how to approach an interagency response to this wicked problem. Several months after the conclusion of the study, one of them shared how the knowledge gained from participating in it had influenced their ongoing work:

> "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".

5. Discussion, contributions and conclusions

In Sydelko et al. (2021), we described the use of a problem structuring method (systemic perspective mapping) with extensive boundary critique to create a better collective understanding of the wicked problem of international organized drug crime and its interface with local gang crime in Chicago. In the current paper, following on from that first one, we have focused on illustrating the use of the VSM board game for collectively co-designing a tailored interagency organization that can enable collaborative responses to the variety of complex issues interacting to create the wicked problem. The two papers, read together, offer a larger systemic intervention approach that contributes to the emerging field of interagency design in OR.

In addition, the research we have done on this approach could be seen as a contribution to behavioral OR (e.g., as discussed by Franco et al., 2021); particularly 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). We have demonstrated that it is at least possible to mitigate, if not entirely eliminate, the negative consequences of some individual differences, such as the tendency of some stakeholders to see their own perspective as the only right one; e.g., by building awareness of the inevitably partial understanding of wicked problems that all stakeholders come in with, so they approach listening to others with openness and humility, as discussed in Sydelko et al. (2021). We also suggest that we have demonstrated the value of the VSM board game as a boundary object (Star & Griesemer, 1989; Star, 2010; Franco, 2013), which enables negotiations and agreements between people who read different meanings into it. 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 worth noting that our 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, 2023) 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, our paper 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; Espinosa, Harnden & Walker, 2005; Franco & Montibeller, 2010; Espinosa & Walker, 2013; Tavella and Papadopoulos, 2014; Espinosa et al, 2015), and the corresponding rethink of the philosophy underpinning its use in OR 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" (Taket & White, 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 OR practitioner alone to understand the VSM if he or she expects participants to use it.

Earlier in this paper, we conceptualized the problem of accessibility using Sperber and Wilson's (1995) relevance theory (first introduced into OR by 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 OR 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 may see straight away that its language and diagrams are complicated. We will explain below how the innovations described in this paper addressed both of these problems, and will then extend relevance theory by adding a third dimension to it (in addition to perceived cognitive inferences and the amount of work to realise them). We will demonstrate that our approach, in common with other participative approaches to the VSM (and indeed other collaborative systems thinking and OR methodologies), addresses this third dimension too.

Let us start with the question, how did our approach improve our stakeholders' perceptions of the perceived cognitive inferences that the VSM could generate for them? One answer to this is that we built trust in the value of the broader systemic intervention approach (Midgley, 2000, 2006, 2015, 2018, 2023; Boyd et al., 2004; Midgley and Rajagopalan, 2021; Midgley & Lindhult, 2021) that the VSM was integrated into. As described earlier (and in more detail in Sydelko et al., 2021), the whole project was prefaced by extensive boundary critique, empowering stakeholders to identify others who would need to be involved. The use of our new problem structuring method (systemic perspective mapping), first with each agency representative individually, and then with the whole group, helped the stakeholders realize two significant cognitive inferences: that they each had only a partial understanding of the wicked problem, so insights could be gained from listening to other perspectives; and that it was actually possible to generate a common interagency understanding (i.e., an improvement) by integrating their perspectives into a single visual map. These insights were so powerful for the stakeholders (see Sydelko et al., 2021, and Sydelko, 2023, for their feedback) that significant trust in the next steps was built. Indeed, as we came to the end of the problem structuring, the stakeholders were actually 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.

Thus, the systemic intervention approach helped to build *trust in systems thinking*, and the systemic perspective mapping created a rich context for co-designing the multiagency organization. Together, they gave stakeholders confidence that using the VSM would indeed generate significant cognitive inferences, and then deployment of the VSM further augmented the trust-building process.

The development and use of the board game was highly engaging for the stakeholders, as it involved a more fully 'embodied' learning experience than just reading about the VSM or listening to the facilitator explain it. This further contributed to the possibility of significant cognitive inferences. The game also introduced some fun (a positive tone of felt sense giving rise to dopamine rewards) into the proceedings, and it helped structure the process of identifying and addressing viability issues in a step-by-step manner, starting with the mission statement for BlueNet, and then progressing to the transposition of System 1 responsibilities directly onto the systemic perspective map. In terms of relevance theory (Sperber & Wilson, 1995; Velez-Castiblanco et al., 2016), this lessened the apparent work associated with learning the VSM, thus enhancing the model's perceived relevance.

