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A systems perspective on systemic innovation

Gerald Midgley[1,2,3,4,5,6] | **Erik Lindhult**[3]

[1]Centre for Systems Studies, Faculty of Business, Law and Politics, University of Hull, Hull, UK

[2]Department of Informatics, Faculty of Technology, Linnaeus University, Växjö, Sweden

[3]School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden

[4]Victoria Business School, Victoria University of Wellington, Wellington, New Zealand

[5]School of Political and Social Sciences, University of Canterbury, Christchurch, New Zealand

[6]School of Agriculture and Food Sciences, University of Queensland, Brisbane, Queensland, Australia

Correspondence
Gerald Midgley, Centre for Systems Studies, Faculty of Business, Law and Politics, University of Hull, Hull HU6 7RX, UK.
Email: g.r.midgley@hull.ac.uk

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Abstract

The term 'systemic innovation' is increasing in use, but there is no consensus on its meaning: five understandings of the term can be identified, each based on a different view of what the word 'systemic' should refer to. The first understanding focuses on technologies, where the innovation in focus is synergistically integrated with other complementary innovations, going beyond the boundaries of a single organization. Therefore, 'systemic' refers to technological innovations interacting in a larger product system. A second use of the term refers to the development of policies and governance at a local, regional or national scale to create an enabling environment for innovation systems. Here, 'systemic' means recognition that innovation systems can be enabled and/or constrained by a meta-level policy system. The third use of the term says that an innovation is 'systemic' when its purpose is to change societal laws and norms to place new enablers and constraints on innovation in the interests of ecological sustainability. What makes this systemic is acknowledgement of the existence of nested systems: innovation systems are parts of economic systems, which are parts of societal systems, and all societies exist on a single planetary ecosystem. The fourth use focuses on collaboration in innovation networks with multiple actors. This has evolved from the first understanding of systemic innovation, but the critical difference is the primary focus on *people and processes* rather than technological products. The word 'systemic' refers to the interdependency of actors in a business or community context, leading to a need to cocreate value and innovate in concert or through coevolutionary dynamics. The fifth use of the term 'systemic innovation' concerns how people *engage in a process to support systemic thinking and action*, and it is primarily this process, and the thinking and action it gives rise to, that is seen as systemic, rather than the innovation system that they exist within or are trying to create. It is this fifth understanding that accords with most of the literature on systems thinking published over the last 50 years. The current paper offers a contemporary perspective on what systems thinkers mean by 'systemic', and this not only enables us to provide a redefinition of 'systemic innovation', but it also helps to show how all four previous forms of

innovation that have been described as systemic can be enhanced by the practice of systems thinking.

KEYWORDS

ethics of innovation, innovation systems, systemic innovation, systemic intervention, systems thinking

1 | INTRODUCTION

The term 'systemic innovation' has been increasing in use in recent years. It has developed predominantly in the innovation studies and management fields as a response to an ever more interconnected, complex and dynamic economy and society, which affects innovation activity and the theoretical models of innovation that people use. While most of the papers on this draw upon the innovation literature in a relatively sophisticated manner, with only a handful of exceptions they do not reference much (if any) of the literature on systems thinking or systems science. The latter are two closely related transdisciplinary fields with a hundred-year history and many specialist journals. See Midgley (2003a), Kijima et al. (2021) and Cabrera et al. (2022a) for three sets of representative historical and contemporary readings. It is our contention that, by drawing upon the literature on systems thinking in particular, we can enhance both the theory and practice of systemic innovation.

Here, we have written a largely conceptual paper based on our separate and joint experiences of three decades of practice in both systems thinking (first author) and innovation (second author). Below, we start our analysis with a brief overview of the major currents of thought in innovation studies, for the benefit of readers who are familiar with systems thinking, but have had little immersion in the innovation literature. We then move on to look at *systemic* innovation in particular, and we explain the five different ways in which this term has been used by writers on innovation. This part of the paper has been informed by a Scopus literature search using the term 'systemic innovation', and we clustered the papers into emergent themes based on the different meanings of it assumed by their authors. Only one of the five meanings involves the explicit use of systems thinking to enhance innovation, and explaining the value of this will set us up for a much deeper dive into contemporary ideas about systems thinking, for the benefit of readers who are well-versed in innovation studies, but have less knowledge of the systems field. We will argue that the use of systems thinking can enhance all the other ways of conceiving of systemic innovation—and indeed, it can add value to some of the most recent thinking in innovation studies where the 'systemic' prefix is not yet being used.

2 | BACKGROUND IN INNOVATION STUDIES

'Systemic innovation', as a concept grounded in practice, has its origins in the emerging field of innovation studies in the 1980s and 1990s. As background, we provide an overview of this context and describe developments in the today-thriving discipline of innovation.

Systemic perspectives and systemic theories of innovation are becoming increasingly common in the innovation field. They have developed from penetrating critiques of dominant linear models of innovation (i.e., visualized as a one-way pipeline from scientific invention through commercialization to the market) and firm-centric assumptions (i.e., that innovation happens within a single organization). In response to these critiques, the relevant authors have developed more interactive, systemic and network-focused alternatives (e.g., Kline, 1985; Lundvall, 1988; Rothwell, 1992).

Rothwell (1992) summarizes developments in thinking about innovation in terms of five generations of innovation process models, which gradually created a paradigm shift from a 'technology push' model (i.e., one where the invention of a technology drives all subsequent activity) towards an envisioned "system integration and networking" model (p. 236). The term 'systemic innovation' has been coined to express what this paradigm shift is all about, although (as we shall see shortly) the literature on it is quite fragmented and the term has been appropriated by people with quite a wide range of concerns, eventually leading to the emergence of five different meanings of systemic innovation.

In its early days, the discipline of innovation studies was predominantly focused on the introduction and diffusion of technological innovations and technological products entering business and society. The idea was that innovators create a new technology, and then imitators follow in a subsequent diffusion stage (Schumpeter, 1934). Many authors in the innovation literature are still focused on characteristics of innovations and their effects

on customers, businesses and societies (Rogers, 2003). Others talk in terms of the scale of the change: for example, incremental innovation involves small steps, often linked to ongoing learning and continuous improvement initiatives, while radical innovation involves bigger leaps in performance and involves more risk (Leifer, 2000). Architectural or disruptive innovations (Abernathy & Clark, 1985; Christensen, 1997), which are contrasted with niche or regular innovations, change the whole trajectory of performance, and the competencies required to take advantage of the innovations have a transformative effect on industries and markets.

Often definitions of innovation are derived from an object-orientated view, where the concerns are novelty (whether new to the world, or new to the specific actor or context), value, utility and use (Garcia & Calatone, 2003). Innovation objects are predominantly products, often with a novel technological element, although *processes* for producing products can be viewed as innovative too. Increasingly, services (some of which are intangible) are given the status of innovation objects on a par with products (Carlborg et al., 2014). Research on more complex innovation objects (like systems, organizational networks and social entities, as well as ideas and concepts) has been developing too, but in more narrowly-focused streams of inquiry.

Innovations as objects of creation, use and study are outcomes of *processes* of innovation, of *innovation activities*. An important origin of research on innovation as an activity or a process was the work of Schumpeter (1934), who depicted storm winds of creative destruction where entrepreneurial individuals and firms introduce innovations that out-compete and replace established products and practices. Schumpeter (1934) saw innovation as the implementation and introduction of new products, new processes, new sources of raw material, new forms of organization, or the opening up of new markets by entrepreneurs. In his early work, Schumpeter (1934) saw entrepreneurial individuals, often associated with new firms, as leading the introduction of innovation and overcoming resistance from actors with established views and practices. However, in his later works in the 1940s, he argued that innovation could be a planned accomplishment of corporations, arising from science-based research and development (R&D) (Freeman, 1995; Schumpeter, 1942). This view was later institutionalized as the dominant, linear model of innovation (Godin, 2006).

Until the mid-1980s, the innovation mainstream focused on science-based, technological inventions and adopted a linear model, which favoured specialized R&D functions and systematic steps in the innovation process (Kline & Rosenberg, 1986). Indeed, even in the 1980s, the linear, firm-centric model was further institutionalized in research, showing that seemingly successful firms tightly manage the product innovation process through disciplined, step-wise, idea-to-launch systems, such as the well-known stage-gate model. This conceptualises the innovation journey as a linear chain of management decisions, which at any point could result in the gate being closed on an innovation (Booz & Hamilton, 1982; Cooper & Kleinschmidt, 1986). The stage-gate model has since become the norm for technology and product innovation management in the majority of industries (Cooper, 2011), also giving rise to the ubiquitous use of a funnel metaphor, depicting the idea-to-launch process as one where inputs (e.g., ideas, finance, design processes) go into the wide mouth of the funnel and the innovation comes out of the other, narrow end (e.g., Tidd & Bessant, 2013). Identifying key activities and design processes for organizing innovation (albeit mostly in a linear sequence) was an important starting point for innovation management as a practically oriented discipline as well as a thriving consultancy business.

However, in the second half of the 1980s, evidence began to mount that a variety of factors outside R&D departments (e.g., a firm's leadership, market orientation and/or practices of employee participation) were important for innovation, as were external factors beyond the company boundary (Lundvall, 1988). The predominant 'technology push' orientation was therefore tempered by a 'market pull' alternative, leading to the recognition of customers and users as important sources of insight, and these people could even become agents in the innovation process (Von Hippel, 1988). This represents a step away from seeing innovation as an expert R&D function, leading to the involvement of users, coworkers and other internal and external actors in more participatory and democratized approaches to innovation (Von Hippel, 2005).

In efforts to comprehensively capture the various factors and their interactions in shaping innovation processes, the concept of 'innovation systems' was introduced in innovation research (Freeman, 1995; Lundvall, 1992). The concept aimed to focus attention on the dynamic processes related to learning and innovation that are part of economic development, but are neglected by neoclassical economic theory. The concept covers both the micro and macro levels in explaining the economic performance, not only of organizations, but even more so higher-level units like nations, regions and industry sectors. The use of the systems concept had limited links to the systems science and systems thinking fields at this time. It was simply a way to intuitively convey the importance of the interrelatedness of elements giving rise to a whole (e.g., in terms of national developments), with this whole being more than the sum of its parts. Context- and path-dependency were recognised too (Dosi, 1982; Thrane et al., 2010).

The move to start using systems terminology was in line with the focus on interactive learning and knowledge generation as core mechanisms in innovation system development. The systems concept has attracted significant attention among policy makers: 'the "system" dimension of the term has moved the attention in the policy circles in charge of research, innovation and industrial development from linear to interactive thinking of innovation' (Lundvall, 2007, p. 97). Indeed, systems concepts started to develop a deeper importance when people began to refer to the intricate interplay and coshaping of micro relations and macro structures in complex coevolution and self-organizing processes (Lundvall, 2007).

While this is the case, it should nevertheless be acknowledged that the ideas about innovation systems that have been developed in the sphere of policy have less to say about the micro-level action-orientation of innovators than the macro scale. A stream of research taking an innovation-systems approach further than most others, focuses on the 'triple helix' model of innovation, based on the idea that there are interactions, and indeed there is mutual evolution, between academics, industries and governments in the fostering of economic and social development (Etzkowitz & Leydesdorff, 1995). Some researchers have also included civil society, the public and the media, arguing for a more inclusive 'quadruple helix' approach (Carayannis & Campbell, 2009).

'Systemic innovation' as a concept (as opposed to the idea of an 'innovation system') emerged in innovation studies from the recognition of a particularly systemic aspect of innovations, namely the interconnectedness of different technological innovations and the context that they are part of. In Teece's (1986) original conceptualization, systemic innovations are dependent on *complementary innovations and adjustments in the larger product system*, leading to challenges for firms to successfully appropriate value. Because complementary innovations could be developed by different companies, this raised questions for the firm-centric paradigm, but Teece nevertheless argued that a focal (usually large and dominant) firm is still needed to successfully coordinate and manage the interdependencies involved in systemic innovations (also see de Laat, 1999, and Bröring, 2008). In this way, the concept of systemic innovation could point to the need to look beyond single-company boundaries while remaining largely aligned with the prevailing firm-centric paradigm.

It was not '*systemic* innovation' but instead '*open* innovation' (Chesbrough, 2003) which was the term that initially came to be coined to represent a new paradigm in innovation management, and this is still one of the leading concepts alongside idea-to-launch and stage-gate thinking and practices. In a sense, systemic innovation, and the challenge of profiting from innovation when innovations are interconnected, was a forerunner (perhaps even a prerequisite) for Chesbrough's (2003) development of open innovation at the beginning of the 21st century. Open innovation was formulated in more paradigm-challenging terms than Teece's (1986) systemic innovation: Chesbrough (2017) contested the prevailing assumptions and clarified alternative points of departure for innovation studies:

> The open innovation paradigm as I've defined is best understood as the antithesis of the traditional vertical integration model in which internal innovation activities lead to internally developed products and services that are distributed by the firm. In a sentence, open innovation is a distributed innovation process that relies on purposively managed knowledge flows across organizational boundaries, using pecuniary and nonpecuniary mechanisms in line with the organization's business model to guide and motivate knowledge sharing (Chesbrough & Bogers, 2015, p. 3).

Industrial R&D is still an important focus in this work, as well as the funnel metaphor, but it is now seen as a more distributed activity, and the funnel is perforated by inflows and outflows of innovation-relevant knowledge. With an explicitly open-systems view of open innovation, where different actors become relevant to consider, various forms of collaboration come more into focus; for example, with coworkers, users, partners and even competitors.

