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Multi-stakeholder structured dialogues: Five generations of evolution of dialogic design

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Abstract
The paper reviews the evolution of Interactive Management, later referred to as Structured Democratic Dialogue, starting from the early 1970s up to this date. The authors propose a generational classification scheme consisting of five periods based primarily on whether some or all stages of the process were implemented synchronously or asynchronously and whether the participants' presence was physical, virtual or hybrid. Other aspects such as modifications in the steps of the process; the evolution of the software; domains of applications; file management; methods of collecting or recording contributions, votes, clarifications and preparation of reports; and key players are also considered and reported within the context of the primary scheme. The paper considers key advances achieved at each generational stage in terms of process or software, discusses associated challenges and concludes with a view towards the future of the emerging fifth generation.

KEYWORDS
community operations research, interactive management, interpretive structural modelling, structured democratic dialogue, virtual deliberation

1 | INTRODUCTION

Structured Democratic Dialogue (SDD) is a participatory design methodology that seeks to bring together diverse stakeholders to collectively address complex socio-technical problems (Christakis & Bausch, 2006; Flanagan, 2020). SDD has been recently added to the repertoire of Community Operations Research (COR: Laouris & Michaelides, 2018; Laouris & Romm, 2022a, 2022b) tools as a powerful Problem Structuring Method (PSM), especially appropriate for large-scale societal interventions. The method has been featured in the ONLIFE manifesto (Laouris, 2015) of the European Commission, the Reinventing Democracy project[1] (Laouris & Romm, 2022a, 2022b; Manifesto: Reinventing Democracy in the Digital Era, 2016), several large-scale reform interventions, including local authorities (Laouris & Michaelides, 2018), regional planning for developing the wine villages of Cyprus (Michaelides & Laouris, 2023), and promoting peace and reconciliation in the Middle East (Laouris, 2022a, 2022b). These recent developments have thus widened the breadth and scope of applications also within Operations Research (OR) practitioners and beyond. Because this methodology is not widely known within some systems science, especially in the OR

[1]Supported by the UN Democracy Fund

communities, a short review of its evolution and anticipated future might be helpful. The precursors of this method go back to the early 1970s when Warfield developed an Interpretive Structural Modelling algorithm (ISM, Warfield, 1974a, 1974b, 1974c, 1976, 1994) to explore how the different factors influencing an issue are interrelated. ISM considers *influence* relationships (in contrast to *causal*) between factors and relies on transitive logic[2] to reduce the number of inquiries necessary to explore all possible combinations. Warfield embedded this algorithm into a process named Interactive Management (IM, Warfield, 1999; Warfield & Cardenas, 1994). Over the years, researchers and practitioners continue to modify and refine the underlying scientific grounding and the process of implementing the method. The primary vision remains, however, to enable people from all walks of life to act as systems scientists and to harness their collective wisdom without needing them to understand all the complexities and jargon of systems science to address and resolve complex socio-technical challenges. This paper reviews the evolution of the critical characteristics of the methodology. The purpose is to pave the road for systems scientists to scale up the process enabling thousands to engage in meaningful deliberations. We are at a point where methods for accelerating positive, humanistic institutional and societal change are urgently needed to exit the path that leads humanity towards dark futures. The review does not focus on developments in the underlying scientific grounding or modifications of the ISM algorithm. The authors provide a helicopter view of how the different characteristics and aspects of the process and supporting software have evolved over the years and propose a scheme for classifying the evolutionary periods into five generations. The paper begins with a short review of the terms used to refer to these processes and the key stages and then considers the aspects of physical versus virtual presence of the participants and whether stages of the process are conducted synchronously or asynchronously. The classification also considers the evolution of the software; file management; methods of collecting or recording contributions, votes and clarifications; and reports' preparation. The key players and domains of applications in each generation are also documented. The paper concludes with a discussion of how the various aspects will need to evolve to enable considerable scaling up of the method.

[2]Transitive relations state that if object x bears a relation to object y and object y bears a relation to object z, then object x also bears a relation to object z (if (xRy and yRz), then xRz).

2 | A CONTINUOUS EVOLUTION BUT WITH CHANGING NAMES

A literature review reveals that authors have used different terms to refer to their applications. Warfield and his group named their process 'IM' (Warfield & Cardenas, 1994) in the early days. In the same year, Fitz and his group called it the 'Technology of Social Learning' (TSL, Fitz, 1974). Christakis and colleagues refer to the process under the name CogniScope or 'Structured Design Process' (SDP), or structured dialogic design (Christakis & Bausch, 2006; Flanagan & Christakis, 2010). Others have referred to their approach as the structured dialogic design process and then also as the SSD (both of which are practiced under the SDD label). The institute for the 21st century Agoras (a 501-c-3 entity incorporated in the State of California in the USA) secured a trademark patent for 'SDD' from the U.S. Patent and Trademarks Office. The intent behind this action was not to claim specific ownership of the process but rather to provide a canonical reference of the most extensively validated form of the practice (The CogniScope platform series: the authors' synchronous co-localised Generation 1 configuration – as acknowledged on page 15). Different software platforms developed by different teams have sought to distinguish themselves by using different working names for the core IM/ISM functionality, the most recent of which is Logosofia. This point is of little practical relevance, given that this paper focusses on the process's reconfiguration elements to accommodate asynchronous and virtual group use.

For consistency and simplicity, the authors will refer to all relevant applications using the IM/SDD notation in this paper. The distinct steps of a typical implementation (e.g. idea generation and idea clarification) are referred to as 'stages'.

3 | THE ESSENTIAL STAGES OF THE PROCESS

The IM/SDD methodology is typically used to address and resolve, by consensus, complex societal challenges utilising the collective wisdom of relevant (typically people from all walks of life) stakeholders. However, in early applications, especially technological ones, *experts* (i.e. in contrast to laypersons) would generate a list of factors they considered relevant to investigate in order to address a challenge, select those they considered more important and proceed to apply the ISM algorithm in order to explore how these factors are interrelated. Typically, establishing a consensus might not constitute a challenge in solving such kinds of problems because experts may

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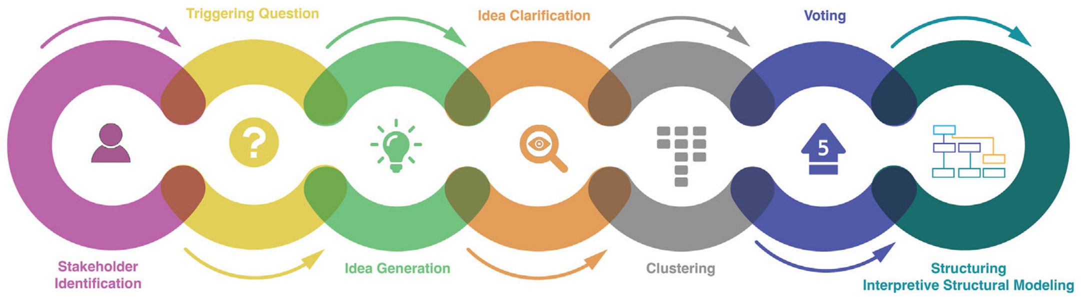

FIGURE 1 Stages of typical classic SDD. SDD, structured democratic dialogue. [Colour figure can be viewed at wileyonlinelibrary.com]