Both the visual nature of the game (which enhanced accessibility) and the use of tokens also contributed to increasing participants' understandings of their differences and interdependencies,

which was essential for the learning necessary for effective collaboration. The board game promoted relational engagement behaviours by structuring open discussions, during which the participants could articulate their different and sometimes conflicting perspectives, and allow their assumptions to be challenged. In particular, the use of tokens helped to clarify disparities of information and power, which the stakeholders could then consider addressing in their interagency design: for instance, as the participants discussed power disparities, it occurred to one person (and all the others enthusiastically agreed) that the S3 could be designed to reduce these disparities by making it explicit that all the agencies should be equally free to voice their opinions and agree on the rules and protocols they should all follow. The group learning dynamic we observed throughout the process, in which different ideas for the interagency evolved, showed how the participants changed their minds incrementally, as the interagency was being co-designed (also see Franco, 2013, pp. 730, for some reflections on the theory of how such learning is enabled). All of this learning represents valuable cognitive inferences, so (in relevance-theory terms) it no doubt reinforced the initial judgement made by the participants, when they first agreed to engage with the VSM, that the model would be relevant.

As explained above, our combined systemic methods not only increased the perceived cognitive inferences from using the VSM, but also reduced the work involved in learning it. This way, we addressed both aspects of Sperber and Wilson's (1995) relevance theory, thus making the VSM appear useful to our stakeholders so they would want to engage with it.

However, earlier we mentioned that there is the potential to enhance relevance theory by introducing a third dimension. The third author of this paper has been concerned 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 we introduce this context as a third dimension, we can propose a *social* relevance theory. The social context includes peer expectations placed on an individual by others; for example, their family, friends, work teams, line management, professional societies and communities of practice. 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. Our use of both the systemic intervention approach as a whole, and our implementation of the VSM in particular, addressed the social context in order to motivate engagement. It did so by making the approach participatory right from the first collective engagement with stakeholders at the boundary critique workshop in the National Defense University, where we took them out of their day-to-day peer communities and put them with a new community of practice. There, norms of engagement could be established quite quickly. Thus, when people saw *collective* engagement, it set up peer expectations of *individual* engagement. Once this peer community was established, the effects of the expectations of its members also influenced the participants who joined the study later on.

It is important to acknowledge that our approach is not unique in harnessing peer expectations: it is a benefit of all participative approaches, once successfully initiated with senior management support (see OECD, 2017, for an explanation of why senior management commitment matters). This is the case for most problem structuring methods (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; Taket & White, 2000; Ackoff, Magidson & Addison, 2006; Laouris & Romm, 2022), as well as use of the VSM in a participatory mode (e.g., Espejo & Harnden, 1989; Franco & Montibeller, 2010; Espinosa & Walker, 2013; Tavella and Papadopoulos, 2014; Espinosa et al., 2015; Harwood, 2019). However, harnessing peer expectations is not the benefit of participation that is most commonly mentioned in the literature: usually, emphasis is placed on the value of mutual learning (e.g., Checkland, 1981; Checkland & Scholes, 1990; Ackoff et al., 2006) and/or emotional commitment to emergent solutions (e.g., Flood, 1995; Bilson, 1997; Franco & Montibeller, 2010), rather than buy-in to methodologies that, in the absence of peer expectations for engagement, might not appear so relevant to individuals.

We have explained how our approach to using the VSM addressed all three aspects of social relevance theory: the potential for significant cognitive inferences was enhanced by establishing trust in the overall systems approach through prior boundary critique and problem structuring, and also by use of a more 'embodied' learning approach than is usually employed when teaching the VSM; the perceived work involved in learning the VSM was reduced by the positive felt sense (fun) that came from playing the board game; and participation in interagency workshops set up peer expectations of individual engagement, thus addressing the need for a propitious social context. Communication of the relevance of the VSM to the participants was therefore enhanced.

While we need to avoid over-blown claims to utility based on just one case study of practice (Checkland, 1981; Midgley et al., 2013), we nevertheless feel cautiously optimistic that our approach offers promise for governments to use in the context of other challenging wicked problems, when there is a need for both a shared understanding of the issues and the design of an interagency organization. The next step in our research is to test the same combination of methods on a completely different wicked problem, and this work is already underway (Project Systemic, 2020).

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