Research on service innovation and 'servitization' in industry also challenged the technology- and product-centric views in innovation studies (Vargo & Lusch, 2004). The latter tend to reduce services to add-ons to products, or say that services are just products that are less tangible. Once a service is understood as emerging through interactions between the server and the served, the idea of *cocreating* services with customers and users becomes important (Prahalad & Ramaswamy, 2004). This implies recognizing that services are value-creating processes where innovation starts from an understanding of the customer context rather than the company desire to provide something (Gustafsson et al, 2016).

Intraorganizational and interorganizational, multi-stakeholder interactions in innovation have become an expanding and prominent area of study too (De Bresson & Amesse, 1991; Mortati, 2013). Yet another stream of research is focused on value creation: value creation and profiting from innovation is more complex in a multi-organizational context because of technological interdependencies, as both Teece (1986) and Chesbrough and Teece (1996) have observed. This complexity makes people turn to business model innovation as a core area

of concern, so all the partners in innovation can find a way to benefit financially (Chesbrough & Rosenbloom, 2002). Having the best performing product or technology does not necessarily mean that product-centric business models will be viable and profitable. Chesbrough and Rosenbloom (2002) show, in their path-breaking study of Rank Xerox and the challenge of commercializing technological knowledge generated from their Menlo Park Research Center, that new technologies often need new business models. Business models are usually entrenched in the dominant thinking of a company (Foss & Saebi, 2015), and the fact that they might have to be negotiated with external parties so that everyone can enjoy a viable business can be challenging for traditionally-minded leaders and managers. In business model innovation, there are often important dimensions of social and organizational innovation too (Damanpour, 1991).

The focus on negotiated business models aligns well with the idea of 'value creation', which expands the system boundaries in innovation from the firm to include, not only customers, but also the value networks or value-creating systems of actors involved (Normann, 2001; Normann & Ramírez, 1993). The term 'value' is used to indicate that the benefit for a participant in innovation need not be directly financial: for instance, it may be knowledge-acquisition, publicity or (in the case of some corporate social responsibility innovations) the feeling of doing something worthwhile for other people or ecosystems. The more creative people can be in thinking of different forms of value, the more possibilities open up for collaboration, cocreation and business model innovation (Normann, 2001).

An additional stream of research that has widened perspectives on innovation has focused on the challenges of sustainability transitions and ecoinnovations, which fly in the face of dominant, non-sustainable socio-technical systems (Geels, 2004; Hellström, 2007).

We also see that the 'eco' label has been appropriated as a metaphor by a research community that uses it in a less environmentally-conscious sense to refer to the recent surging interest in business, service and also innovation 'ecosystems' (Valkokari, 2015). Innovation ecosystems are interacting, interdependent and coevolving actors and related resources, sharing in the purpose of innovation. There are scholars who question the extent to which this biological analogy is useful if not used rigorously, and they ask whether there are risks of smuggling in erroneous assumptions (e.g., Ghazinoori et al., 2021). Indeed, some question whether adding the prefix 'eco' brings any significant insights at all, over and above the established concept of an innovation system (e.g., Oh et al., 2016). As we saw earlier, the innovation systems stream of research has been using the concept in similar ways for many years (Lundvall, 2007).

On the other hand, it could be argued that there is potential in the concept being more explicitly linked to a body of systems theory about the natural world (Ritala & Almpanopoulou, 2017): it could attract new insights from systems science, as well as a more thorough investigation of the relationship between innovation and sustainability. Even within applications to purely human 'ecosystems', the concept brings attention to mutuality in value creation and innovation; e.g., in digitalized platform development (Gawer & Cusumano, 2014).

In sum, in recent years, the field of innovation studies has been thriving, and its theories are increasingly being applied to understand nontechnological (e.g., social and organizational) innovations (e.g., Tidd & Bessant, 2013). Although the systems thinking field has been quite preoccupied with the development and testing of methodologies for managing change in and across organizations, communities and societies (see, for example, Jackson, 2019), it is noteworthy and somewhat surprising that there has been very little explicit focus on 'innovation' (with a few exceptions, like Colvin et al., 2014; Ison, 2016; Lindhult & Midgley, 2014; Laszlo et al., 2017; and Midgley & Lindhult, 2017). Perhaps the dominant, not-so-systemic approaches to innovation studies and innovation management, focused on developing and commercializing products and services in a linear and firm-centric manner, might have put systems scholars off the field. Another possibility is that the field of innovation studies, particularly innovation management, is a younger discipline, which might not have come to the attention of systems thinkers who relate their work to other traditions, such as operational research (e.g., Jackson, 1991a; Keys, 1991; Midgley & Ochoa-Arias, 2004a; Mingers & White, 2010; Ormerod, 2011; Robb, 1986; Ulrich, 2012).

However, the community of scholars working on innovation management has substantially grown in size and accelerated in influence during the last two decades, as it makes its way in an increasingly Schumpeterian and interconnected world. The paradigm shift in this field towards more interactive, networked and explicitly ecosystemic models and processes is currently partial, and there is little theoretical or methodological cohesion: the interactive and ecological view of innovation has been characterized as looking more like modern art or a plate of spaghetti and meatballs (Godin, 2006; Tidd & Bessant, 2013) than a coherent research programme. Therefore, it seems ripe for input from scholars steeped in systems thinking, who can arguably bring theories and methodologies to bear (as well as frameworks that make sense of the variety of systems theories and methodologies) that have a much deeper grounding in knowledge of systems (and thinking systemically) than some of the ideas currently in vogue in innovation studies. It is one of the

purposes of this paper to open a conversation between innovation and systems scholars to see what will emerge.

3 | MEANINGS OF SYSTEMIC INNOVATION

Below, we push our fork into the plate of spaghetti and move it around a little to create some patterns—that is, patterns to make sense of the literature. We focus specifically on *systemic* innovation because, as we saw earlier in our introduction to the innovation field, the innovation literature as a whole contains what we might view as systemic, partially systemic and nonsystemic ideas, so focusing more narrowly on 'systemic innovation' is most likely to draw out relevant theories already being discussed by innovation writers, which systems thinkers can fruitfully engage with.

We will argue that there are actually five major strands of substantially different thinking in the systemic innovation literature. While Takey and Carvalho (2016) claim that greater cohesion in the field will come from focusing only on the most widely used understanding of systemic innovation and discarding the rest, we believe it is a mistake to screen out less common uses. This is not only because they contain important ideas that can be enhanced by systems thinking (as we will shortly show), but also because it is arguably the most recently introduced and (so far) *least used* meaning of systemic innovation that is currently the most advanced in terms of its understanding of systems.

After having exposed the variety of ideas, we will take a deep dive into contemporary systems thinking. When we come to the surface again, we will be in a position to argue that systems thinking can actually provide a theoretical and methodological perspective with the ability to enhance *all* the forms of systemic innovation discussed in the innovation literature. Indeed, we will end by referring to recent trends in innovation studies where the term 'systemic' is not commonly employed to show that systems thinking could be much more widely useful.

3.1 | 'Systemic' innovation means complementary innovations coming together in a larger, primarily technological, product-orientated innovation system

We will start our examination of the first meaning of 'systemic innovation' with reference to a literature review of the field undertaken by Takey and Carvalho (2016). They say that "systemic innovation (SI) corresponds to the type of innovation that only generates value if accompanied by complementary innovations. It opposes autonomous innovation, which can be developed independently of other innovations" (p. 97).

In common with our own earlier review of the general literature on innovation, Takey and Carvalho (2016) trace the need for a concept of *systemic* innovation back to the works of Teece (1986) and Chesbrough and Teece (1996), who explain how more and more business innovations require collaborations across organizational boundaries to yield the necessary synergies. Indeed, companies can no longer take for granted that all the knowledge they need to produce the next generation of technologies, products or services will be found in-house (Chesbrough, 2003), and nor can they assume that any single innovation can be successfully pursued outside the context of a whole *innovation system* (Chesbrough & Teece, 1996). So, an innovation system goes beyond the boundaries of a single organization, and multiple innovations need to be coordinated (e.g., Alin et al., 2013; Andersen & Drejer, 2008; Chesbrough & Teece, 1996; Gopalakrishnan & Bierly, 2001; Kano, 2000; Maula et al., 2006; Mlecnik, 2013; Takey & Carvalho, 2016; Taylor & Levitt, 2004; Teece, 1986; Van den Ende et al., 2008).

Innovation, in this understanding, is 'systemic' because complementary innovations need to be brought together in a larger, primarily technological, product-orientated innovation system. We will leave full discussion of the nature of systems until later; for now, it is sufficient to note that a system was classically defined in the early days of systems science as an organized set of parts, differentiated from their environment, giving rise to emergent phenomena that cannot be attributed to any one part, or sub-set of those parts, in isolation (e.g., Angyal, 1941; Bunge, 1977; Flood & Carson, 1993; Marchal, 1975; von Bertalanffy, 1956; von Bertalanffy, 1968). The emergent phenomena are therefore properties of the *whole system*. A multiorganizational innovation system is very clearly systemic using this definition, as the different contributory technological innovations (parts) are organized together into a whole system, where the overall success of the emergent innovation enterprise cannot reasonably be attributed to just one sub-innovation or participating company—although, as Teece (1986) and Bröring (2008) argue, it is often the case that one organization needs to act as a central coordinator.

3.2 | Systemic innovation refers to 'regional policy systems to support innovation'

An understanding of systemic innovation that is less often used, but still appears regularly in the literature, is

one that focuses on policies (e.g., Woiceshyn & Eriksson, 2014), frameworks (e.g., Wieczorek and Hekkert, 2012) and methods (e.g., Schoen et al., 2011) at the national or regional scale to bring the kinds of innovation systems discussed in the previous sub-section into being, or enhance their performance if they already exist. Generally speaking, it is government that intervenes to support industries, the public sector, voluntary organizations and often cross-sector networks in their coordination of innovations (Rullani et al., 2016). This kind of intervention establishes the context that enables or constrains collaborative innovations (Autio et al., 2014).

Mostly, systemic innovation initiatives led by government have a geographically defined scope, as the emphasis is on regional competitiveness (Cooke et al., 1998; Li & Zhong, 2011), with different continents (e.g., Manjón & Romero Merino, 2012), countries (e.g., Laranja, 2012) or sub-national regions (e.g., Cook et al., 1997; Doloreux, 2004) seeking to improve their own innovation capacity and ultimately the employment, wealth prospects and quality of life of their citizens. Some of the literature points to the weaknesses in national or regional innovation systems due to the absence of government support (Turner et al., 2016), private sector engagement (de Laurentis, 2006) or the inadequacies of incentives to innovate (Wilts et al., 2011).

Government agencies are conceptualized as being at a meta-level to the innovation system in most of the above-referenced works, creating enablers and constraints for innovation. However, in some papers on policy systems (e.g., Carlsson & Stankiewicz, 1991; Guo, 2010; Jenssen & Koch, 2007), government is described as just one player *alongside* multiple other private and public-sector actors, in which case the definition of 'systemic innovation' is a hybrid of the one discussed in this sub-section of the paper and the last.

It is the emphasis on the role of government as a coordinator, facilitator or funder that differentiates this understanding of systemic innovation from one that focuses almost exclusively on synergistic innovations across the boundaries of industrial organizations (Section 3.1). Johannesson (2013) draws upon Miller's (1978) living systems theory (which discusses organizational and social as well as biological systems) to distinguish between *economic innovations* (value creation through the development of products and services) and *institutional innovations* (changes in the governance meta-system that enables and constrains economic activity). Importantly, Johannesson (2013) argues that institutional innovations can have a far greater impact on our lives than might at first appear to be the case because they can *change the rules for future economic innovations*. For him, the design of institutional changes *is* systemic innovation. We would surmise that this would also be the case for Devine (2005): he does not use the term 'systemic innovation', but shows how problems in national innovation systems can be diagnosed using Beer's (1981, 1985) viable system model: a theory of organization that has been widely deployed for improving the viability of private sector companies (e.g., Hoverstadt, 2008), public services (e.g., Espejo & Reyes, 2011), multi-agency collaborations (e.g., Midgley et al., 1998) and even whole communities (Espinosa & Walker, 2013). Devine (2005) uses it for the design of national innovation systems. He makes the point that national innovation systems can be viewed as meta-systems supporting and enhancing the viability of innovation activities across many private, public and third-sector actors in a defined geographical space.

3.3 | Systemic Innovation as 'a game-changer for sustainability'

The third understanding of systemic innovation that we find in the literature is usually discussed in the context of a transition to a more sustainable society (e.g., Karabeg, 2013; Pinkse et al., 2014). Often multiple innovations are involved, and together they move society towards a tipping point, beyond which a more desirable pattern of production and consumption is achieved (Bergman et al., 2008; Whitmarsh & Nyqvist, 2008). When it comes to sustainability, the innovation is often "game-changing" (Szekely & Strebel, 2013, p. 472) in the sense that it transforms the rules and/or infrastructure used by organizations for future innovations (similar to the previous definition of systemic innovation, except the origins of these rule changes do not have to come from a purpose-built governance system). A good example is the transition to renewable, low carbon energy (Tsoutsos & Stamboulis, 2004): if and when we reach a situation where human energy consumption becomes sustainable, it will mean the end of the current situation where new innovations that involve increased energy consumption inevitably play their part in adding to the cumulative effects of carbon emissions and ultimately climate change.