not have significant disagreements. The focus is on applying the ISM algorithm in order to identify those factors that have the greatest influence on specific aspects of the system. To the present day, quite a few applications, especially in the east (e.g. China; Hu et al., 2015; India: Hussain et al., 2016) and the middle east (e.g. Iran; Etemadinia & Tavakolan, 2021), use the ISM algorithm as a tool to conduct risk analysis. The algorithm is also used for technology assessment and forecasting (e.g. Christakis et al., 1980; Linstone et al., 1979). Such applications are not the focus of this review. On the contrary, the authors are interested in how the methodology has and will continue to support multi-stakeholders, with diverse and opposing positions, to address *collectively* contemporary convoluted, complex socio-technical challenges and *converge to a shared understanding and consensus* as to how to reform ill systems in which they are embedded. A typical contemporary socio-technical application begins with the identification of the most appropriate stakeholders (Figure 1, far left circle), ensuring requisite variety of perspectives, interests and opinions. Some IM/SDD practitioners (e.g. Christakis & Bausch, 2006; Flanagan & Christakis, 2010) call this the discovery phase.[3] The assumption is that they might have conflicting interests and diametrically opposite points of view and positions, but all share the wish to improve the problematic situation. Next, they frame the problem using a question (called TG, Triggering Question) capable of *triggering* the generation of factors that are relevant (Figure 1, second item from the left). In a situation where they wish to identify and address the most important inhibitors towards change, the factors are referred to as barriers or obstacles. If the purpose of their dialogue is to agree on a strategy and take the most effective set of actions to achieve the desired change, the factors might be called initiatives, actions, policies, reforms and others. When the purpose of the dialogue is to produce a collective, shared vision for an ideal future state of the system, the factors may be called characteristics. These are the three key archetypes of dialogues, but scientists have documented many more (see, for example, Diedrich & Christakis, 2021). In a typical application, the stakeholders are expected to respond to the TQ by offering their observations as single-sentenced, concise statements in a round-robin fashion (Figure 1, third item from the left). Practitioners have, however, occasionally collected these responses prior to the face-to-face event (e.g. via Email or Google docs) or combined this stage with the next, that is, the clarification stage (Figure 1, fourth item from the left). The important point is that observations are *authored* (i.e. they have a 'parent') and *numbered*. Their numbering makes it possible to depict their relations by coding them as columns and rows of binary square matrices (Warfield, 1974b). Researchers and practitioners interested in supporting stakeholders to develop shared understanding, build consensus, and generate momentum for change, however, have established that the structuring (i.e. the ISM) stage cannot be conducted without previously going through steps that aim to clarify and also deepen the meaning of every factor.[4] The latter requires that distinctions are made to facilitate the sharpening of understanding of what lies behind each factor. These requirements are fulfilled through the stages of clarification and clustering (Figure 1, fifth item from the left). After the clustering, the participants are requested to choose their top five preferences (Figure 1, sixth item from the left). Interestingly, only about half of the ideas generated receive votes, and only about a quarter of all ideas receive two or more votes. That is the reasoning behind the use of the term 'the talking point' by Flanagan and Christakis (2010), that is, the participants are ready to engage in a quality dialogue only *after* they clarify the ideas and especially after they explore how specific aspects of their ideas might make them similar to other ideas (the clustering process forces them to draw further distinctions). Thus, evolutionary learning begins

[3]Not to be confused with the use of the term 'discovery process', which refers to the process of exploring relations between factors during the ISM application.

[4]The SDD Law of Requisite Action states that the capacity of a community of stakeholders to implement a plan of action effectively depends strongly on the true engagement of the stakeholders in designing it. In other words, without going through all the stages of an SDD process the plans are bound to fail (laouris et al., 2008a).

even before conducting the ISM. The structure that is produced at the end of the mapping process (Figure 1, last item on the right), called an Influence Maps (IM), helps the participants identify those factors that are most influential. In the case where the factors constitute barriers, those at the root of the structure are the *root causes*. This was also the reason why Christakis (Christakis & Bausch, 2006) used the term 'root cause mapping' (RCM) to describe the domain of practice for the use of the methodology in the context of third-phase science (as opposed to the traditional root cause analysis, which is found solely on objectivity and facts (Christakis, 2006). When the factors are actions, then those at the root are referred to as *deep drivers*. The ISM process supports the participants to explore how one factor might influence another and utilises transient logic to reduce the number of pairs that need to be examined. One could theoretically explore many types of relations. Simpson and Simpson (2018, 2019a,b) developed an augmented model exchange isomorphism which details 27 logical property groups that may be associated with system structural modelling tasks and processes. Only nine of the twenty-seven groups have a transitive property, and out of these nine, only four were directly addressed by Warfield, whose primary focus was on one set only, that is, transitive, irreflexive and asymmetric relations, also called the partial order.

TABLE 1 Periods of ISM evolution according to Warfield (reprinted from Warfield, 1979).

1	**The early period: conceptions of component**	**1736–1858**
	1736 – Euler – graph theory.	
	1847 – Bloole – mathematical logic	
	1858 – Cayley – matrix	
2	**The period of mathematical development of components**	**1858–1930**
	1870 – Peirce	
	1910–1913 – Whitehead and Russell	
	1914 – Weiner	
	1930 – Kuratovski	
3	**Period of intuitive application**	**1930–1960**
	1934 – Black – feedback amplifier	
	1938 – Shannon – switching theory	
	1940's – Wiener – cybernetics	
	1950's – Ford and Fulkerson – flow problems	
	1951 – Mason – signal flow	
	1953 – Newell and Montrol – ferromagnetism	
	1957 – March and Simon – organisations	
	1958 – Churchman and Ackoff – preference analysis	
4	**The period of popularisation**	**1960–1975**
	1960's – Harary	
	1964 – Gore – administrative decision-making	
	1966 – Alexander – architecture	
	1967 – Harbunis and Stearns – sequential machines	
	1968 – 1973 – Warfield's ISM algorithm refined	
5	**The period of widespread application in many fields**	**1975-**

4 | THE EVOLUTION OF ALGORITHM(S)

The ISM algorithm lies at the core of the process. Although Warfield (1974a, 1974b, 1974c, 1976) is credited for its invention, he views his invention as a part of an evolutionary process. During the 1979 (unpublished) invited talk at the Canadian Operations Research Society annual meeting in Quebec, he conceptualised this evolution spanning five periods (Table 1, Warfield, 1979). He viewed the invention of graph theory, mathematical logic and matrices as essential components (18th and 19th century) and the development of their underlying math as the necessary condition for applications in diverse fields and domains to emerge. He credits Harary, Gore, Alexander, Harbunis and Stearns for developing ideas and algorithms that popularised ISM and served as precursors. In this talk, Warfield revealed that his work towards developing and refining the algorithm spanned 1968–1973 (bolded line added by the authors in period 4 in Table 1). Even though irrelevant to this table, Özbekhan (1969), an ethicist at the Wharton School of Pennsylvania University, must be credited for shaping the thinking for the ethical and social use of the ISM logic within the broader IM methodology.

Since its inception by Warfield, the ISM algorithm has seen many improvements and variations (Jena et al., 2017), which are beyond the scope of this review.

5 | THE EVOLUTION OF IM/SDD SOFTWARE

The implementation of the IM/SDD process requires the use of software which embeds the ISM algorithm. However, an equally important purpose of the software is to automate the entire process (i.e. not just the ISM stage) by offering friendly and usable interfaces to both the IM/SDD assistants operating it and, more importantly, the participants. Usability in connection with real-time documentation reduces cognitive overload for the participants, thus allowing them to focus entirely on the content of their discussions. Figure 2 documents software applications in a timeline. The first applications were developed in FORTRAN by David Malone under Warfield's (1989) supervision. Between 1974 and 1987, many versions of ISM were created in collaboration with

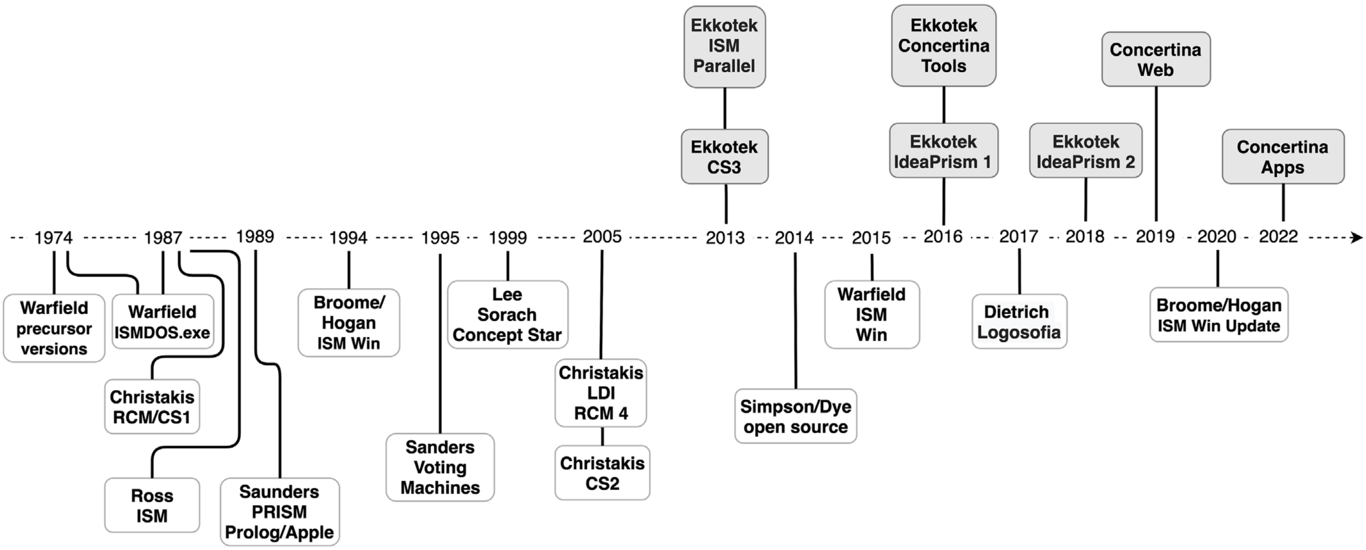

FIGURE 2 Timeline and release years of IM/SDD software solutions. Applications depicted above the timeline are those developed by the authors' group. SDD, structured democratic dialogue.

his colleagues (i.e. mainly Christakis and Broome), and also at different centres (Warfield, 1995; see also Warfield, 1989). Many of Warfield's associates who had access to the code made modifications or developed different versions, which, however, did not offer something fundamentally different. Saunders developed an Apple version in PROLOG. Ross used two computers to expand the memory capabilities. Christakis developed Cogni-Scope in LINGO (scripting language within Macromedia Director) to offer quite friendly interfaces and reports. The first, fully functional, DOS-based ISM software was completed at George Mason University in 1987. Christakis developed an early DOS-based RCM (1987) and later CogniScope v.1 and v.2 (2005). Broome and Hogan developed the first windows-based software (1994), which was updated in 2020. Lee and her Canadian company Sorach developed windows-based Concept Star in 1999. The authors' group has developed most contemporary applications (depicted above the timeline in Figure 2), including CogniScope v.3[5] (2013), ISM Parallel™ (2013, the first App to allow asynchronous ISM), mobile Apps such as IdeaPrism™ (2016) and web-based Concertina (2019). Simpson and the 2nd author developed the first open-source version in 2014 using java. Dietrich developed web-based Logosofia[6] in 2017. This summary might have missed a few. Several high-profile organisations have developed ad hoc ISM-based systems to solve problems they were facing, for example, Battelle Memorial Institute, University of Dayton, IBM, Hitachi, Fujitsu, Nippon, University of Hokkaido, University of Northern Iowa, University of Virginia, Saudi Arabia Government, Naval Surface Weapons Center, ITESM Mexico, City University London, GeneSys, Northern Telecom and Ford. It should also be noted that the ISM is built in several mathematical libraries, including Matlab.

6 | HYBRID APPLICATIONS

The digital era has made it possible for selected (or even all) stages of an IM/SDD application to be conducted virtually without physical presence. It also allowed specific tasks to be undertaken asynchronously, that is, each participant contributing individually towards a particular task at a different time between sessions. As we dive into the discussion of how these two aspects have been applied to the generational classification, it is helpful to clarify the terminology. We distinguish among *physical* versus *virtual presence*, *synchronous* versus *asynchronous* modes of participation, and *classic* versus *hybrid* approaches. The term hybrid, however, denotes variations in physical/virtual presence and synchronous/asynchronous processes or combinations thereof. The many combinations in conducting an IM/SDD process physically/virtually or synchronously/asynchronously make classifying applications in distinct generations based on these aspects challenging. Almost invariably,

[5]Christakis donated the code to Ekkotek Ltd. who committed to updating to v.3 complying with about 30 new requirements imposed by the Agoras community during a planetary SDD in 2010. See: https://www.futureworlds.eu/wiki/Cogniscope_Software

[6]Available at http://logosofia.decisionpoint.design

TABLE 2 Time–space matrix (adapted from Johansen, 1988).

	Same time	Different time	Combination same/different time
Same place	Face-to-face	Asynchronous interactions using text or video	Combination of synchronous and asynchronous interactions
Different place	Synchronous interactions using tele/video conferencing with participants in distributed locations	Asynchronous interactions with participants in distributed locations	Combination of synchronous and asynchronous interactions in distributed locations
Combination same/ different place	Synchronous interactions using tele/video conferencing with participants in same or distributed locations	Asynchronous interactions with participants in same or distributed locations	Combination of synchronous and asynchronous interactions with participants in same or distributed locations

asynchronous implies also virtual. The interesting question, however, is which stages of the process had been implemented asynchronously (and typically also virtually) and which virtually (typically, but not always, synchronously).

For the purposes of our classification, we have borrowed approaches from the field of computer-supported cooperative work (CSCW), a term coined in the 1980s (Greif, 1988) to describe processes of people utilising technology collaboratively. Because our main interest is whether participants are physically versus virtually present and whether stages of the process are conducted synchronously *or* asynchronously, we grounded our scheme on Johansen's (1988) time–space matrix modified by adding a third column and row to denote the cases where the time or the place condition is combined. Table 2 depicts the different cases.

Our classification scheme is furthermore informed by Penichet et al.'s (2007) proposal of adding other aspects as secondary parameters. In our case, however, these secondary parameters include methodological and software improvements, managing data and files, methods of display, methods of recording clarifications, and methods of reporting.

In our notation, we use 'AND' to emphasise that a certain deviation *extends* the classic model without modifying it. Alternatively, when a process is conducted in a way that deviates from the classic, we use the term BUT. Table 3 documents 14 cases of IM/SDD applications. In line with this notation, a typical standard-form IM/SDD process is then denoted Case 0, that is, all stages are implemented with the physical presence of all. In some early applications described in the next section, one or a few participants may have joined virtually, with all others being in a physical face-to-face meeting (see below for the example from dialogues in Mexico and Spain). We denote this as Case 1 in Table 3, that is, the physical presence of virtually everyone in all stages AND the virtual presence of a few in all stages. Other deviations from Case 0, which have been extensively applied in previous years, involve (a) the case of a standard, physical, face-to-face implementation, in which, however, a subgroup is assigned to complete an unfinished clustering (Case 2) or (b) conducting the whole clustering on behalf of the entire group (Case 3: e.g., Laouris et al., 2008b, p., 24; Laouris & Romm, 2022a, p., 1075). Also, it is usual that the group structures, for example, all factors with three or more votes, but time constraints do not allow them to consider factors with fewer votes. This relatively common situation is unpleasant because it might heighten the erroneous priorities effect (first observed by Kapelouzos, 1989; term coined by Dye, 1999; see also Dye & Conaway, 1999). A common remedy involves asking the participants to leave their chairs, grasp their printed ideas[7] displayed on the walls and propose (to their peers) a place within the MAP (also displayed on the wall). An alternative remedy involves assigning a subgroup to continue the structuring stage, adding additional factors (selected by the whole group) to the MAP (Case 4).

Next, we consider deviations that involve conducting specific tasks *asynchronously*. A variation, which is also extensively applied, involves pre-collecting ideas asynchronously via email (e.g. Laouris et al., 2008b) or submitting through a Wiki; (e.g. Laouris et al., 2010) or participants submitting their preference votes by email (e.g. Laouris & Michaelides, 2007, p., 283; Laouris et al., 2017, p. 249) between the clustering and the structuring sessions, both conducted physically and face-to-face (i.e. Case 5).

[7]The criterion for choosing which ideas is agreed ahead. The group could decide to allow anyone who wishes to grasp her idea, provided it received two or more votes, or they choose, as a group, additional ideas, or they choose ideas from clusters that have not been represented so far.

TABLE 3 Classic form IM/SDD and cases of deviations.

Case	Description
0	Physical presence of all in all stages
1	Same as 0 AND virtual presence of one or few
2	Same as 0 or 1 BUT subgroup completes unfinished clustering in a synchronous physical meeting
3	Same as 0 or 1 BUT sub-group conducts the entire clustering in a separate synchronous physical meeting
4	Same as 0, or 1, or 2, or 3, BUT subgroup extends structuring in a separate synchronous physical meeting
5	Same as cases 0–4 BUT virtual/asynchronous [pre-collecting of ideas AND/OR submission of preference votes]
6	Same as 0–5 BUT each or some participants complete the clustering individually asynchronously and their products clusters are merged into one
7	Same as 0–5, or 6 BUT each or some participants extend the structuring individually asynchronously and their products are merged into an overall map (using one or more iterations)
8	Virtual (teleconference or video conference) *synchronous* presence of all in all stages
9	Same as 8 BUT virtual/asynchronous [pre-collection of ideas AND/OR submission of detailed clarifications AND/OR submission of preference votes]
10	Same as 8 or 9 BUT clustering AND/OR structuring extended AND/OR conducted entirely by a subgroup AND/OR using multi-scoring
11	Same as 8 or 9, or 10 BUT clustering AND/OR structuring conducted individually asynchronously (scaled-up situation)
12	Virtual *synchronous* presence of all in all stages in immersive reality
13	Same as 12 BUT non-sensitive tasks [pre-collecting ideas AND/OR submitting detailed clarifications AND/OR submitting preference votes] conducted asynchronously
14	Same as 12 or 13 BUT also clustering and structuring conducted individually asynchronously (scaled-up situation)

In our notation, we consider these two stages 'sensitive' because they demand significantly higher levels of concentration, focus and interactions between the participants, rendering them immensely challenging in a virtual mode. To summarise, deviations 2–4 are those where all participants are present physically in all stages, except that a subgroup is assigned to complete (Case 2) or conduct the whole clustering (Case 3), or extend the structuring (Case 4), whereas deviation 5 refers to situations where ideas are pre-collected virtually/asynchronous, or preference votes are submitted by individuals asynchronously. Deviations 6 and 7 refer to the cases where all or some participants complete the clustering (Case 6) or extend the structuring (Case 7) individually asynchronously, and their individual products are merged into one (e.g. examples reported in Laouris, 2022a, 2022b).