Like the two previous understandings of what it means to be systemic, an emphasis here is on innovation systems. However, unlike those previous understandings, the *context* in which those systems are embedded is viewed much more broadly and is seen as highly influential in the creation of both risks and benefits from innovation (Hellström, 2003). Society is viewed as a system that contains the economy, including its innovative subsystems, and all three levels (society, economy and

innovation systems) are a target for transformation. Beyond society, there is also the planetary ecological system: e.g., the Parliamentary Commissioner for the Environment (2002) in New Zealand conceptualises all economic and social activity as existing in an ecological context. Thus, the idea of a *systems hierarchy* (or set of nested systems) is important to this ecologically-orientated understanding of innovation. Hierarchy theories have been around since the early days of systems science (e.g., see Bertalanffy, 1956, 1968; Gayer, 1969; Smith & Sage, 1973; Gasparski, 1994; Giampietro, 1994; Wilby, 1994). Unlike the perspectives on the national and regional governance of innovation discussed in the previous section, which recognise just two system levels (economic innovation systems and their governance meta-systems), sustainability-orientated writers on systemic innovation think in terms of multiple levels, ultimately extending to the planetary boundary. It is the largest container system (the planet) that sets constraints that all its sub-systems must live within (Jackson, 2009; Meadows et al., 2004; Steffen et al., 2015), and it is because humankind is transgressing these constraints that there is a need to change the rules for innovation before too many negative consequences of environmental change are realized.

3.4 | Systemic innovation as 'collaboration in innovation networks and ecosystems'

A fourth, more recent and rapidly expanding use of the concept of systemic innovation is in the context of collaboration between multiple, interdependent actors, often clustered in specific social ecosystems (e.g., Den Ouden, 2012; Lindhult et al., 2018; Mortati, 2013; Toivonen, 2016; Vargo et al., 2015). Despite superficial similarities, the focus is not the same as in the Teece (1986) tradition, where the innovation emphasis is on *technological* interdependencies in complex *product* systems, but rather on the business and value creation interdependencies that motivate actors to coordinate innovation activity. Stam (2015) emphasises the importance of leadership of the coordination by highly ambitious entrepreneurs, although he also recognises the role of government in creating a facilitative legal and regulatory environment. In this sense, Stam's innovation ecosystem theory incorporates the idea of a policy meta-system, discussed in Section 3.2, although he describes government's role as 'adjusting' the innovation environment rather than providing leadership.

There is a movement here towards *innovative processes*, with a focus on their dynamics and how to design them, rather than viewing the resulting objects (e.g., technologies, products or services) emerging from the process as the innovation. This calls for an interactive business logic where firms innovate, not only by developing and launching products and services, but also by organizing and designing value cocreation in complex business systems (Normann, 2001; Normann & Ramírez, 1993). For systemic innovation, this means the end result is not only an innovative process giving rise to new product and service concepts, but also (as discussed in the earlier review of innovation studies) new business models too (Adner & Kapoor, 2010; Boons et al., 2013). It is these business models that determine how value created by a complex network of actors will be captured and distributed (Takey & Carvalho, 2016).

The idea of service-dominant logic (Lusch & Vargo, 2014; Vargo & Lusch, 2004) as an emerging framework has been a particular inspiration for this meaning of systemic innovation (Toivonen, 2016). Service-dominant logic emphasizes the active role of customers and/or users in the determination and creation of value in the context of use. This goes well beyond a sole focus on the innovation efforts of providers of products or services, as is common in a firm-centric view. Viewed through a service-dominant logic lens, value is created through the collaborative processes of doing something for and with other actors in (eco)systems of service-for-service exchange (Lusch & Vargo, 2014). To give a relatively trivial example in order to make it a little clearer, a hairdresser does not provide a service in isolation from his or her customers: the customers must contribute to their new hairstyle by travelling to the salon and engaging in a conversation about the style they want, so an innovation in the context of that customer-hairdresser relationship can emerge. Note that innovating in the context of use means that the innovation does not have to be a hairstyle that has never been attempted by other hairdressers before; it may just be innovative in the context of that single relationship between the hairdresser and client.

In this view, "innovation is driven by collaborative efforts to find or develop new ways to create value" (Vargo et al., 2015). Value cocreation is central in this view of systemic innovation. Business networks research has long been interested in the cocreation of innovations (Håkansson & Snehota, 2017; Möller & Halinen, 2017), and this has informed *innovation network* research.

Value cocreation is systemic in the sense that it focuses attention on complementarities in multi-stakeholder constellations (Korhonen, 2014; Meynhardt et al., 2016). Lindhult et al. (2018) describe what they call 'systemic value logic' in innovation, and this is focused on identifying and exploiting synergies, which can

enhance the overall mutual value that is coinnovated among parties involved in a business system (Mele et al., 2014; Russo-Spena & Mele, 2012; Tantalo & Priem, 2016). Innovation is understood as a process that is not simply linear, but also continuous, systemic and based on complex interactions between actors, activities and heterogeneous resources (Mele et al., 2010; Spigel, 2017). There is design involved, but also relationships in a network coevolve through distributed leadership without any need for central control, pointing to complexity dynamics in systemic innovation: e.g., complex response processes that are part of joint value discovery and realization (Goldstein et al., 2010; Lindhult & Hazy, 2016).

Ecosystem perspectives often underpin this understanding of systemic innovation. An ecosystem is self-producing, in the sense that it maintains and renews its ecosystemic nature by creating new elements and relationships within itself as required (Spigel, 2017). In Takey and Carvalho's (2016) literature review, half of the retrieved papers on systemic innovation used ecosystems and/or networks as units of analysis. If uses of other ideas from ecology are included as well, then ecosystem-related ideas are in nearly two thirds of the literature. Having said this, it should be noted that there is little conceptual clarity about the similarities and differences between viewing systemic innovation in terms of *networks* or in relation to *ecosystems* of innovation actors (Lusch & Vargo, 2014). Adner (2017) adds that the term 'ecosystem' has been used in too many different ways, causing confusion, and he attempts to clarify what the term means. Lusch and Vargo (2014) argue that a 'network' connotes stasis in relation to connections and ties, while ecosystem concepts are more amenable for representing dynamic human exchanges. They also suggest that the idea of an 'innovation ecosystem' encourages a more specific focus on roles and the nature and direction of exchanges compared with the 'innovation network' concept.

The word ´systemic´ in this tradition refers to the interdependency of actors in a business or community context, leading to a need to innovate in concert or through coevolutionary dynamics. The notion of *redesigning* ecosystems of actors is involved (e.g., in the value flow model of den Ouden, 2012), and here we see a shift in focus away from just the idea of an ecosystem of actors towards more of a process understanding of systemic innovation. This meaning of systemic innovation connects with themes that the systems field has long been engaged with, like synergism (Corning, 1983, 2014) and the interaction of multi-stakeholder networks in systemic constellations (e.g., Gregory & Midgley, 2000; Harries et al., 1999; Plamping et al., 1998; Taket & White, 2000).

Terms like 'synergistic innovation' and 'cocreation' tend to be used with the assumption that interdependencies and complementarities can enable integration into a whole that is more than the sum of its parts, where 'more' means something better. However, systems and complexity research has shown that this positive bias is problematic, as the emerging systemic properties can also be detrimental: e.g., climate change can be viewed as an emergent property of collective human innovation across the whole planet, resulting in the accumulation of excessive greenhouse gasses in the atmosphere, which is why some authors (e.g., Goldsmith, 1988) argue for turning back the tide of industrial innovation rather than pursuing new innovations that aim for greater sustainability. Interactions, interdependencies and different perspectives on the benefits and risks of innovations can generate conflict, marginalization and even the splitting and fragmentation of a systemic constellation of actors (see Midgley & Pinzón, 2011, for a review of these issues and how they can be prevented). There is a need for generative processes that can enable synergy and cocreation so that the emerging whole can create enhanced value and performance using multiple criteria (e.g., Friend & Hickling, 2005). This is where systems thinking can be brought into the picture of systemic innovation, which leads us to a fifth understanding of the concept:

3.5 | Systemic innovation as 'a process that involves people thinking in terms of systems'

The final meaning of systemic innovation that we can find in the literature is the most recently introduced and so far least used, but we argue it is this one that has the most potential to take our theory and practice to the next level: innovation is viewed as a process, which can be augmented by the use of systems modelling embedded within stakeholder dialogue methods to support social learning, enabling those stakeholders to get a 'bigger picture' understanding of the possibilities for, and potential consequences of, innovations (Colvin et al., 2014; Gannon & Monat, 2015; Ison, 2016; Laszlo, 2017). In other words, the innovation process is constructed in such a way that the participants within it use methodologies, methods and techniques *to make their thinking and action more systemic*.

Like us, Ison (2010, 2016) identifies the need for a deeper understanding of what 'systemic' means. A critical point he makes is that a 'system' does not have to be viewed as a real world 'thing', but can be seen instead as a useful way of making sense of situations we face and how we might address them – *thinking in terms of systems*

is useful in the context of action to create change. Also see Checkland (1981), whose work on systems thinking has informed Ison's (2016) reframing of systemic innovation. Thinking in terms of systems can be conceived as 'systemic praxis', which is a mode of inquiry where people dynamically and interactively engage in systems thinking and theorizing as well as practical action and experimentation, with the aim of purposefully transforming or improving situations and enhancing value (Colvin et al., 2014). Importantly, Ison (2016) claims that

> "a system in this tradition is a product of a distinction, formulation, or invention by someone, or a group, concerned with improving situations using systems thinking. In this tradition practitioners realise that when a system is generated it is not a thing but a system-environment (or context) relationship *mediated by a boundary judgment made for a purpose*" (p. 39, emphasis added).

It is the last sentence above that hints at the utility of systems thinking, and it is worth expanding upon to begin to explain why this reframing of systemic innovation offers such potential. Keep in mind the earlier, classical definition of a real-world system that we provided: an organized set of parts, differentiated from their environment, giving rise to emergent phenomena that cannot be attributed to any one part, or sub-set of those parts, in isolation. We can now add to this an essential extra element of theory: if a system is defined using a boundary judgement for some purpose (such as pursuing a particular focus for innovation), it is *observer* (or participant or stakeholder) *dependent* (Churchman, 1970; Ison, 2016; Midgley, 2000; Ulrich, 1983), and the *purposes and values* that are brought to bear in defining the system really matter (Alrøe, 2000; Midgley, 2000; Midgley et al., 1998; Ulrich, 1983, 1987). So, if a system is seen as a conceptual tool (a way of viewing something in the context of action), and not the thing in itself, it provides us with a range of thinking opportunities. These can be phrased as questions, such as:

- Are there stakeholders (those actually or potentially involved in or affected by an innovation) who might have different purposes to us and therefore could see the system differently? What would happen if we took account of their views?
- Are there different values that might matter in understanding the operation and outcomes of the system? What are the implications for innovation and action in pursuit of those values?
- Can we rethink the boundaries of the system to include new elements or exclude current ones? If we do this, how might it change our understanding of the potential dynamics and outcomes?
- How would changing the boundaries that define the context impact on how we understand the way that it enables or constrains the activities of the system? What are the implications for action?
- Can we change the relationships between the parts of the system (e.g., through synergistic dialogue or the reform of processes)? If we do, how would this impact its emergent properties?
- Are there other emergent properties that we might not have considered? Are these desirable or undesirable, and what consequences does the answer have for our pursuit of an innovation?

Of course, these questions are all high level and abstract – lacking the content that would be brought in by stakeholders in a situation where real innovations are being pursued. It is actually the synergies that can be obtained from bringing these kinds of questions (derived from the notion of 'a system' as a way of thinking about things) together with the problems, threats and opportunities being faced in business and policy practice that make all the difference to innovation. This is because they encourage us to *think about the way we are thinking* in a real innovation context, and can therefore facilitate reframing. Cabrera et al. (2008, 2015) and Cabrera and Cabrera (2015) call this 'meta-cognition', and it is fundamentally about exposing what we are taking for granted in order to free ourselves from limiting assumptions – not in a random way, but in a way that is strongly informed by systems theory, which places a special emphasis on whose purposes and values matter, how boundaries are set to enable and constrain the innovation process, how the elements being organized within those boundaries are catalyzed to facilitate the emergence of value, how the wider context is understood to facilitate or inhibit innovation, and (to return to the question of whose purposes and values matter) how 'value' is perceived from different perspectives. Value creation from one perspective, using a narrow boundary judgement, might be value destruction from another perspective, using a wider boundary for analysis (Churchman, 1970). An example is when a stretch of rainforest is logged, which may be profitable for the logging company (and value can be added when the wood is made into furniture), but the reduction of irreplaceable biodiversity and the contribution to climate change are systemic side-effects that can be viewed as value destruction (Midgley, 2000).

Quist and Tukker (2013) talk about requirements for systemic innovation, focusing primarily on how multiple

innovations can be coordinated and integrated across organizational boundaries in the context of transitions to greater sustainability at the global and societal scales. Following Argyris and Schön (1974), Quist and Tukker say that one of the key requirements is "double loop learning" (p. 170). Single loop learning is when people find ways to improve an existing system without fundamentally changing the assumptions they are working with. In contrast, double loop learning is when the rethinking of fundamental assumptions is involved. Quist and Tukker (2013) make the point that, if whole new innovation systems are to be conceptualized across organizational boundaries, and new values concerning sustainability are to prevail, then double loop learning is critically important.

Actually, systems thinking can help with *both* single loop and double loop learning. For single loop learning, there are systems approaches to improving the efficiency of service delivery and/or manufacturing processes (e.g., Gregory, 2007; Ohno, 1978; Seddon, 2008; Seddon & Caulklin, 2007): essentially, these are aimed at innovating the relationships between the component parts of existing systems to remove waste, enhance performance and increase the emergent value, as defined by stakeholders. However, the utility of systems thinking really becomes apparent when applied to facilitating double loop learning (Flood & Romm, 1996a): it can revolutionise how value is defined if we rethink the boundaries of what matters using new value sets and involve previously invisible stakeholders. This can transform what is seen as a meaningful innovation (e.g., Ufua et al., 2018).