Case 8 is when the whole process is conducted entirely virtually AND synchronously using teleconferencing or video conferencing. Cases 9 and 10 are deviations of Case 8 with ideas pre-collected asynchronous AND/OR preference votes submitted asynchronously (Case 9), or clustering or structuring is extended AND/OR conducted entirely by a subgroup, AND/OR using multi scoring to improve road maps (Case 10). Case 11 marks a situation where the process can be scaled up to engage large numbers of participants (Laouris et al., 2014, p. 179; Laouris & Romm, 2022a, 2022b, p. 1084) by conducting the clustering AND structuring individually and asynchronously. Finally, Cases 12 to 14 are equivalent to those above, but instead of teleconferencing /video conferencing, the process takes place in immersive reality environments such as SecondLife™ or the emerging Metaverse.

Figure 3 highlights the key stages of modifications. Starting from the bottom, the first modifications are when idea statements are pre-collected, clarifications or votes submitted by email, or even when the clustering or structuring is being amended or completed by a subgroup. The next level is when the process is conducted virtually (with or without the previous 'asynchronous' modifications). The following level concerns

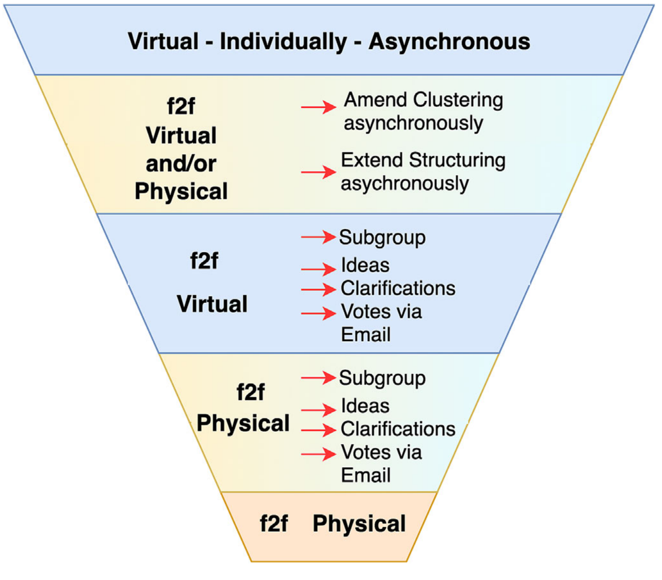

FIGURE 3 Graphical representation of key modifications. [Colour figure can be viewed at wileyonlinelibrary.com]

modifications of the 'sensitive stages', that is, clustering and/or structuring being amended, extended or entirely conducted individually, asynchronously. The final modification represents scaled-up applications in which all processes are conducted asynchronously.

Now that we have highlighted distinctions in the various modifications, we proceed with applying the classification scheme.

7 | DEVELOPMENT OF THE GENERATIONAL CLASSIFICATION SCHEME

The physical face-to-face presence of all participants has been considered a strict requirement for the IM/SDD since its inception. Face-to-face applications conducted in strict compliance with Warfield's IM process and using Warfield's ISM software are classified as Generation I (see Table 4). We propose distinguishing early applications using experimental algorithms or precursors of Warfield's ISM software or conducted mostly in Lab environments (i.e. GIa: Fitz, 1974; Fitz & Troha, 1977; Sage, 1977; Warfield, 1973a, 1973b, 1973c, 1973d) from later worldwide applications conducted until the early 2000s (i.e. Broome, 1997, 1998, 2002, 2004; GIb: Warfield, 1977). Christakis and his Global Agoras colleagues have developed a more comprehensive methodology which formalised the inclusion of the stages prior to applying ISM. Their approach was grounded on four (later increased to seven; see Christakis & Bausch, 2006) axioms and six (later increased to seven; see Laouris et al., 2008a) systems science laws. New software, named RCM and later CogniScope, is an integral part of the new methodology. Although in several occasions, the methodology is also referred to as 'the CogniScope method' (Christakis & Dye, 2008; Magliocca & Christakis, 2001), they mostly used the terms structured design process, structured dialogic design process and later SDD. They also refer to the entire application as a co-laboratory of democracy (Christakis & Bausch, 2006; Christakis & Underwood, 2008; Flanagan, 2006; Hays & Michaelides, 2004; Laouris et al., 2014). This upgraded model has been used in hundreds of applications organised by centres across the globe, including the Institute for 21st Century Agoras (2003 until today), the Future Worlds Center (2005 until today) and the Cyprus Academy of Public Administration (2009 until today). The authors consider the emergence of this new model as the milestone signalling the beginning of Generation II. We propose classifying early applications by Christakis, Bausch, Flanagan, Harris, Author2, and others using the CogniScope v.1 or v.2 software, conducted face-to-face, and in strict compliance with the SDD process as published by members of this group (Christakis et al., 1999; Christakis & Dye, 2008; Dye & Conway, 1999) as GIIa. Applications led by Author1, Christakis, Author2, and more recently Diedrich, using CogniScope v.2, but mostly v.3, and/or web tools such as Concertina Web™ and Logosofia™, or asynchronous mobile Apps such IdeaPrism™, are classified within GIIb. During this same period, researchers and practitioners have experimented with voting machines, virtual walls, and adding an additional stage after the structuring in which the participants are requested to score the ideas that made it into the Influence Map (IMap) for impact, feasibility, probability of happening without intervention and others. Although the ISM produces a structure (i.e. the IMap) that reveals which factors have the greatest influence, it does not provide any information regarding, for example, their feasibility or the probability that these will be addressed without intentional intervention. The authors have introduced a multi-parameter evaluation of the factors that made it to the IMap to produce better roadmaps. For example, a factor that made it to the root of the IMap has a high impact but very low feasibility might not be chosen for immediate intervention. Alternatively, a factor that has a high impact and is feasible, but has a low probability of happening without intentional intervention, should be given priority. Multi-scoring can also be conducted by experts who did not participate in the dialogue to adapt the IMap to the reality of the specific situation (e.g. the Future Poland project[17]). Organisers and participants of an IM/SDD often face the challenge of 'selling' the results to decision-makers or experts who were not part of the process. Allowing them to evaluate the factors for impact, feasibility and probability of happening without intentional intervention allows them to engage in the process and also to add their own considerations as to how to use the results for developing a strategy and a roadmap.

Cliff Sanders (personal communication with 2nd author, 1995) and Jeff Dietrich (personal communication with 2nd author, 2020) used physical voting machines during the clustering and structuring stages.

Our group used IdeaPrism™ to enable participants to submit their ideas, clarifications and/or preferences or other votes (vide infra) asynchronously. IdeaPrism™ is a mobile App that allows participants to record a short video clip clarification, either individually, asynchronously or (when used in a physical setting) in real time while they pitch for their idea in front of the other participants (see Figure 7 for an example from the Reinventing Democracy project). Even though IdeaPrism™ also offers the option for users to vote in real time during the clustering stage, this feature has not yet been extensively

TABLE 4 Classification scheme: five generations of evolution from interactive management to structured democratic dialogue.

G	Name(s)	Years deployed	Case(s)	Software	Key contributors
Ia	Technology of social learning Interactive management	1970–1974	Case 0: Experimental algorithms or precursors of Warfield's ISM software running under DOS Mostly in lab environments	Experimental algorithms ISM DOS (Warfield)	J Warfield RW Fitz H Özbekhan
Ib	Interactive management	1974–1990s 1995–1999	Case 0: Strict compliance with IM process Process spread in up to 9 months	ISM (by Warfield)	J Warfield Many B Broome Cyprus
IIa	Dialogic design process Structured dialogic design	1987–2005	Case 0: Strict compliance with SDD process	Cogni system Root cause mapping CS v.1 CS v.2	A Christakis K Bausch LD Harris KMC Author2 TR Flanagan
IIb	Structured democratic dialogue (including hybrid)	2005 until today 1995 2016 2017 until today	Cases 0–5: Mostly f2f; some hybrid Early voting machines (Cliff Sanders) Projected data on walls (reinvent democracy) Multi scoring ideas on MAP: For impact, feasibility, and probability of happening without intervention	CS v.2 CS v.3 IdeaPrism Concertina web Logosofia	Author1 A Christakis Author2 J Diedrich
IIIa	Mostly virtual mostly synchronous SDD	2006–2008	Cases 8–10: Early planetary dialogues. All stages conducted synchronously using teleconferencing All stages conducted synchronously using voice. Wikis to collect and documents and discuss Process distributed in shorter sessions using time between session to extend clarifications, collect votes	CS v.3	A Christakis G. Underwood Author1
IIIb	Virtual synchronous SDD	2019 until today	Cases 8–10: All stages conducted synchronously using video conferencing Process distributed in shorter sessions using time between sessions to improve clarifications and collect preference votes and multi-parameter scores. Google docs host ideas/clarification, discussions, results of stages including votes, and relevant documents. Multi scoring Modern and/or virtual voting machines	IdeaPrism Concertina web Concertina tools	Author1
IVa	Virtual hybrid a/synchronous SDD	2013	Case 11: Early experiments extending mapping individually asynchronously	IdeaPrism ISM parallel	Author1
IVb		2021 until today	Case 11: Using tools enabling individual asynchronous clustering AND/OR structuring	Experimental new software	Author1