A proviso, however, is that we need to appreciate the full implications of widening the boundaries we work with: as Lleras (1995), Colvin et al. (2014) and Foote et al. (2021) show, it is all too easy to enable transformative systemic thinking in a local context, only to find that it is then out of step with the thinking in the wider organizational, policy or economic system, and innovations therefore meet resistance. There are systems thinking modelling tools that are useful for getting a better understanding of the wider systemic barriers to innovation, and these can help in the identification of leverage points for change: Bergman et al. (2008) and Turner et al. (2016) provide analyses of barriers in systemic innovation contexts using these kinds of tools. Generally speaking, however, widening the boundaries of people's thinking *has to involve widening the boundaries of who is considered a stakeholder and needs to be engaged* (Churchman, 1970; Midgley, 2000; Ulrich, 1983) if the innovations are to be implementable. If this is not possible in the short term, an evolutionary approach can be taken, where people look for niches in which new systemic innovations can be embedded and flourish, and these can be scaled at a later date when tensions come to a head in the wider system, making the latter more receptive (Geels, 2005; Karabeg, 2013; Tukker et al., 2008).

So, having started to explain this fifth way of thinking about systemic innovation, and having begun to make the case for the utility of systems thinking, we will now dive more deeply into the latter to explain how its theory and practice has evolved since the 1950s. We will draw out the implications for our understanding of systemic innovation along the way. Afterwards, however, we will return to the other four definitions of systemic innovation and examine how a systems approach could help their advocates tackle their main concerns. This is important because it is potentially disruptive to advocate for a minority understanding of systemic innovation (concerned with thinking systemically) just when the majority in our research community are beginning to settle on the idea that an innovation is systemic because it is generated by a real-world technological or human innovation ecosystem. If our new way of thinking is to be received positively, rather than being seen as an irritating irrelevance, we must be able to argue that it can add value for the majority of researchers in our community.

4 | SYSTEMS THINKING

The first thing we need to clarify, before our deep dive into the history of systems thinking, is that the field is very diverse and somewhat fragmented. This is partly because there has been an emphasis, since the 1950s, on the development of systems methodologies (and associated methods) to support management and policy intervention, and many of these methodologies make different philosophical assumptions about the world and our knowledge of it (Bowers, 2011; Jackson, 1991a, 2000, 2019; Midgley, 1992a, 1996a, 2000, 2001, 2016a; Midgley et al., 2017; Mingers & Brocklesby, 1997; Pretel Wilson, 2017). Nevertheless, despite this diversity, there has actually been an overall evolution in thought in the systems thinking research community, with two well established paradigm shifts taking place between the 1950s and the 2000s, even though some systems thinkers still cling onto older ideas (as Kuhn, 1962, made clear when he introduced the concept of 'paradigm', the fact that some people stick with older ideas is to be expected). It will be useful to give an overview of this history, not least because the first paradigm shift that took place in systems thinking (moving from a focus on real world systems to *thinking in terms of systems*) is precisely the one that we believe is needed to rethink systemic innovation.

Then the second paradigm shift will be reviewed because the first one proved to be inadequate on its own:

both the older and newer ideas were relatively naive concerning power relationships and were limited methodologically. Systemic innovation researchers and facilitators can learn from the second paradigm shift too, so they do not fall into the same traps as systems thinkers did – we can launch a new view of systemic innovation that already starts where systems thinkers are now. While this will be a very brief exposition of the history of systems thinking, more detailed accounts can be found in Hammond (2003) and Senalp and Midgley (2021), who focus on the early days; Jackson (1991a, 2000) and Midgley (2000, 2003b), who cover the rest of the 20th Century; and Jackson (2019) who brings us closer to the present day.

4.1 | The early systems sciences

Systems thinking is a child of the systems sciences, and it has also been strongly influenced by cybernetics and complexity theory. It is noteworthy that these three scientific communities were in close communication back in the 1940s (Hammond, 2003; Midgley & Richardson, 2007). Systems scientists were trying to establish the foundations for a general theory of all open systems (e.g., cells, organs, organisms, families, organizations, communities, societies, planets, solar systems and galaxies) in order to transcend the specialised languages of the disciplines and reunite science, which was perceived as overly fragmented by arbitrary disciplinary boundaries (e.g., Boulding, 1956; Bertalanffy, 1956, 1968).

While it is self-evident that this grand reformation project did not reunite science in the mid-20th Century, the work of systems scientists has nevertheless fundamentally informed how we began to think of organizations, in subsequent years, as open, adaptive systems that thrive by generating value to meet community/customer needs and desires (Beishon & Peters, 1981), and of course we know that value can be added through synergistic partnerships in processes of innovation (Chesbrough, 2006) and coproduction (Normann, 2001).

Alongside their colleagues in systems science, cyberneticians (e.g., Ashby, 1956; Bateson, 1970; Wiener, 1948) focused on how systems use feedback processes to self-regulate and adapt to their environments, and their work not only informed some important 20th Century understandings of organization (e.g., Beer, 1981, 1985), but also gave rise to information theory (Shannon, 1948; Shannon & Weaver, 1949), radical new theories of the mind (Bateson, 1972) and ultimately computing and artificial intelligence (Gefter, 2015). In a complementary strand of work, complexity theorists were particularly preoccupied by differentiating between simplicity (predictable causality), organized complexity (the domain of systems) and disorganized complexity (where patterns are difficult to find) (Weaver, 1948) and by articulating the generic properties of complex adaptive systems, including human organizations (Simon, 1962). This work would later inform a scientific revolution in our understanding of complex causality and the inherent unpredictability of complex adaptive systems that attracted several Nobel Prizes (for Simon, 1962; Prigogine, 1987; and Gell-Mann, 1994). It should be clear from these descriptions that the agendas of the three research communities were very closely related, and they were all talking about the development of theories of real-world systems.

It was in the 1950s that people first began to ask what the implications are of systems theory for management and policy intervention. A number of different systems methodologies for applied research and intervention were developed at this time. Perhaps the four best known are *System Dynamics* (e.g., Forrester, 1961), a methodology for quantitatively modelling complex feedback processes and considering the impacts of changes to system relationships; *Systems Engineering* (e.g., Hall, 1962; Jenkins, 1969), an approach that focuses on the design of whole organisational systems, using quantitative methods, to meet given purposes in an optimal manner; *Systems Analysis* (e.g., Miser & Quade, 1988; Optner, 1973; Quade et al., 1978; Quade & Boucher, 1968), which helps in assessing costs, effectiveness and risk given multiple scenarios; and *Viable System Modelling* (e.g., Beer, 1959, 1966, 1981, 1985), which facilitates the diagnosis of organisational problems through comparisons between a real organisation and an ideal model derived from cybernetic and systems theories.

Note that a key assumption of all of these approaches, which were widely applied between the 1950s and 1970s, is that it is possible to objectively model real-world complex systems (often using computers) and thereby predict or anticipate the effects of different proposals for business strategy or government policy. There were clear implications for innovation, even though this word was hardly ever used by systems methodologists: potential strategies or policies could be creatively generated and then tested for their likely systemic effects, and these tests would go beyond the good intentions of those proposing them to include considerations of wider impacts on society and the environment (Forrester, 1961, 1969; Meadows et al., 1972).

4.2 | The 1st paradigm shift: from real-world systems to *ways of thinking* in systems terms

However, this work came under sustained attack in the 1970s and 1980s: for some of the original critiques, plus

later reviews of the debates, see Hoos (1972), Lee (1973), Lilienfeld (1978), Ackoff (1979), Checkland (1981), Jackson (1991a), Midgley (2000) and Midgley and Richardson (2007). In a single paper like this, it is impossible to cover every issue that has been discussed in the literature, so here we will focus on one particular critique that is very relevant to systemic innovation: the assumption of objectivity in modelling. There was often a failure to realise that 'the system' was being seen from a particular point of view, and in most systems analyses this was the point of view of the expert modeller and/or the paying client (Checkland, 1981; Jackson, 1991a). Unsurprisingly, gaps often appeared between the expectations of clients, modellers and other stakeholders. These approaches did not work well in situations characterised by multiple stakeholder perspectives because there has to be agreement on the nature and parameters of the issue to be addressed if modelling is going to be effective (Jackson & Keys, 1984). In the absence of this agreement, modelling can actually cause or exacerbate stakeholder conflict, as from some perspectives the model might be addressing the wrong problem or not accounting for the variables that matter (Midgley, 2000).

This is highly relevant to systemic innovation. As Ison (2016) argues, the assumption of objectivity brings certain dangers with it: if we see innovation systems as objective 'things', there is a tendency to take their boundaries, parts and/or interconnections for granted. This may "lead us down the wrong pathway from the start" (p. 39) when it comes to innovation. Or, as Ulrich (1983) says, analysing how systems *ought to be* (or could be) in the eyes of stakeholders is as important as understanding what currently exists, and taking as immutable what currently exists can limit our innovation potential. There is a delicate balance to be struck here because stakeholders have to move to a future, more desirable state from where they are at present (Checkland, 1981), so the current situation should not be totally disregarded. However, understanding that systems are always seen from a point of view, so the systems idea is best reconceptualised as a tool for thinking (e.g., to explore the possible points of view we might adopt), is helpful for striking this balance because it reminds us to test our assumptions about what needs to be taken as given and what can and should be changed (Checkland & Scholes, 1990).

Note that the move to seeing the systems idea as a tool for thinking does not mean that we should conclude that real-world systems do not actually exist (Mingers, 2006, 2014). Saarinen and Hämäläinen (2010) and Cabrera et al. (2022b) argue that we are constantly navigating real-world systems that exceed our capacity to fully understand them, so employing the systems idea as a means to critically rethink (reframe) what those systems are or could be is exceptionally useful. While the term 'systems thinking' had already been coined a couple of decades previously (e.g., Watanabe & Ishii, 1964), it was Checkland (1981) who used it explicitly in this new way and did a lot to popularise the term.

The bottom line for systemic innovation is that, even if a researcher prefers to stick with one of the earlier definitions (concerning networks of technological innovations, governance of those networks, innovation for sustainability or ecosystems of collaborators), practice still inevitably involves multi-stakeholder coordination. It is not only the technical and organizational challenges that go with this that matter, but also stakeholder perspectives on the overall innovation initiative (and its contributory parts); whether it is responsive to their values; and whether the initiative might be seen as having positive or negative social or environmental effects. Using the systems idea as a thinking (or learning) tool helps here, as we can question what perspectives, boundaries, elements (e.g., participants and resources), relationships and anticipated emergent properties are most relevant in a systemic innovation initiative.

As a response to the attack on systems methodologies from the 1950s and 1960s, a new set of systems methodologies for intervention emerged in the 1970s and 1980s. Examples are *Soft Systems Methodology* (Checkland, 1981), which helps stakeholders compare systemic analyses of proposed transformations with people's perceptions of the current situation that they want to change; *Interactive Planning* (Ackoff, 1981), which asks stakeholders to innovate using an almost-clean slate, encouraging consensus on far-reaching visions of change; *Interactive Management* (Warfield, 1994), which supports stakeholders in forming a consensual view of how their different understandings and desires for action can all be integrated into an emergent change agenda; and *Strategic Assumption Surfacing and Testing* (Mason & Mitroff, 1981), which supports stakeholders in subjecting two or more alternative policies or business strategies to dialectical (oppositional) debate, from which an innovative new understanding may emerge. All these approaches are strongly participative (implemented in multi-stakeholder workshops), compared with earlier ones that were more expert-driven, which makes them appropriate for use in 'living labs' (Eriksson et al., 2006; Niitamo et al., 2006) or 'change labs' (Vänninen et al., 2015).

Following this paradigm shift, some of the earlier methodologies from the 1950s and 1960s were thoroughly reconceptualised in the 1980s and 1990s to take account of multiple perspectives instead of assuming objectivity (e.g., Espejo & Harnden, 1989; Senge, 1990; Sterman, 1994; Vennix, 1999), and these authors

displayed greater humility with respect to prediction: in response to some high profile failures to predict social dynamics and inform policy using computer models (Lee, 1973), the new generation of systems thinkers acknowledged that social systems are usually much too complex for detailed prediction, so the emphasis instead should be on *systemic learning* by stakeholders about the *possible* effects of different courses of action (e.g., de Geus, 1994; Sterman, 1994). One idea informing all these approaches is that it matters for stakeholders to participate as equals in the learning process, as nobody has a complete understanding on their own, and invariably solutions will require accommodations between stakeholders to facilitate coordinated actions across boundaries (Checkland & Scholes, 1990).

Most importantly, all the methodologies in this new generation embodied the idea that systems thinking is about *thinking in terms of systems*. However, this is not merely a move from objectivism to subjectivism. Checkland (1985) stresses *inter-subjectivity*, which is about the collective construction of meaning across stakeholder and organizational boundaries. This does not require consensus or a shared worldview—merely a willingness to find sufficient accommodations to enable coordination (Checkland & Poulter, 2006; Checkland & Scholes, 1990). The importance of intersubjectivity (as opposed to subjectivity) cannot be overstressed. All the methodologists associated with this new wave of systems thinking understood that emergent inter-subjective understandings, giving rise to possibilities for systemic innovation, do not arise in a vacuum: dialogue processes are needed to support people in getting to them; and to promote better systemic insight, these processes can usefully be informed by the systems idea (building systemic, mostly qualitative models, but understood as *explorations of possibilities for change*). Thus, both *the process and the thinking it enables* is viewed as systemic, and (in one way or another) all the methodologies discussed above help people explore different perspectives, evolve new purposes, rethink boundaries and the value judgements giving rise to them, and delve into how actions need to be linked up systemically to deliver innovative emergent properties that add value.

'Value' here is understood in terms of transformations that are subject to two assessment criteria (Checkland & Scholes, 1990). The first is *systemic desirability*: the innovation must account for all interactions and effects that are important to the participants, so transformations that cause more problems than they solve, or have unacceptable side-effects, are avoided. The second is *cultural feasibility*: it must actually be possible to implement the innovation within the cultural and other constraints identified in the systemic analysis. While Mingers (1980, 1984) and Jackson (1982, 1991a) say that this second criterion is inherently conservative, acting to prevent radical, counter-cultural innovations, it should be noted that Checkland (1981) and Checkland and Scholes (1990) are clear that what counts as a cultural or environmental constraint is open to contestation by stakeholders, and indeed there are tools in their methodology for enabling this. Also, Checkland (1988) makes clear that, in practice, the facilitator plays an important role, because he or she can ask questions that support people to think carefully about how to make counter-cultural innovations more feasible.

The central lesson for systemic innovation from this second generation of systems approaches has already been discussed: the meta-cognitive use of the systems idea as a device to enhance critical thinking about what should be accounted for in defining value from an innovation process can help stakeholders reframe when they are 'stuck', and it can also help them anticipate possible negative consequences of proposed innovations as well as ones that constitute positive value. What has not yet been mentioned, however, is the opportunity to import the methodologies and methods discussed above (as well as others) into the practice of systemic innovation in industry and government. The literature on systems thinking includes literally thousands of examples of the successful use of systems approaches for innovation (mostly in the form of case studies of practice, with some methodological learning coming out of them that others can utilise), including many where the purpose was explicitly to coordinate across the boundaries of multiple organizations (e.g., Brocklesby, 2015; Collins & Ison, 2010; Gregory & Midgley, 2000; Hale & White, 2014; Kärkkäinen & Hallikas, 2006; Midgley et al., 1997, 1998; Sydelko et al., 2021; Taket & White, 2000; White, 2001). Interestingly though, the word 'innovation' itself is not used very much in the systems literature, with words like 'transformation', 'change' and 'improvement' being more common instead. It is one of the intentions of this paper to stimulate a productive dialogue across the innovation and systems thinking research communities.

4.3 | The 2nd paradigm shift: understanding power relations and mixing methods

Just as the first generation of systems thinkers was criticised by the second generation, so the second generation was critiqued by a third in the 1980s and 1990s, and extending into the 2000s. There were actually two different strands of work that evolved in parallel in these decades:

The first was started in response to a bitterly entrenched paradigm war between the first and second generations (Dando & Bennett, 1981; Jackson & Keys, 1984), which threatened to split the systems research community. A large flurry of proposals were made for *methodological pluralism* (i.e., drawing creatively from both traditions, and reinterpreting their methods through new frameworks or guidelines for choice) to give us a more flexible and responsive intervention practice than either of the previous two paradigms (e.g., Flood, 1989, 1990; Flood & Jackson, 1991a, 1991b; Flood & Romm, 1996b; Gregory, 1992, 1996a, 1996b; Jackson, 1987a, 1987b, 1991a, 1991b, 2000, 2003; Jackson & Keys, 1984; Keys, 1988, 1991; Midgley, 1989, 1990, 1992a, 1996b, 2000, 2001; Mingers & Gill, 1997; Oliga, 1988).

The second strand of work focused on *power relationships* in systems practice: that is, the mistaken assumption in the first generation that the systems modeller and/or the paying client know best often resulted in the coercive imposition of 'solutions' and/or their failure due to the absence of stakeholder buy-in (e.g., Ackoff, 1979, 1981; Checkland, 1981; Churchman, 1970; Eden et al., 1983; Jackson, 1991a; Rosenhead, 1989; Rosenhead & Mingers, 2001; Ulrich, 1981); and, in contrast, a practice-limiting belief in the second generation that stakeholder participation in dialogue, in and of itself, allows the better argument to prevail, ignores (or overly minimises) problems of bias, mistrust, coercion, groupthink, deceit, ideological framing and disempowerment (Jackson, 1982, 1991a; Midgley, 1997a; Mingers, 1980, 1984; Munro, 1999; Thomas & Lockett, 1979).

These two parallel strands of work were then integrated into a new 'systemic intervention' approach by Midgley (2000), who recognised that the work on systemic power relationships could support deep diagnoses of the contexts in which we want to innovate, and these diagnoses could then inform the construction of interventions drawing creatively upon methods from both previous generations of systems thinking *and* from other traditions (e.g., the social and natural sciences). Below, we will concentrate primarily on this later, integrated work and its implications for systemic innovation, as it goes beyond the separate work in the two previous parallel strands. It is also still influential 21 years after its first introduction.

It should be noted that systemic intervention has been developed through over one hundred action research cycles, where theory and methodology have informed projects involving the facilitation of innovation and change, and reflections on these projects have fed back to refine and develop the theory and methodology (for some overviews of the approach, see Midgley, 2000, 2004, 2006, 2015, 2022; Boyd et al., 2004; and Midgley & Rajagopalan, 2021). This kind of action research is what Strumińska-Kutra (2016) and Cunliffe and Scaratti (2017) describe as "engaged scholarship" (Strumińska-Kutra, 2016, p. 864) and, in the text below, we illustrate some of the points we make with brief vignettes from our innovation projects.

The systemic intervention approach makes three fundamental assumptions about the nature of the world and our place in it: first, everything in the world is either directly or indirectly connected with everything else; second, the complexity of this is so far beyond human understanding that we always have a partial view. It is partial in two senses: there are always boundaries defining what we consider relevant in any situation, and the setting of boundaries is strongly driven by value judgements, which are associated with our purposes, or what matters to us (Alrøe, 2000; Churchman, 1970; Cilliers, 1998; Midgley, 1992b, 2000; Midgley & Rajagopalan, 2021; Ulrich, 1983, 1987, 1993). The third assumption is that intervention is unavoidable: everything we do (even when we refrain from doing something) has an impact on the world and/or our understanding of it (Midgley, 2000; Walker, 2007). Thus, all knowledge creation takes place in relation to a context of action. This is quite obvious in the case of much applied research for innovation, where the change context might be in industry, government or across more than one sector of society, but it is also the case for so-called 'pure' research, where the action arena is academia, and we want to intervene to change the debates that take place within it (Midgley & Ochoa-Arias, 2001).

Let us now bring these three observations (interconnectedness, partiality and the inevitability of intervention) together to draw a critically important conclusion: because we act in relation to values-informed, bounded knowledge, and we cannot avoid our actions having impacts, it puts *ethical responsibility* (defined as explorations of possible values and their associated boundary judgements with a view to anticipating their outcomes to inform choice) at the heart of systems practice. We derive ethical responsibility as a central principle of practice because, if our value and boundary judgements always have impacts, then their potential consequences need be considered if we are to avoid unanticipated negative outcomes. This is not to say that all the outcomes of our value judgements and subsequent actions can be predicted in advance, but we know that the anticipation of outcomes can be *enhanced* (even if it remains imperfect) by reflecting on values and boundaries that are taken for granted (Helfgott, 2018; Midgley & Ochoa-Arias, 2004b; Ulrich, 1983, 1988).

Earlier, when we were discussing the fifth definition of systemic innovation, we explained how the classical definition of a system (an organized set of parts, differentiated from their environment, giving rise to emergent properties that cannot be attributed to any one part, or sub-set of those parts, in isolation) is enhanced by recognition that system boundaries are meaningful in terms of human purposes and values. The systemic intervention approach recognises that the boundary idea (which is always associated with values) is actually the *most fundamental* of the systems concepts (Midgley, 2000), for two reasons. First, the vast majority of our experiences as human beings are 'given' to us by our perceptions: we make thousands of distinctions at any moment in time without consciously having to think about them, giving rise to the experience of a concrete, real world around us (Maturana & Varela, 1992; Mingers, 1995). The framings we use to make sense of this world (or what Senge, 1990, calls 'mental models') are a part of this unconscious distinction-making, which is what makes reframing so hard for people if they have no tools to support them. The boundary concept, perhaps more than any other element of the systems idea, is a useful tool for metacognitive reframing because it can allow us to systematically ask what interactions we are leaving out of our understanding; who might see things differently; what values might impel the use of a different boundary; and what the consequences would be of changing this boundary. The second reason why the boundary concept is arguably more fundamental than the other systems concepts is that the perspectives, parts, wholes, interactions and emergent properties that we are aware of are always dependent on a prior conscious or unconscious boundary judgement (Midgley, 2000). As Ulrich (1983, 1988), Midgley and Ochoa-Arias (2004b) and Midgley et al. (2018) make clear, no view of the world is comprehensive (all perspectives are bounded), but we can achieve *greater* comprehensiveness by exploring different possibilities for making boundary judgements than we can by taking any one boundary for granted.

The value of the boundary concept to systemic innovation practice has already been recognised by Gibbert and Välikangas (2004) and Välikangas and Gibbert (2005), who talk about how boundaries simultaneously enable and constrain human activity (also see Cilliers, 1998; Juarrero, 1999; and Midgley, 2000). This is a vitally important observation: one reason why reframing is so difficult when organizations hit problems is that boundary judgements get taken for granted and entrenched precisely because they have been historically enabling, and nobody has had to seriously question their utility before. In the 'fuzzy front end' of the innovation process (Takey & Carvalho, 2016), if innovators are 'stuck' in their attempts to identify a potential innovation, the boundary concept can help by raising questions about who to involve and what issues to consider, and then the other systems concepts (concerned with identifying parts of the system, their necessary interactions and how they can be interpreted from different perspectives) can be brought on stream to support the development and implementation of a new vision of innovation.

A consequence of realising that boundaries are enabling is that we need to challenge the familiar metaphor of 'transcending' boundaries, as if, once we have broken a constraint, our thinking is absolutely free (for examples of the use of this metaphor, see Mitroff & Linstone, 1993, and Wilber, 2001). When we reframe, *we do so by adopting another boundary that is informed by different values (what matters to us in the context of action), which then enables a new (innovative) pathway for action*. This is so important, not just because it tells us that explicitly redrawing boundaries is useful for innovation (Välikangas & Gibbert, 2005), but also because of the inescapable connection between boundaries and values. The metaphor of transcendence encourages a suspension of critical thinking once we have broken a constraint, and this is potentially dangerous: we reframe using a new set of values, and our understanding remains partial, even when transformed. Thus, it is important to make the new values explicit to avoid the complacency that can come with the success of reframing, as the new values may themselves carry problems we are not yet aware of. While comprehensive analysis of the limitations of boundaries and values is impossible (Ulrich, 1983), being explicit about them, and the actions they enable, is the first step to openness to new questions and further possibilities for innovation. This is essentially about ethical responsibility: because all boundary judgements come with associated value judgements, a key question is 'what matters, and why, over what timeframe, and from whose perspective?' Also see Helfgott (2018), who has a very similar question at the heart of her approach to thinking about resilience, which is informed by the same ideas on boundaries.

We can provide an example of questioning boundaries from our own practice. The first author was involved, with a small team, in a consultancy with the senior management of a national public water company that was about to be privatised and split into 9 regional companies. We were asked to help explore if there could be a role for a public sector body to serve the new companies after privatization. The managers' values were all concerned with the business model in the new reality and their own survival in the public sector. Realizing that water is an ecological resource, we argued for an independent ecologist to join the discussions with the senior

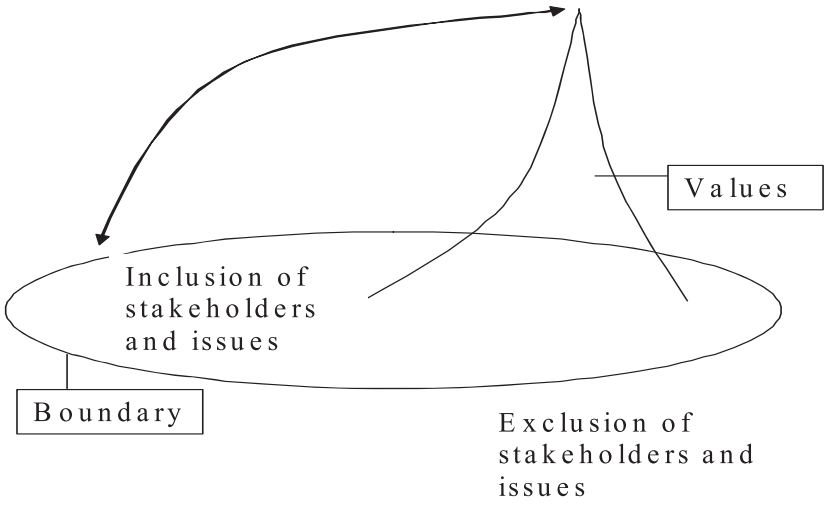

FIGURE 1 Basic relationship between values and boundaries

management. This was a widening of the boundaries of participation, and would potentially introduce new values, but we did not know what might emerge as a result. After a fruitless first day of exploration, when the senior managers continued to operate with their business framing, the consultants consciously broke that constraint by introducing the ecological boundary and associated values. The ecologist explained how all the rivers in the country are linked by underground aquifers. There was a sudden realization: if one company was to allow water quality to fall to unacceptable levels, it would affect the operations of all the other companies. The need for an independent body to oversee the monitoring of water quality became clear, and one way to ensure independence from the companies' operations was to make it a public sector organization.

The relationship between value and boundary judgements, first proposed by Churchman (1970) and then elaborated by Ulrich (1983) and Midgley (1992b), is captured in Figure 1 (the peak represents the values and the oval represents the boundary of what is seen as relevant): it is a two way relationship because values (linked to purposes) direct the drawing of boundaries concerning what is viewed as relevant and who is considered a legitimate stakeholder, but previously given boundaries that have become taken for granted can constrain the set of values that it is legitimate to express. This is why it is so important to explore *both* boundaries and values, as tacit restrictions on thought in relation to either one of them can be challenged with a focus on the other.