(Continues)

TABLE 4 (Continued)

G	Name(s)	Years deployed	Case(s)	Software	Key contributors
Va	Immersive reality	2009	Cases 12, 13: Early experiments in SecondLife	CogniScope v.2	Author1 G. Underwood Author2
Vb		2023 until the future	Cases 12–14: Anticipated experiments in Metaverse All process, including pre and post SDD processes as well as documentation and reporting, take place inside the virtual world	Metaverse environments	TBN

used. However, the option of scoring ideas for different properties (e.g. likelihood, impact, feasibility and probability of happening without intervention) has been used extensively to produce better roadmaps.[8]

The technology that made the first virtual synchronous process possible was teleconferencing and later video conferencing. We distinguish between early applications that were using only voice (i.e. GIIIa) from those using modern synchronous video conferencing (GIIIb). In both cases, the process was distributed in shorter sessions using the time between sessions to extend clarifications, collect votes, and Wikis, or later Google docs was used to share documents and engage participants in one-to-one or one-to-many discussions. Multi-scoring of ideas has become a new standard in and after GIIIb.

The distinctive characteristic of the fourth generation is when also the sensitive stages (i.e. Clustering AND/OR Structuring) are conducted individually asynchronously. Similarly, as above, we propose distinguishing early experiments (GIVa), which were conducted using the same software as for the classic applications, from later experiments for which specialised software for individual use has been developed (GIVb; Concertina Tools for Parallel Clustering or Mapping). Finally, the emergence of the fifth generation is characterised by the advent of immersive reality environments such as SecondLife™ and more recently the emerging Metaverse. Again, we propose the distinction between early experiments (i.e. GVa) and the anticipated developments in the Metaverse (i.e. GVb).

The cases corresponding to each generation are shown in the fourth column la of Table 4. The last two columns of the table document the key actors and the predominant technologies. Figure 4 depicts the generations along a timeline. The key actors and the predominant technologies used are also included in the diagram.

[8]Note yet published in peer-reviewed articles but available for download as project reports. CARDIAC: https://futureworlds.eu/wiki/CARDIAC; MARINA: https://futureworlds.eu/wiki/MARINA

8 | SYNCHRONOUS VERSUS ASYNCHRONOUS PROCESSES

As mentioned above, the digital era allows specific tasks to be conducted asynchronously. That is, each participant contributing individually or a smaller group convening at a different time to complete a specific task between sessions. For example, around 2005, practitioners started experimenting with pre-collecting ideas via email (e.g. Laouris et al., 2017, p. 249) or collecting votes by email (Laouris, 2022a, 2022b, p. 5) in-between sessions. The corresponding applications were referred to as *hybrid*. It should, however, be noted that the term hybrid is often used to denote both variations in physical presence and also synchronicity. The collection of ideas before a face-to-face event has typically been used as a tool for preparing participants rather than as a replacement for the idea generation stage. Thus, this asynchronous stage, like collecting votes via email, does not challenge compliance with the IM/SDD methodology. In more recent years, practitioners have assigned the completion of the clustering or the mapping stage to a smaller group. In both situations, the whole group conducted about half or more of the clustering or mapping stage. It has been argued that after the participants cluster about half of the ideas or structure about 10–12 ideas, they begin to offer more specific pro-Yes or pro-No arguments based on what has already been discussed before (see discussion in Laouris, 2022a, 2022b). The authors have hypothesised that participants gradually develop a 'shared mental model', which subconsciously helps them make decisions that are almost predictable. Thus, even a subgroup can complete

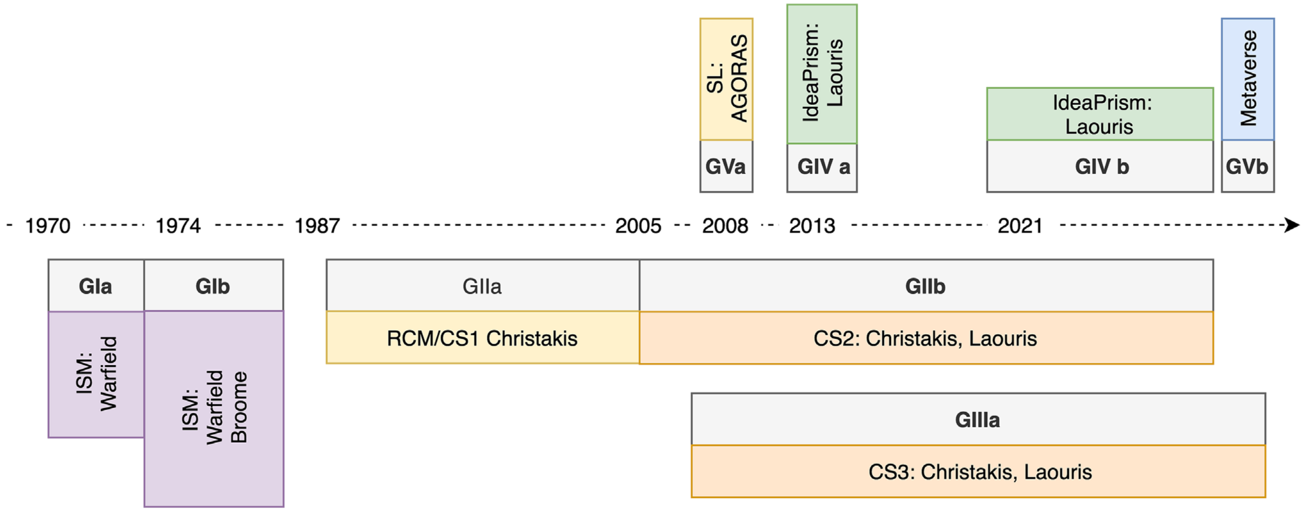

FIGURE 4 Timeline of generations: key actors and software. [Colour figure can be viewed at wileyonlinelibrary.com]

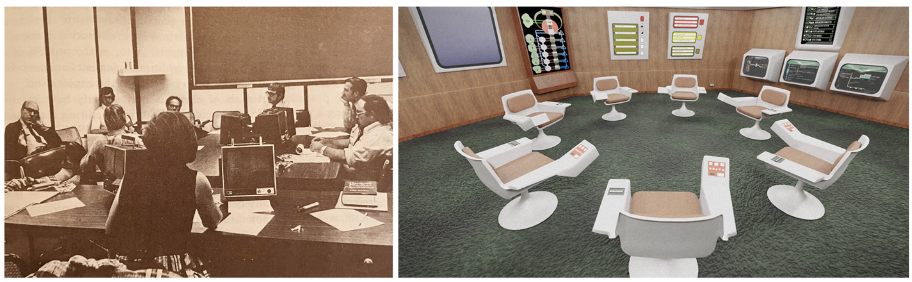

FIGURE 5 (left) Virtual participation of experts during the Battelle Memorial in 1973. From Warfield (1976). (right) A 3D render of the Operations Room of the Cybersyn Project in Chile (1971 to 1973). [Colour figure can be viewed at wileyonlinelibrary.com]

these stages in a way that all participants recognise as their own.

9 | EARLY EXAMPLES USING TELECONFERENCING AND VIDEO CONFERENCING

As soon as teleconferencing and video communication technologies allowed remote participation, practitioners began experimenting with that. For example, in some historic experiments during the First Interloquium event in the State of Guanajuato in Mexico in 1994, the organisers placed monitors around a table to depict participants located at different geographic locations (personal communication with Carlos Flores Alcocer). In a more recent occasion, in 2011, the organisers of an SDD implemented in the context of CARDIAC, a European Commission project,[9] have 'seated' an American expert participating on a virtual screen to allow him to participate on equal footing with all others. The oldest known case, shown in Figure 5 (left), was reported by Warfield (1976).