The diagramming convention in Figure 1 can then be extended to help us understand both conflict and marginalization processes. Starting with conflict (Figure 2), we see that it can be conceptualized as stakeholder groups operating with divergent values but overlapping

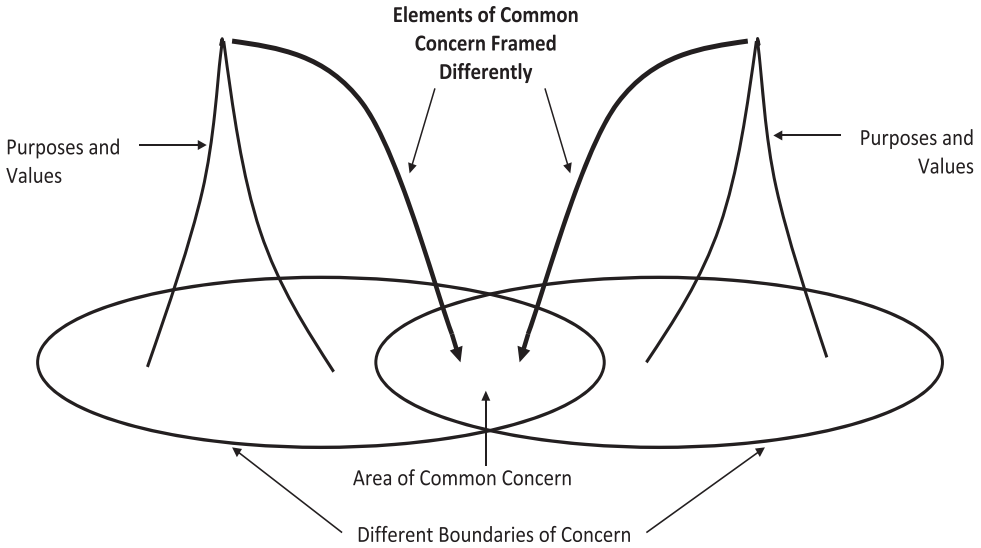

FIGURE 2 Conflict, with the elements of common concern framed differently (from Midgley, 2016b)

boundaries, so a phenomenon of interest to both is framed differently by the two sides (Foote et al., 2021; Midgley, 2000, 2016b; Midgley & Pinzón, 2011; Yolles, 2001). When conflict becomes entrenched, the stakeholders end up stereotyping or demonising each other (Figure 3). Issues of identity come to the fore (also see Midgley et al., 2007). Figure 3 is helpful because it tells us that there are three potential approaches that can be used to address conflict and turn a destructive or unproductive situation into one in which synergistic innovations can emerge: interveners can work to transcend narrowly conceived values; draw causal connections between elements in the two sets of boundaries so that everybody ends up working with a wider system boundary; and/or challenge stereotypes (Midgley, 2016b).

While it is often claimed that stakeholder conflict is a resource for innovation (Andrade et al., 2008; Stacey et al., 2000; Sword, 2007; Yolles, 1999), we observe that this is only the case if the conflict can be handled productively. Thus, knowing how to turn an unproductive conflict into a productive one (in the sense that the participants can identify new innovations that address or transcend their competing concerns) is vitally important. Systems thinking can help with this, and for some examples from our own innovation practice, see Foote et al. (2007) and Midgley (2016b).

The diagramming convention in Figures 1, 2 and 3 can also be used to conceptualize *marginalization* (Midgley, 1991, 1992b). Figure 4 shows how one stakeholder group can draw a narrow boundary while another group can draw a wider boundary. This brings the values being pursued by the two groups into conflict. The people or issues in the margins (between the two boundary judgements) then become the focus of conflicting interpretations: those wanting to draw a narrow boundary will interpret whatever or whoever is in the margins as *profane* (marginal elements need to be derogated so they can justifiably be ignored in the work of organizations); and in consequence, those drawing a wider boundary will view whatever is in the margins as *sacred*, as they want to point out the importance of the marginal people or issues. The words 'sacred' and 'profane' are not used in a religious sense, but to indicate the strength of feeling that goes with these attributions. What is more, one or other of these attributions often becomes solidified through the use of organizational rituals, making it dominant over the other. An example that has been discussed in the literature (e.g., Midgley, 1992b, 2000) is unemployment: the unemployed are in the margins between a narrow boundary defining employees and a wider one defining citizens capable of working, and they are subjected to exercises that are widely experienced as ritual humiliation (being forced to 'sign on', attend job application workshops, do workfare, etc.). Another example is environmental issues that are routinely marginalized because, if industrial organizations were suddenly required to account for all their side-effects and externalised costs, their profitability could be seriously undermined, and indeed our whole economic system could go into crisis (Midgley, 1994).

This is important for systemic innovation in four ways. First, marginalization processes can reinforce innovation-limiting boundaries and values, making them very difficult to challenge. If a potential innovation is associated with an issue that an organization (or network of organizations) is unconsciously colluding in marginalizing, it may be resisted, even if it could bring significant financial, social and/or environmental benefits. The identification of marginalization, and conscious action to address it, especially in 'fuzzy front end' innovation initiatives, is therefore necessary. Indeed, the importance of 'deviant' ideas is well recognised in the innovation literature (Collm & Schedler, 2014).

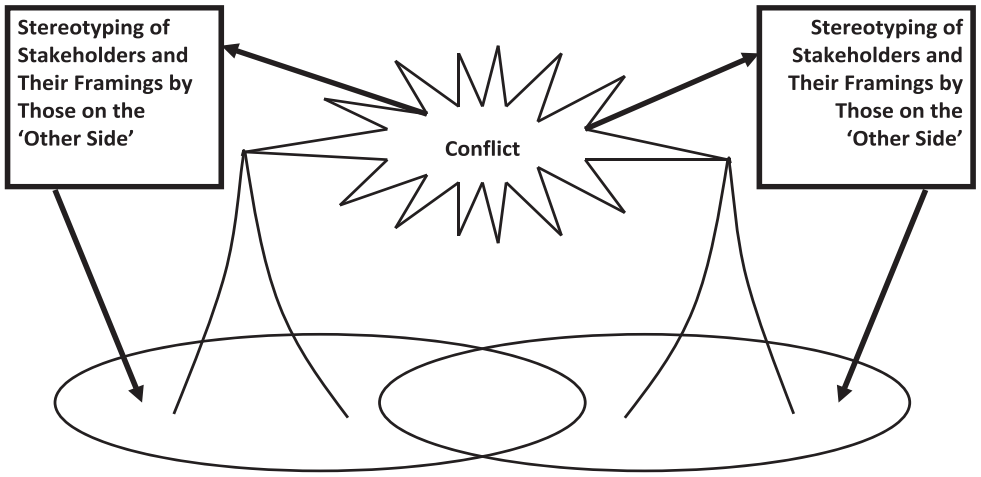

FIGURE 3 The addition of stereotyping to the model of conflict (from Midgley, 2016b)

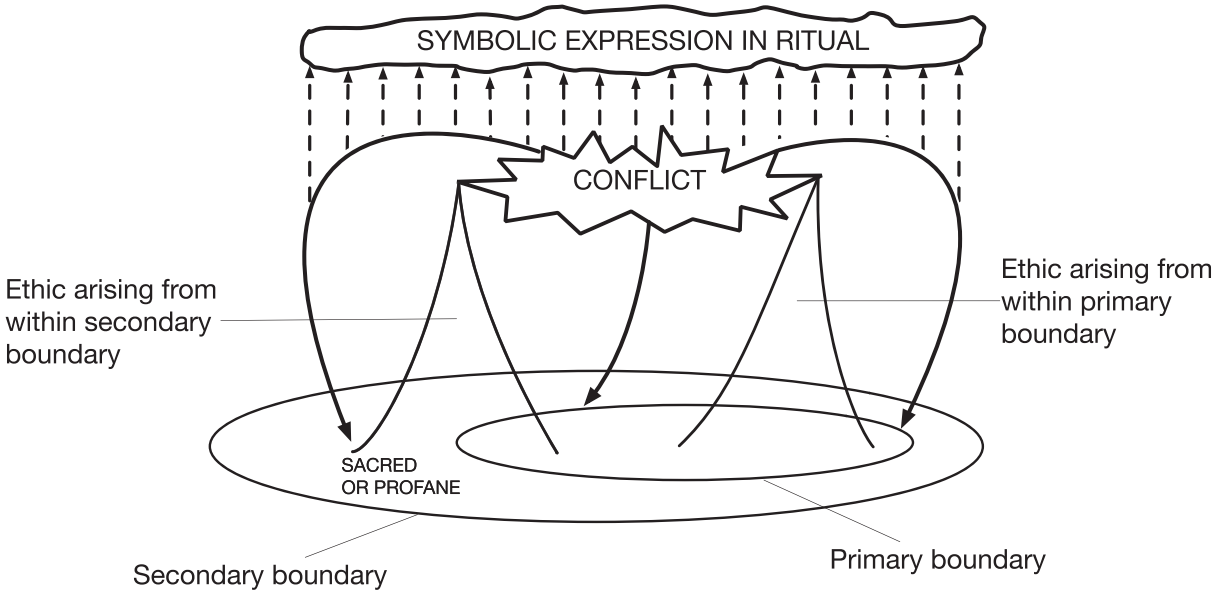

FIGURE 4 Marginalization (adapted from Midgley & Pinzón, 2011, p. 1548)

The second sense in which marginalization is important is in relationships between partners in innovation systems. If there is a dominant player (and both Teece, 1986, and Bröring, 2008, argue that there usually needs to be if a systemic innovation system is going to be successful, because coordination is essential), there can be a tendency for them to prioritise narrow self-interest and start to marginalize other participants. One of us witnessed this in a supply chain innovation project where the dominant industrial partner initially supported its suppliers in coordinating innovations to meet their collective needs. As the dominant partner's product line became successful, the suppliers were then given incentives to drop other customers and solely supply the central company. After the network of suppliers had been made dependent, the company then aggressively cut what they were willing to pay them, reducing the profit margins of the suppliers by an average of 75% and commensurably increasing their own profits. However, they did not anticipate an economic downturn, and the now-fragile supply chain collapsed, dragging the dominant company down with it. Tensions between narrow self-interest and wider, 'enlightened' self-interest in systemic innovation initiatives may spawn marginalization dilemmas, and these are useful to identify and explicitly address in advance of these sorts of problems manifesting themselves.

The third way in which marginalization matters is when we look at regional innovation dynamics, where peripheral areas often suffer in comparison to more central ones (Kaufmann & Malul, 2015; Pelkonen & Nieminen, 2015). Greater insight into how to intervene in such dynamics might come from the application of Midgley's (1992b, 2000) marginalization theory.

The fourth and final way in which marginalization is important to systemic innovation is within organizations, when the latter are attempting to balance the continued delivery of current products or services (maintaining the revenue flow) against the need for new innovations to initiate the next product or service lifecycle (as discussed by Beer, 1981). When there is competition for resources between day-to-day delivery and innovation, this can generate marginalization. The authors recently worked with a large multinational engineering company where this was a significant problem. Their current products were generating diminishing returns, and the senior management was aware of the importance of innovation, but there was a dynamic within the company that pitted those with a 'technology' focus against those with a 'service' orientation. The view of the Innovation Unit within the company was that the next cycle of innovations would come from using a 'service-dominant logic' (Vargo & Lusch, 2004, 2008), while those trying to maintain the profitability of production in an increasingly competitive market thought the answer was maintaining their traditional focus on new technologies embodied in products. Given that the large majority of employees were technology orientated, this put the Innovation Unit in a marginal position. The situation was further complicated by a strategic plan that mandated the top down

selection of innovations for investment, while the Innovation Unit were pointing out that nearly all past profitable innovations had come from 'skunk works' (the curiosity-driven activities of scientists and engineers, undertaken outside the boundaries of organizationally-sanctioned projects). Thus, the Innovation Unit was doubly marginalized: for their view of where innovations would come from *and* for their disagreement with the strategic plan. In the three years that we worked with the Innovation Unit, it was restructured twice, with roles changed and key individuals transferred elsewhere, which seriously compromised its delivery of new innovations, thus fulfilling the prophesy of failure made by those wanting to preserve the status quo. It is vital to identify the potential for these kinds of destructive dynamics and improve mutual understanding across functions within organizations, so everybody understands how necessary differences in values and boundaries link to important differences in roles.

Exploring multiple possibilities for making value and boundary judgements, transforming entrenched conflicts into generative discussions and diagnosing and rectifying issues of marginalization can all liberate the potential for innovation, remove 'innovation taboos' and ensure constructive participation across inter- and intra-organizational boundaries, as we have seen. However, the systemic intervention approach also advocates *methodological pluralism*: mixing methods drawn from a variety of methodological sources (whether originally associated with systems thinking, in its various guises, or not) to create a highly flexible intervention/innovation practice (Midgley, 2000; Midgley et al., 2017).

It is beyond the scope of this paper to review multiple systems methods and their utility for different aspects of the innovation process (that would require a whole book). Also, there is a limit to the production of rules for choosing methods because each innovation context is different, which is why Midgley (1989, 1990, 1997b, 1997c, 2000) emphasises the "creative design of methods" (Midgley, 2000, p. 217) in response to an analysis of the specific context, and especially the relationships between stakeholders. However, we would like to reflect on one generic issue concerning methodological pluralism of particular relevance to systemic innovation:

Let us take the traditional conceptualisation of innovation as a process which progresses from an initial exploration of ideas through to resourcing, testing and then implementation (Chesbrough, 2006), with a later phase of organizational development to support scaling and expansion (Brown, 2017). However, in working with this idea, we reject the common assumption that the 'initial exploration' has to be done by technologists within a single organization: multiple stakeholders and/or organizations can potentially be involved, as in the practice of 'living labs' (Eriksson et al., 2006; Niitamo et al., 2006) or 'change labs' (Vänninen et al., 2015). Also, along with Godin and Lane (2013), we challenge the idea that most innovations are generated by scientists (science can be influential, but so can non-scientific disciplines and perspectives, either instead of, or alongside, science). Finally, following Chesbrough (2006), we reject the 'funnel' metaphor, where thinking can initially be wide (in terms of both ideas and stakeholders) but, as we progress to implementation, the innovation is conceived much more narrowly and is implemented by a single organization. Rather, innovation can involve networks of stakeholders throughout the whole process, including the eventual delivery of innovations in the form of products, policies and services (Chesbrough, 2006; Normann, 2001).

Keeping these three caveats in mind, there is nevertheless a substantial difference between the kinds of methods that might be required for the 'fuzzy front end' phase of systemic innovation; the 'firming up' phase, when organizations have to explore how best to distribute investments, responsibilities, risks and benefits; the 'delivery' phase, when capabilities are being utilized in a coordinated manner to produce value (variously defined by the different stakeholders); and the scaling and expansion stage. At the 'fuzzy front end', explorations of boundaries, purposes and values (already discussed) are essential, and various systems methods for this can be brought on stream (e.g., Boyd et al., 2004; Cohen & Midgley, 1994; Midgley et al., 1998; Midgley & Shen, 2007; Ulrich, 1983). Once it comes to bringing together the intellectual property, investments, resources and activities of innovation partners to assess the viability of delivering upon an innovation, methods from other approaches that are much more focused on the systemic coordination of activities (acknowledging different perspectives) will be useful (e.g., Checkland & Poulter, 2006; Wilson, 1990; Wilson & van Haperen, 2015), in addition to disciplinary knowledge (e.g., from Law, Finance, Management and Engineering). Then, when it comes to refining the collaboration during the implementation or delivery of an innovation, methods concerned with improving the efficiency and effectiveness of workflow processes (e.g., Gregory, 2007; Ohno, 1978; Seddon, 2008; Seddon & Caulklin, 2007; Ufua et al., 2018) may come to the fore. Finally, when the structure and communications of an organization need to be reviewed to support scaling and expansion, the Viable System Model (Beer, 1985), discussed earlier, can help with this. Here, the analysis of conflict and marginalization processes may also be useful because often tough choices face

organizations when they start to scale innovations, as they may not have the resources to simultaneously maintain the delivery of older products and services while also investing in the growth needed for expanding upon the delivery of the new innovation (Beer, 1981; Brown, 2017).

In addition, if this systemic innovation process is taking place in the context of a national or regional innovation plan, then methods for exploring purposes, values and boundaries are useful for actually creating the plan; and the Viable System Model can be useful for coordinating the organizational delivery (Devine, 2005). It is then within this that specific product, service or policy innovation processes can be embedded.

The logic of the methodological progression expressed in the last two paragraphs is very important (Boyd et al., 2007): if we want to keep the idea of ethical responsibility at the heart of systemic innovation, which the systems theory discussed earlier calls for (Midgley, 2000; Ulrich, 1983), then we need to move from highly creative and inclusive explorations of values and boundaries through to the detail of implementation, dealing with issues of power, conflict and marginalization along the way, always with the possibility of iterating back to values and boundaries again if something that had previously been taken for granted becomes problematic (Córdoba & Midgley, 2003, 2006, 2008).

5 | REDEFINING SYSTEMIC INNOVATION

As discussed earlier, this understanding of systems thinking is contemporary, and (in our view) it provides a good basis to inform systemic innovation theory and practice. There are two reasons. First, it offers a systems theory of how multiple perspectives, value/values, power, conflict, identity, cocreation and marginalization play out in stakeholder relationships (e.g., Midgley & Pinzón, 2011), which is important because these things have been identified as significant barriers to systemic innovation (e.g., Andersen & Drejer, 2008; Brown & Duguid, 2001; Chiesa & Frattini, 2011; Lehtinen, 2011; Li & Zhong, 2011; Moodley & Morris, 2004; Turner et al., 2016). Second, the systems thinking literature offers more than just a way to *understand* the above barriers to innovation: it also offers a wide range of methods for intervention to address them and 'liberate' (Flood, 1990) the potential for innovation. If we embrace methodological pluralism, we can include the best methods from all forms of systems thinking within our systemic innovation tool kit, alongside more commonly deployed methods for innovation and management, providing a flexible and responsive resource to innovators, innovation managers and innovation facilitators.

We can now move to formulate a new conceptualization of systemic innovation, based on the foregoing discussion. At its most basic, *systemic innovation involves processes where innovators and their stakeholders use systems concepts and practices to change thinking, relationships, interactions and actions to cocreate new value.*

These processes are the enactment of a praxis that is situated in a real-world context of potential innovation, where people are trying to find ways to address complex problems or create something new. Such processes draw on the conceptual and practical resources at hand: for example, the engagement of actors and their different framings of the situation. Who becomes an innovator and/or a stakeholder may emerge through the systemic process, and their roles may be defined through that same process.

Systemic innovation processes are initiated and managed by engaged actors in situations based on available capacities and competences for innovation and systems thinking in practice. Constructing such processes can be supported by a facilitator, who can bring in relevant systems-methodological expertise as well as facilitation skills. However, a facilitator is not essential if the requisite expertise resides with any of the participants, and those participants have the trust of the others involved. Increasing numbers of organizations are hiring specially-trained people with the role of 'systems thinking practitioner' (Institute for Apprenticeships and Technical Education, 2021), so we believe that, over time, external facilitators will come to be utilized less frequently.

The purpose of a systemic innovation process is to enable viable and value-enhancing emergent outcomes (products, services, policies, changes in behaviour or understanding, etc.). Using systemic processes increases the opportunities for such outcomes by structuring the interactions between participants in a manner that enhances systemic awareness (e.g., helping people to rethink boundaries, interconnections, perspectives and how the parts of systems cohere to create emergent value, or not), but as in all human praxis, there is no *guarantee* of success.

It should be noted that this definition breaks from the idea that systemic innovation is solely characterised by innovations that only generate "value if accompanied by complementary innovations" (Takey & Carvalho, 2016, p. 97), which is the most commonly used previous definition, stemming from the works of Teece (1986) and Chesbrough and Teece (1996). These authors use the word 'systemic' to indicate the presence of a real-world *innovation system*, and we have argued, in contrast, that there is value in concentrating on praxis where people

are *thinking and acting systemically,* and designing/using systems-methodological processes to support the systemic thinking and action of others, so they too can innovate. This is not to say that systems thinking lacks utility for understanding and developing interdependent innovations and innovation systems (far from it—see the next section); rather, we want to emphasise the use of the 'systems idea' as a tool for critical thinking so innovators and innovation facilitators do not fall into the trap of taking for granted the boundaries, interactions, perspectives and patterns of emergence in innovation systems. If these things are taken for granted, it makes them appear immutable and limits the potential for innovation.

In operationalising this definition, innovators and innovation facilitators can take advantage of the following:

- The network of stakeholders to be involved in a systemic innovation can be decided through stakeholder analyses (e.g., Ackermann & Eden, 2011; Gregory et al., 2020; Mitchell et al., 1997), and the boundaries of participation can shift over time, although they will generally become firmer the closer the participants get to delivering value. New participants bring fresh knowledge and the potential for new synergies.
- Systemic innovation has ethical responsibility at its heart, understood as the deliberate and participative exploration of multiple boundaries, purposes and values of potential relevance to the innovation, which can support reframing and counter resistance to change while making participants more aware of their economic, social and environmental responsibilities. Talk of ethical responsibility does not have to assume a universal set of values (Freeden, 1991; Midgley, 2000). What we are referring to here is the basic understanding, represented in Figure 1, that people's purposes and associated values link with the boundary judgements they make about who or what should be included in or excluded from innovation processes. Whenever decisions about purposes and boundaries need to be made, they are *ethical* (i.e., values-based) decisions, simply because the question needs to be asked, 'what is the right thing to do?' The more that purposes, values and boundaries can be explored in the context of the participation of stakeholders with different perspectives, the more paths for innovation can potentially open up (Churchman, 1979). Note that the view of ethics that is embraced here is not the one that is commonly used in science, where the focus is a circumscribed set of issues (like informed consent, confidentiality and avoidance of harm) that are well known to cause concern. Neither is it the rules or guidelines for people to live by that are discussed in many religious texts: *every single decision we take* is ethical, as is acting in the absence of conscious decision making, because all that we do and say can be judged in term of its appropriateness (Habermas, 1979), and our decisions may well have consequences (which may be only partially knowable in advance). Such consequences can be viewed as beneficial or harmful—even both at the same time, if some stakeholders will make gains while others experience losses. Realizing that ethicality relates to all our decisions (not just those referring to a predefined, circumscribed list of issues or rules to live by) brings into sharp focus the fact that taking purposes, values and boundaries for granted (i.e., acting without deliberate thought and dialogue) has the potential to *hide* the ethical dimension of innovation processes from us, and the first we may know about it is when we find ourselves in conflict with stakeholders (see Cronin et al., 2014, for a systemic innovation process to use in the face of conflict). Put another way, we need 'slow' thinking within our innovation processes to counteract the biases and taken-for-granted norms that are implicit in the 'fast' thinking that we inevitably do much of the time (Kahneman, 2011). Our responsibility is to create opportunities for exploration, balancing the desire to consider as many pathways for innovation as possible with the pragmatic resource, logistical and time constraints that will inevitably intrude—and how we judge what this balance should be *is itself an ethical decision* that involves us asking, 'what is the best we can do in the circumstances?' (Ulrich, 1983).
- The systems thinking that flows into systemic innovation offers theory and methods to understand and intervene in conflicts and processes of marginalization when any of the following three conditions apply:
  - Overcoming conflict or marginalization is judged to be ethically necessary;
  - Addressing a particular conflict or marginalization is the reason for innovating; or
  - Conflict and/or marginalization are barriers to innovation.
- It offers a range of methodologies and methods to support all aspects of the innovation process, including:
  - Exploring purposes, values, boundaries, stakeholder perspectives and the construction of innovation processes (e.g., Midgley, 2000; Ulrich, 1983) at the 'fuzzy front end' when 'valuation' (the process of appreciating value for multiple participating stakeholders) is important (Lindhult et al., 2015);
  - Reforming or designing organizations (e.g., Beer, 1985; Espinosa & Walker, 2017), meta-organizational coordinations (e.g., Lowe et al., 2016; Midgley et al., 1997, 1998; Sydelko et al., 2017, 2021) and policy governance systems (e.g., Devine, 2005);

- Visioning far-sighted innovation futures (e.g., Ackoff, 1981; Ackoff et al., 2006; Christakis & Bausch, 2006; Helfgott, 2018; Laouris & Michaelides, 2018);
- Participatively developing, comparing and evaluating alternative innovation proposals (e.g., Checkland & Poulter, 2006; Mason & Mitroff, 1981);
- Refining and enhancing value in the process of its delivery (e.g., Gregory, 2007; Ohno, 1978; Seddon, 2008; Seddon & Caulkin, 2007; Ufua et al., 2018); and
- Evaluating systemic impacts (e.g., Boyd et al., 2007; Gregory & Jackson, 1992a, 1992b; Midgley, 1996c; Reynolds et al., 2016; Williams & Imam, 2006).

This is a logical progression from idea exploration through to delivery and evaluation, and while not all systemic innovation initiatives will require all of these aspects, methodologies and methods for them are available if required.

6 | INTEGRATING THE SYSTEMIC INNOVATION AND SYSTEMIC INTERVENTION FIELDS

We started this paper by explaining the five different definitions of systemic innovation that have been discussed in the literature, and have advocated for the one that is most recent and (so far) the least used. We also mentioned the need to show that our approach can add value to the work of those who are using the other four definitions of systemic innovation. We will therefore revisit these below, and through our analysis we will point to the possibility that a widely accepted systems approach can integrate as well as enhance our field.

6.1 | Rethinking innovation systems

The first and most commonly used definition is the one referred to in Sections 2 and 3.1: the word 'systemic' refers to the existence of an innovation system that enables the coordination of technological innovations across organizational boundaries (Chesbrough & Teece, 1996; Takey & Carvalho, 2016; Teece, 1986). While we earlier described our definition of systemic innovation as a break from a sole focus on innovation systems, it does not make innovation systems irrelevant. On the contrary, we have emphasised the utility of the systems *idea* to inform the design of innovation processes that can support participants in thinking systemically, and the purpose of this, for someone interested in facilitating the development of an innovation system, is to enable them to keep an open mind about the boundaries that could be set for both the participation of stakeholders and the issues and technologies to be engaged with. Systems thinking can also help people to remain open to different purposes and values that might be relevant (e.g., everything from sustainability and local livelihoods through to meeting customer needs and providing shareholders with a return on investments); it can support managers in the design of multi-organizational structures and communications; and it can provide collaborative methods to aid *self*-organization among diverse participants. We therefore argue that systems thinking can *add value* to the practice of working with innovation systems.

There is an interesting paradox here. Our explanation of systemic innovation implies that the coordination of innovations across multiple organizations is not its defining feature, and indeed systems thinking is potentially relevant to so-called "autonomous innovations" (Takey & Carvalho, 2016, p. 97) in single organizations too, given that even these have to be used in a context, so they are never *strictly* autonomous. However, if we bring systems thinking to bear to explore the context of any potential innovation, this will generally involve sweeping in stakeholders so they become possible participants in the innovation initiative, and the ultimate outcome is therefore *more likely* to be the evolution of an innovation system. Deemphasising innovation systems in favour of systems thinking in our definition of systemic innovation could actually increase the success of innovation systems!