Relevant is also the Cybersyn Project[10] during the presidency of Salvador Allende in Chile, which aimed to aid in the management of the national economy (Figure 5, right). Project Cybersyn was based on viable system model theory approach (Beer, 1984) to organisational design and adhered to Gestalt principles to give users a platform that would enable them to absorb information in a simple but comprehensive way. These experiments have revealed that though it is possible to organise IM/SDD processes in more or less the same way, with participants located at different geographic places, their virtual presence introduces extraneous cognitive load to those physically present and violates some of the requirements of the process (for a critical review, see Laouris & Michaelides, 2007). In the CARDIAC case, the participants reported that on many occasions, the remote participant was given more time and attention. Another challenge was related to interruptions in connectivity and associated delays. Practitioners have successfully

[9]'CARDIAC - Advancing Research and Development in the area of accessible and assistive ICT', 2010–2013, was an FP7 project funded by the EC; Contract 248582; https://www.futureworlds.eu/wiki/CARDIAC

[10]https://en.wikipedia.org/wiki/Project_Cybersyn

implemented dialogues with participants distributed across the globe, referred to as 'planetary dialogues', as early as 2006. The 'rescuing the enlightenment' dialogue in 2006,[11] sponsored by the Flinders International Asia Pacific Institute, engaged nine students (enrolled in 'Democracy and The Enlightenment' course; based in Adelaide, Australia), two experts based in Cincinnati, Ohio, and Fayetteville, Georgia, and one reporter/observer based in Washington, DC in responding to triggering question, 'What factors will help significantly in rescuing the enlightenment from its failings?' The remote participants were able to view the same CogniScope screen as those present in the room in Adelaide using Claripoint™, a special software that allows broadcasting of a computer screen through the internet. Their virtual presence in the room was made possible using traditional telephone conferencing. The 11 participants generated 49 ideas, which they uploaded in a wiki. Over the first 6 days, they engaged in one-to-one and one-to-many email conversations to clarify those ideas. A smaller group consisting of the KMT clustered them in nine groups and participants submitted the votes via email. On the seventh day, the whole group engaged in a synchronous focussed and open dialogue supported by Claripoint™. After about 3 h, the participants structured nine factors into four levels. The Spreadthink of their dialogue was 45%, which is on the high end considering that the participants were basically students of the same class, thus sharing the same thinking. A year later, in 2007, the Philanthropolis project[12] engaged 22 senior experts located in Cyprus, Greece, France, Japan, USA, and Venezuela in a planetary dialogue dedicated to the memory of the great systems thinker Hasan Özbekhan. In response to 'What are descriptors/requirements of the ideal image of the Agora of Philanthropolis?' the participants generated 59 ideas. The clarification, clustering and voting stages were conducted in the same way as the 'rescuing the enlightenment', that is, via email. This co-laboratory was envisioned as the first of three. The purpose of Co-laboratory I was the visualisation by the group of the ideal image of the Agora of Philanthropolis. The purpose of Co-laboratory II was to describe the wall of inhibitors that prevents the planetary community of stakeholders from attaining the ideal image. Finally, the purpose of Co-laboratory III was to design an action plan for penetrating the wall of inhibitors and transforming the current planetary situation in the direction of the ideal image over a long-time horizon. Unfortunately, the other two were never implemented. The participants clustered the descriptors in 14 groups. The voting resulted in 38 descriptors receiving one or more votes, thus resulting to a 61% Spreadthink, again on the high end. They structured 14 into an Influence Map, with 8 being in a single cycle (pointing to a higher situational complexity).

During the Obama Vision project,[13] which took place in 2008, two new approaches were introduced. First, not only the structuring but also all other stages (i.e. Idea generation, clarification and clustering) were conducted *virtually but synchronously*. Second, the SDD facilitation team used multi-channel communication to provide one-to-one support. The participants were requesting the floor to speak or later submitting their votes by sending a message to one of the assistant facilitators (person sitting on the right in Figure 6), who was informing the main assistant facilitator (sitting in the centre in Figure 6), who was, in turn, announcing the message for the main facilitator to take action. The third assistant facilitator was operating the CogniScope software, following the lead of the main facilitator. Although this setup required a team of four, the process did not suffer from as much extraneous cognitive overload as the previous two. An international panel of 15 experts from 9 countries, members of the institute for 21st Century Agoras, had three ∼2-h long teleconferencing sessions spread over a week. They generated 59 inhibitors in response to 'In the context of Obama's vision for engaging stakeholders from all walks of life in a bottom-up democracy employing Internet technology, what factors do we anticipate, on the basis of our experiences with SDDP, will emerge as inhibitors to the actualization of his vision?' They clustered them in 13 categories, and following the voting process, 41 ideas received one or more votes, thus exhibiting a Spreadthink of 67% (i.e. just like the previous ones, on the high end). In a very similar application, 22 SDD practitioners (including assistant facilitators) from across the globe shared their requirements for upgrading the CogniScope 2 software to version 3.[14] In response to 'In anticipation of the evolution of the Internet and other interactive technology platforms (social networks and others), what should be the requirements for the next generation of Cogniscope/Webscope software (CSIII) for the enhanced and scaled-up practice of SDD', they submitted 88 requirements. Following the asynchronous voting, 39 requirements received one or more votes, thus exhibiting a Spreadthink of 41%.

[11] https://www.futureworlds.eu/wiki/Planetary_Dialogue_SDDP_on_Rescuing_the_Enlightment

[12] https://www.futureworlds.eu/wiki/Planetary_Dialogue_Agora_of_Philanthropolis

[13] https://www.futureworlds.eu/wiki/Planetary_Dialogue_SDDP_on_Obama%27s_Vision

[14] https://futureworlds.eu/wiki/SDDP_Design_of_the_next_generation_Cogniscope/Webscope#Contributors

FIGURE 6 Snapshot from the Obama Vision setup. [Colour figure can be viewed at wileyonlinelibrary.com]

The facilitators were located in Crete, Cyprus, and the USA for the above planetary dialogues. What all early 'planetary dialogues' had in common were (i) a relatively small number of participants, (ii) a number of ideas generated smaller than the typical average and (iii) relatively high Spreadthink. The researchers concluded that remote virtual participation poses challenges, and the quality of dialogue could be compromised, mainly because some of the stages were not conducted synchronously (thus depriving authentic real-time interactions between participants) and because of increased cognitive overload due to the requirement for more intensive focussing and noise in the background.

10 | CONTEMPORARY APPLICATIONS USING VIDEO CONFERENCING

With the advent of broadband internet and the wide availability of video conferencing platforms, and also imposed by travel constraints because of the COVID-19 pandemic, IM/SDD applications began to be conducted virtually without compromising quality. The authors conducted entirely virtual dialogues between 2021 and 2022 using the model in Table 5. This new model is referred to as virtual structured democratic dialogue (vSDD). Note that the typical stages of the process have been slightly modified. For example, the Idea Generation stage has been replaced with an offline process where participants submit their statements along with their clarifications as text and short video clips. Also, even before their first synchronous meeting, the participants are encouraged not only to submit their contributions but also to engage by viewing others' contributions and asking their respective authors for further clarifications. In IdeaPrism™, clarification questions use templates to encourage participants to be specific (Table 6, left column). The App also offers options such as (i) 'adopt' an idea, thus also becoming a parent with a 'stake' in the future of this idea, (ii) suggesting another person as a potential adopter or suggesting a missing stakeholder who could be invited to join the dialogue. IdeaPrism™ also offers the option to suggest that an idea is identical (thus proposing to merge or delete) or is included or includes another.

During their first synchronous (virtual meeting), the participants of contemporary applications like those described below *pitch* their contributions. Others are allowed to ask for clarifications, just like in the standard form implementation of the clarification stage. An offline process follows where participants are encouraged to engage in further interactions using IdeaPrism™ features and/or are requested to make their clarifications 'SMARTer', building upon the questions and discussions they had. During this step, the participants are encouraged to update their clarifications, including responses to the 'SMART' parameters.

TABLE 5 Schedule of IM/SDD stages depicting on- vs offline and assigned durations. Brackets indicate that time spent is optional.

Wk.	Stage	Description and duration of actions		
1	Project overview	ONLINE	Participants' introductions; presentation of project goal and process	1 h
2	Idea generation clarification	OFFLINE	Participants submit 2–3 responses to TQ: Single-sentence statements; 1 paragraph; 1 min video	30 m
		OFFLINE	Participants view video clarifications of others and possibly ask questions	(1–2 h)
		ONLINE	Synchronous event to share, discuss, and clarify all contributions	2 h
		OFFLINE	Participants edit and resubmit their contributions following SMART criteria	30 m
3	Clustering		Participants conduct pairwise comparisons between ideas	2 h
	Importance voting	OFFLINE	Participants choose and submit five ideas they consider the most important	20 m
4	Mapping	ONLINE	Pairwise exploration of the influence of one idea on another to gradually produce a tree of influences	2–3 h
		Hybrid	A subgroup may be assigned to structure more factors to the map in a synchronous virtual meeting, or participants are requested to continue the structuring individually, submitting their adjacency matrices for further processing by the organisers	(1 h)
5	Multi-scoring road Mapping	OFFLINE	Participants score ideas present in the tree for impact, feasibility, etc.	(1 h)
		OFFLINE	Participants use the data to develop their own action maps, roadmaps and other plans	(1–3 h)
		OFFLINE	Participants edit their individual contributions, as well as edit the various deliverables	[2–3 h]

TABLE 6 Templates for engaging in clarifications within IdeaPrism™.