6.2 | Rethinking policy and governance systems

For those who define systemic innovation in terms of the development of policies and governance structures to set enablers and constraints on the operation of (usually regional or national) innovation systems, the kind of systems thinking we have described can also add value. Earlier we mentioned the Viable System Model (VSM) (e.g., Beer, 1985; Espejo & Harnden, 1989; Espejo & Reyes, 2011; Espinosa & Walker, 2013; Hoverstadt, 2008) as a particularly useful tool for informing the development of interorganizational coordination, management, strategic foresight and governance structures. Following Devine (2005), we repeat this recommendation, but wish to add a caveat: a model like the VSM is good for enhancing the viability of organizations and multi-organizational clusters, but has nothing to say about the ethicality of the purposes that those organizations and clusters serve, other than to claim that an organization

must fulfil needs or desires in its environment if it is going to survive or thrive. As Ulrich (1981) points out, some human desires could be considered unethical, or their fulfilment could have unwelcome side-effects. It is for this reason that, in our own practice (e.g., Boyd et al., 2007; Midgley et al., 1997, 1998; Sydelko et al., 2017), we only use the VSM following a stakeholder engagement exercise to support a systemic analysis of the purposes, values and boundaries that an organization or innovation cluster should be working with. Also, 'stakeholders' in this context are not just those people who are *currently* involved in or affected by the activities of an innovation initiative, but also those who *might be affected in future* if the activities change. Thus, the boundaries of stakeholder engagement can evolve along with the reflections of those developing the innovation initiative.

Not only can this ethical focus (alongside use of the VSM and other methods) add value to the development of meta-level governance systems to support regional or national innovation, it is also relevant in support of the kind of innovation geared towards societal change, and particularly ecological sustainability:

6.3 | Rethinking 'game-changing' innovation, particularly in the context of sustainability

The third kind of systemic innovation, which aims to bring about societal shifts (including new enablers and constraints on the ethical direction of future innovations), can clearly be enhanced through the application of systems thinking discussed here, as the latter has the notion of ethical responsibility at its heart. Societal systems are exceptionally complex, and when coordinated attempts are made to transition to new arrangements (e.g., renewable energy replacing fossil fuels), the ramifications beyond the issue in focus can be unpredictable. It is notable that ecological sustainability at the global scale has interactions with many other 'wicked' policy problems (to borrow a phrase from Rittel & Webber, 1973), forming a 'global problematique' (Meadows et al., 1972; Slaughter & Riedy, 2009) where changes in one domain will impact on many others. In such a situation, the dangers of uncritical thinking about the consequences of innovation are acute, and with interconnected issues like climate change, wealth distribution, population growth, peace and security, public health, food production, water availability, and so forth, the stakes are particularly high. Therefore, using the systems idea to inform processes of engagement to enhance systems thinking will be particularly useful in terms of raising awareness of the relevance of multiple values, boundaries, interconnections and both actual and potential feedback effects (Hodgson, 2011). Indeed, the literature on systems thinking for sustainability is large and rapidly growing (e.g., Clayton & Radcliffe, 1996; Espinosa & Walker, 2017; Higgins, 2015; Ison, 2010; Ison & Straw, 2020; Meadows et al., 2004; Nguyen et al., 2012).

The vision of systems thinking we have presented here will arguably add value in the context of systemic innovation for sustainability as much as, if not more than, others that are already being well used in this domain (e.g., Meadows et al., 2004). This is because we know that there are systemic barriers to change (e.g., Kang & Hwang, 2016), with vested interests reinforcing these, so understanding power relations, conflict, marginalization and how to respond to these is highly pertinent (e.g., Ison, 2010; Midgley, 1994; Ulrich, 1993).

6.4 | Rethinking collaboration in innovation networks and ecosystems

This fourth kind of systemic innovation can clearly be enhanced by augmenting the activities in innovation networks and ecosystems with a praxis of systems thinking and action. Of all the four understandings of systemic innovation prior to the one that is explicit about the use of systems thinking, the focus on collaboration in innovation networks and ecosystems is in some ways the ripest for further development. This is because the first three all tend to use the word 'systemic' in the context of discussing real-world systems (whether product-orientated innovation systems, policy-making systems or natural-world ecosystems), whereas a *process* view begins to inform the fourth understanding of systemic innovation: there is an emphasis on innovation processes, including how to design them and deal with the human dynamics involved in them.

It is notable that, in the literature on systems thinking, the paradigm shift from thinking about systems as given to us in reality to the systems idea being a way of thinking about the world, coincided with another shift: from a focus on *systems as structures* (with any consideration of process being limited to explanations of how the structures evolved) to the development of *systemic methodologies as modelling, dialogue and decision-making processes*. The latter shift is commonly attributed to Checkland (1981), although he would be the first to acknowledge the influence on him of prior work by Vickers (1965, 1968) and Churchman (1970, 1979), and the two shifts together are highly complementary because methodologies that give process guidelines for innovating systemically ask people to use systems concepts to help

them rethink the boundaries, interrelationships and emergent properties that matter to innovation. Given that the kind of systemic innovation that focuses on collaboration in networks and ecosystems is already examining methodological processes, enhancing them with the explicit use of the systems idea to increase people's critical capabilities (and hence the number of possible pathways for innovation) makes good sense.

If we are right about the complementarity between systemic innovation focused on collaboration processes in networks and ecosystems and the use of systems-methodological processes, then the potential for research and development in this area could be very significant. This is because the focus on collaboration processes in networks and ecosystems is one of the most rapidly expanding areas of the wider innovation literature.

Mention of this wider literature takes us on to the final claim of this paper: that a focus on systemic innovation, incorporating systems thinking, could enhance many of the most recent ideas in innovation studies, even if the prefix 'systemic' is not currently used in them.

7 | SYSTEMIC INNOVATION AS AN IMPORTANT FOCUS IN THE INNOVATION STUDIES FIELD

We believe that the vision of systemic innovation presented in this paper has the potential to add significant value to recent developments in the wider field of innovation. There are trends indicating that the future of innovation is systemic; e.g., in service innovation, sustainability innovation, business model innovation, platform development and ecosystem design. For instance, a 'business model' is a system-level concept (Zott et al., 2011) providing a "systemic and holistic understanding of how an organization orchestrates its system of activities for value creation" (Massa & Tucci, 2014, p. 9). Business modelling involves innovation processes and practices where the emergent seeds of new or modified business systems are conceived, designed and experimented with through creative inquiry amongst participants. When growth from these emergent seeds can be modelled by involved and affected stakeholders, new or modified business opportunities can be institutionalized in praxis. Thus, business modelling has strong resonances with systemic innovation understood as collaboration within networks and ecosystems, which we have already argued is ripe for enhancement through systems thinking.

There is also potential to enhance the paradigm of open innovation, which is already embracing the terminology of ecosystems (Chesbrough et al., 2014). "The future of open innovation is more extensive, more collaborative, and more engaged with a wider variety of participants" (Chesbrough, 2017, p. 29) than it might have seemed in the past. Our vision of systemic innovation has the potential to contribute to the further development of open innovation, expanding it into a broader paradigm, taking full advantage of its recent anchorage in the systems thinking field. Chesbrough acknowledges the need for this: "The question of boundary conditions for open innovation is one area where we need a lot more work" (Chesbrough, 2012, p. 25), and of course thinking in terms of boundaries is core to the view of systemic innovation that we have expounded. Likewise, Lusch and Vargo (2014, p. 149), in the context of service dominant logic, argue for a broad and long view of the enterprise: "Its boundaries are largely a function of its worldview or systems view and how it tries to develop this view among a network of actors as a shared view". Systems thinkers have been developing, using and validating philosophies, theories and methodologies for understanding and exploring boundaries in the context of practice for over fifty years (e.g., Barros-Castro et al., 2015; Boyd et al., 2004; Churchman, 1970; Foote et al., 2007; Helfgott, 2018; Midgley, 1992b, 2000; Midgley et al., 1998, 2007; Midgley & Pinzón, 2011, 2013; Midgley & Shen, 2007; Nicholas et al., 2019; Shen & Midgley, 2007, 2015; Ufua et al., 2018; Ulrich, 1983, 1987; Velez-Castiblanco et al., 2016), and there is a rich heritage here to draw upon.

By incorporating systems methodologies (for instance, as represented in Midgley, 2003a; Kijima et al., 2021; and Cabrera et al., 2022a), requisite systems thinking skills and competences (e.g., Cabrera et al., 2015; Ulrich, 2001) and the development of 'systems intelligence' (e.g., Hämäläinen & Saarinen, 2007; Jones & Corner, 2012), systemic innovation could better support the negotiation of collaborative advantage, mutualism and synergistic innovation: e.g., see Atun (2012) on health system innovation, Kapsali (2012) on innovation project management and Ng (2018) on service innovation.

Systems thinking embedded in systemic praxis allows diverse values, perspectives and worldviews to be creatively expressed, compared and evolved through dialogue. As tensions and conflicts are inevitable, systemic praxis strives to build a *generative* context (Midgley, 2016c), rather than one in which entrenched opposition and mutual stigmatization can take hold. A generative context is one in which respectful dialogue, enhanced by visual modelling techniques, can unfold so the participants can better reflect upon, critique and innovate both their thinking and their relationships in order to achieve synergistic value cocreation.

This is an important aspect of the ethics of innovation, which gives rise to possibilities for the emergence of common advantage and win-win solutions. Then accommodations and the integration of different value perspectives can be dialogically developed among actors in a non-coercive manner. Questions have been raised in the systems research community about whether accommodation can lead to the erasure of a necessary diversity of perspectives (e.g., Romm, 1996) or is inherently conservative because most accommodations take the wider political status quo as given (e.g., Fuenmayor, 1997). There are three answers to these questions. Checkland and Scholes (1990) argue that the degree to which accommodations accept or challenge the status quo is down to the participants. Second, Checkland and Poulter (2006) define accommodation as very different from consensus, because stakeholders do not have to agree on everything to find a mutually acceptable way forward, so a lot of diversity is preserved. Third, Midgley (1997a) makes the point that there can be no synergy without prior diversity, so it is in the interests of innovators and innovation facilitators to respect and even foster diversity at the same time as looking for emergent, collective opportunities.

Through the systemic modelling of both complex situations and options for addressing them, systemic awareness and the sharing of knowledge can be supported in order to open up new pathways for innovation. As discussed earlier in the paper, this needs to be done with an understanding that comprehensiveness is impossible, so justifications of inclusions and exclusions become important (Ulrich, 1994) in order to preserve the commitment of stakeholders. These justifications are also needed to validate and institutionalize the results in practice (Dewey, 1938), so broader stakeholder constituencies can appreciate who and what has been accounted for (or not) in the generation of an innovation. Thus, when embedded in systemic innovation processes, the exploration of purposes, values and boundaries involved in systemic intervention (Midgley, 2000), plus the justification of choices between boundaries (Ulrich, 1994), links innovation in local networks to broader societal debates on the legitimacy of technologies, business models, products, policies, etc.

8 | CONCLUSION AND FINAL REFLECTION

We have argued that we should understand systemic innovation as the use of processes that draw upon the systems idea to support innovators and their stakeholders in systems thinking. While this contrasts with the other four definitions that people have been using in recent years, it does not undermine our appreciation of the characteristics of technology-orientated innovation systems, the governance of innovation, innovation in the context of societal transitions or collaborative innovation processes in networks and ecosystems. On the contrary, it can enhance research and practice in all these areas by deepening our appreciation of the systems idea, and by providing concepts, methodologies and methods to support critical thinking and ethical responsibility. In this sense, we suggest that our approach to systemic innovation can help to integrate the field, providing a systems language and concepts to support the cross-fertilization and further development of the mostly separate agendas being pursued in association with all four of the other definitions of systemic innovation.

While this has been a largely theoretical paper, as we look towards practice we suggest that a minimum of three different approaches are needed in future research:

1. It is possible to mine the thousands of case studies of systems thinking employed in the service of organizational, social and environmental change that have been published without the 'innovation' keyword, with a view to drawing out further lessons for systemic innovation facilitators and researchers.
2. Given that this paper is the first peer-reviewed publication to bring the systemic intervention approach (and other systems thinking methodologies and methods that can be drawn upon when applying it) to the attention of those interested in systemic innovation, there is a need for others in the latter field to independently test the utility of these ideas in action research mode (see Bradbury, 2015, for a good collection of action research approaches). This will involve facilitating systemic innovation initiatives and assessing their impacts. For this purpose, the evaluation of methods will be essential (Midgley et al., 2013; White, 2006). Our expectation is that evaluations will reveal both further insights to enhance systemic innovation, and issues (such as barriers to using particular systems ideas and methods) that have to be addressed through new conceptual and methodological developments.
3. There is scope to augment the focus on boundaries that we have presented in this paper with more detailed considerations of the value to innovation practice of other systems concepts. For instance, Cabrera et al. (2008, 2015, 2022b) and Cabrera and Cabrera (2015) talk about *four systems thinking skills*: thinking in terms of boundary distinctions (as described in this paper), part-whole systems (with organized relationships between the parts, giving rise to the whole), relationships (especially complex causality and feedback) and perspectives (how the system

appears to different people, depending on their purposes and framings) (also see Lindhult & Midgley, 2014). Again, the utility of this set of concepts can be tested in action research in real innovation contexts.

While systems thinkers generally pride themselves on the development of generic concepts, theories, methodologies and methods that are transportable across application domains (see Midgley, 2003a, for many examples), our experience is that adaptations are usually necessary, and the types of context that systemic innovation facilitators and researchers work in are exceptionally diverse, covering all sectors of society and their interactions. We therefore look forward to the further evolution of these ideas as they extend into systemic innovation theory and practice.

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