Clarification questions	Other options	Proposing similarity
Request better clarification	Adopt this idea	Is identical to
Why do you think …	Suggest an adopter	Is included in
How do you think …	Suggest a stakeholder	Includes
What do you mean	Nominate for incompatibility	
Other		

Three virtual IM/SDDs adhering to the process described here are reported. The first two were organised in the context of a Gender Equality Plans European project, R-I-Peers.[15] They were scheduled as physical workshops in San Sebastian, Spain and Athens, Greece, but because of travel constraints due to the Covid-19 pandemic, they were implemented virtually using Zoom™. The third was organised in the context of MedBEESinessHubs,[16] a Cross-Border Cooperation initiative implemented by the European Union. In contrast to the early virtual IM/SDDs reported in the previous

[15]The 'Pilot experiences for improving gender equality in research organisations' (R-I-Peers) project was funded by the H2020 program of the European Commission. http://ripeers.eu/author/ripeerseu/ https://cordis.europa.eu/project/id/788171

[16]The Mediterranean Bee Hubs in support for sustainable economic prosperity in deprived rural areas (MedBEESuniessHubs) was funded by the ENI CBC 'Mediterranean Sea Basin Programme', the largest Cross-Border Cooperation (CBC) initiative implemented by the EU under the European Neighbourhood Instrument (ENI). https://www.enicbcmed.eu/projects/medbeesinesshubs.

section, these benefited from high-quality video conferencing facilities. The Spanish partners of the R-I-Peers project organised their virtual IM/SDD event engaging 15 participants in dialogue[17] responding to 'What are the best practices to overcome problems, barriers, and issues when implementing your GEPs?'. They generated 29 responses, categorised them into 4 clusters, and voted for 20, thus exhibiting a Spreadthink of 60%. They structured 15 ideas on the MAP. The Greek partners organised an analogous event[18] engaging 15 participants in responding to 'What barriers or obstacles do we face when designing and implementing GEPs?' They generated 54 ideas, which they clustered into 11 categories. The preference voting resulted in 26 ideas receiving one or more votes, thus exhibiting a Spreadthink of 54%. They structured 11 ideas on the IM. The MedBEESinessHubs virtual IM/SDD[19] had 18 participants responding to 'In the context of your work, what are obstacles that prevent efficient stakeholders' dialogues?' producing 35 ideas and clustering them into 6 categories. Their voting resulted in 17 ideas receiving one or more votes, that is, indicating a Spreadthink of 40%. They structured seven ideas into an IM. The authors have implemented a few more entirely virtual IM/SDD. Still, these three are sufficient to demonstrate that (i) the model is readily applicable, and (ii) it produces results of similar quality as those implemented physically, at least considering the evaluations of the owners and participants and the Spreadthink index. Future applications should include more thorough evaluations by participants, especially participants with experience in both physical and virtual settings. In addition, more indices should be used to compare the quality of the outcomes.

11 | THE EVOLUTION OF OTHER FEATURES AND DATA MANAGEMENT WITHIN IM/SDD SOFTWARE

In the following paragraphs, we briefly overview how other critical features of the IM/SDD software have evolved.

[17]https://www.futureworlds.eu/wiki/R-I-Peers_San_Sebastian_Virtual_SDDP_Best_practices_to_overcome_problems,_barriers,_issues_when_implementing_your_GEPs

[18]https://www.futureworlds.eu/wiki/R-I-Peers_-_Athens_Virtual_SDD_Obstacles_we_face_when_designing_and_implementing_GEPs

[19]https://www.futureworlds.eu/wiki/Virtual_SDDP_MedBEESinessHubs_2022

11.1 | Managing data and files

In the first and the first part of the second generation of IM/SDD software, the data was coded in binary files because of early computers' memory and speed constraints. Such files could easily be corrupted by the degradation of even one bit and become unusable. They also have the disadvantage of not supporting cross-platform or cross-application communication. Similarly, the .rcmd file, which was central in the design of the CogniScope family, is binary. For example, upgrading from CogniScope v.2 to v.3, backward compatibility was lost because the structure of these binary files was different. Regrettably, most of the early work has been lost partly for this reason. CogniScope v.3, developed by the authors, offered the option to import the Adjacency Matrix of a project and, more importantly, allowed to export all project data in the XML data file standard. Other improvements included correcting the Spreadthink and situational complexity indices and fixing bugs that led to periodical crashes and cross-platform compatibility (the first product to run on Mac computers). All later generations (i.e. IdeaPrism™, Concertina Apps™ and web version, and Logosofia™) use either cloud-based storage (i.e. MySQL databases) or the XML standard to store data, thus improving stability and readability.

11.2 | Methods of display

The traditional approach requires that all idea statements (i.e. few-word 'tile' of each contribution) are printed in real-time on A4 pages and displayed on a nearby wall in groups of five or more, in vertical columns. This practice is powerful because it corresponds to the 'collective memory' being created and displayed. During the clarification stage, the facilitator might either stand near the wall and point attention to one card at a time or even take it in her hands and put it back once finished. A good practice is to use a marker to place a tick at the top left for those whose clarification has been finished. During the clustering, IM/SDD organisers have used two approaches. One involves reorganising the same A4 cards into a human-sized table on the wall. This approach has the advantage that participants 'see' the ideas 'leaving' the first display and moving to the clusters display in the column in which they have been clustered. Alternatively, organisers print a fresh copy of all ideas and construct the clusters' table on the wall in real time, keeping the original ideas intact. The latter has the advantage that participants continue to have visual access to all ideas in the order in which they were offered.

The map reconstruction is typically not conducted in real time as the participants establish influence relations between two factors. The reason is to keep distractions and cognitive overload to a minimum. The participants tend to think forward or consider relations with other ideas being displayed on the wall instead of focussing on the current question in the case when the emerging IMap is displayed on the wall. The IMap is, however, constructed on the wall upon completion of the ISM stage, either by re-organising already printed pages or using newly printed ones. Similarly, as with the clusters, the advantage of using a new set is that participants continue to have visual access to all previous stages. The arrows are depicted with coloured tape. It is customary to reproduce the IMap from left to right instead of the typical bottom-up tree. The reason is that it makes it easier to think of the flow as an emerging roadmap. The advantage of constructing and displaying the IMap on the wall is that it allows participants to stand up and engage in a group discussion. A good practice is inviting a few individuals to attempt a holistic interpretation. Subsequently, the participants can be asked to consider and discuss all factors that led to an idea that made it to the map's top (or right side). This exercise helps them to volunteer into working groups to discuss further specific tie lines. Another advantage of having the map displayed is that it makes it easy to ask participants to pick up selected ideas (maybe their own) and consider whether and where they could fit on the map. This approach can significantly increase the number of ideas that make it to the final map.

In some rare cases, organisers have simulated all the displays using virtual pages projected on the walls using multiple projectors. In a high-profile SDD funded by the UN Democracy Fund, the authors created an immersive environment by displaying all stages of the process on the surrounding walls (Figure 7), thus creating an immersive informational environment. The digital era has opened tremendous opportunities for sharing, visualising and interacting with information. The Agoras group experimented in 2009 with second life to allow participants to move across virtual spaces, including conference rooms and large open-space theatres. The IM/SDD displays were simulated on large screens within the virtual world. Nevertheless, one should appreciate that the experience was limited because most participants did not have huge monitors or rich bandwidth, leading to a restricted sense of immersiveness. The emerging Metaverse environments open new perspectives.

11.3 | Methods of recording clarifications

In many early applications, especially those generously funded by U.S. institutions, organisers assigned two stenographers to type and subsequently compare and combine their files. As this approach significantly increases the cost of an IM/SDD application, it has been gradually abandoned. In recent years, Dietrich and his colleagues (personal communication) used remote transcript services to transmit the voice and secure a quality transcript of everything being said in almost real time. His approach has the advantage that clarifications are recorded with high quality and can be enriched by copying/pasting additional clarifications when participants respond to questions during the later stages of the process

FIGURE 7 The participants immersed in information through virtual projections on surrounding walls. [Colour figure can be viewed at wileyonlinelibrary.com]

(i.e. during clustering or mapping). Author1 and his colleagues introduced several other approaches to capture the clarifications. In many of their sessions, they ask the participants to pre-submit ideas, including clarifications, even before coming to the event (e.g. Laouris et al., 2017). Alternatively, they ask them to prepare their 2–3 best ideas, both as statements and accompanying clarifications, before the start of the Idea Generation stage. These notes are not collected. During the clarification stage, the participants were asked to update their notes, adding whatever they said which was not included. At this stage, the assistants collect the sheets, type the clarifications, and import them into the software. On some occasions, the authors took pictures of hand-written notes and sent them to colleagues worldwide, asking them to type and return them within minutes. This approach requires access to a larger team of motivated individuals. The other method of the Author1 team relied on video recording (i.e. using their IdeaPrism™ App). They introduced the concept that participants should stand up in front of the group and a small camera and pitch their idea within 1–2 min while being recorded. On some occasions, the participants were encouraged to register their idea by placing their mobile device (running IdeaPrism™) on the tripod before pitching. Using one's device has the advantage that the video is recorded and uploaded to the cloud immediately under their profile.

11.4 | Methods of reporting

The production of a report is an essential step of the process. Early GI applications offered options to export data, including a list of factors or clusters or the hierarchy (i.e. which factors end up at which level of the tree) and the connections between elements in the form of text files. Since the exporting and printing could not have been performed in real time, reports were typically generated and distributed *after* the event. With the advent of CogniScope and from GII onwards, project data exporting and printing could be conducted after each stage of the process. This feature rendered IM/SDD a self-documenting method. More importantly, the immediate sharing of reports reassures participants that their contributions have been appropriately documented and credited. With the emergence of GIIb (i.e. CS v.3™, IdeaPrism™, Concertina Web™ and Logosophia™), professionally looking PDF (and text) reports could be handed to participants in real time. Separate reports are typically generated for each set of data (i.e. list of ideas, list of ideas with clarifications, tables with ideas sorted in clusters, tables with votes and voting analysis including measures of Spreadthink, the influence MAP with all its connections and complexity and other indices). A comprehensive report also serves as a tool to inform decision-makers and policymakers who were not part of the dialogue and engage and mobilise them to apply the findings and recommendations. To satisfy this requirement, the authors and a few other practitioners generated professional reports by hand using desktop publishing applications. We still lack a solution that automatically takes all the project data and orders it to develop a complete report.

11.5 | Extending the original method

The authors have recently extended the SDD process by adding another stage after the ISM and before the road mapping stage. They ask the participants to score (Likert scale) all ideas that made it to the influence map for impact, feasibility and probability for an action to take place or a barrier to be removed without intervention. Figure 8 shows an example from a recent application designed to develop a future vision for Poland.[20] Impact minus the probability of happening without intervention scores is plotted on the *x*-axis, whereas the feasibility scores are plotted on the *y*-axis. The red lines depict the corresponding averages. Thus, all factors that lie above the horizontal red line are more feasible. Those on the upper right quadrant have a high impact but a low probability of happening without intervention and should therefore be given priority. The multi-scoring process provides additional information to support the development of the most effective roadmap. Michaelides & Laouris (2023) have formalised the stakeholder identification and selection process for their wine villages' project, an intervention that took place in the years 2008–2012. They applied an iterative approach to defining internal versus external stakeholders and clustered stakeholders into categories with distinct roles. The categories of potential participants were continuously updated in a Stakeholders' Requisite Variety Matrix. Members of an ad-hoc committee scored (1 to 5) the degree to which each participant represented each category.

11.6 | Towards generation V

We typically assume that technology improves efficiency, impact, or scale and reduces costs, but does it always? Is it possible to measure the added value given that the transitions across generations are imposed more by necessity (i.e. technology push) than the need to improve the impact? Therefore, an emerging challenge is measuring

[20]https://futureworlds.eu/wiki/Future_Finance_Poland_SDD_2022

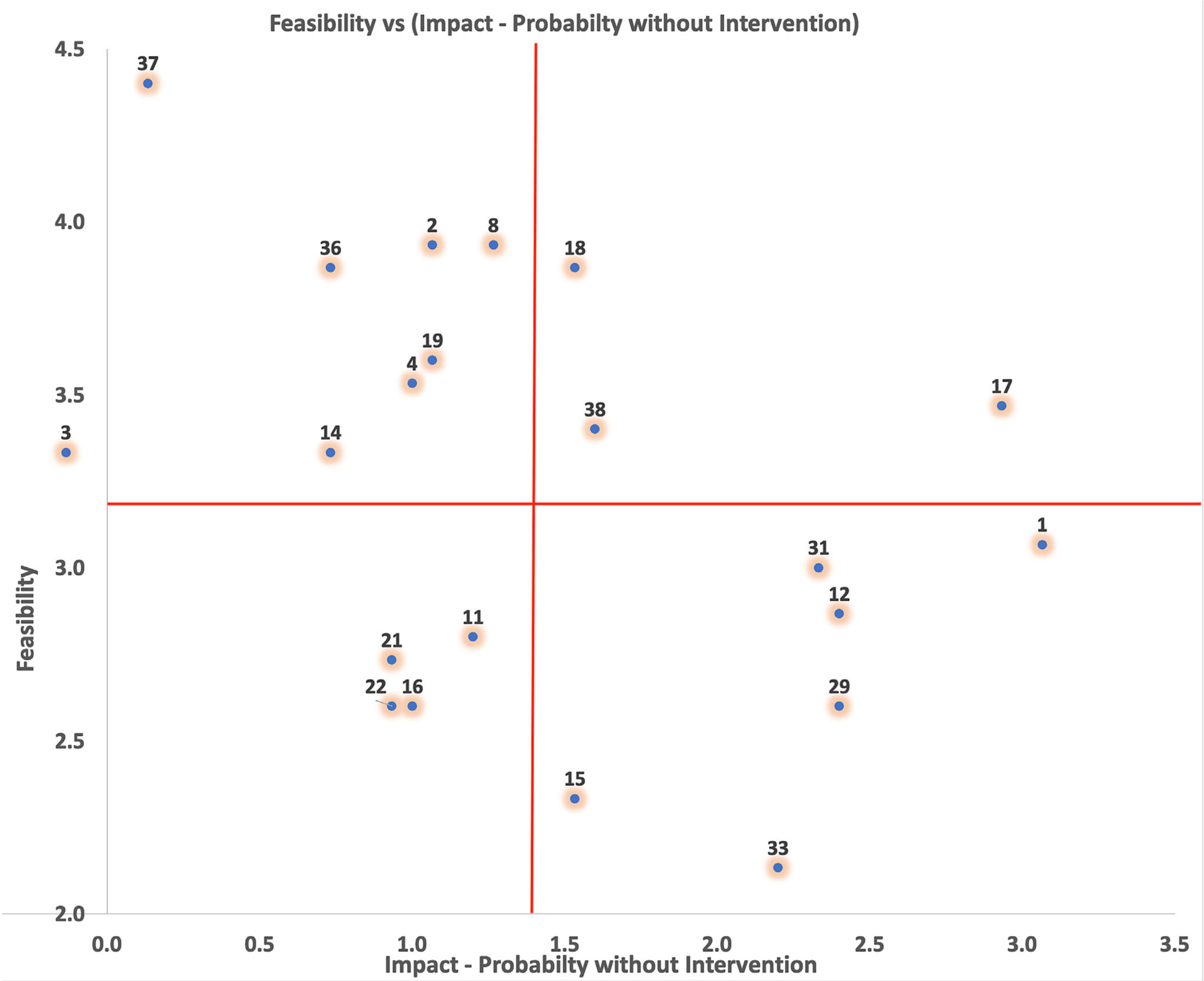

FIGURE 8 Multi-scoring. (From Future Poland, 2021). [Colour figure can be viewed at wileyonlinelibrary.com]

the efficiency, impact, scale and cost of the current pre-standardisation Generation V software platform(s). We must decide what aspects should be evaluated and develop appropriate metrics to address this challenge. For example, emerging GV platforms may facilitate digital monitoring, help us reach larger populations of participants, and allow us to examine the quality and scale of engagement using back-end analytics. Conducting IM/SDD processes in virtual environments also makes it much easier to collect pre- and post-participation surveys not only to measure efficiency gains or improvements in impact but also to attribute the source of those improvements to specific features of the technology. Quantitative data collection can help evaluate the effects of changes in the processes, making it possible to compare results from traditional versus virtual IM/SDD. With technology, we can provide quantitative evidence of its impact and advocate better for its use (or disuse). We still lack sufficient data to discuss whether IMs developed in virtual processes may catalyse or sustain discussion or lead to specific actions in ways analogous to or better than the f2f case. Although f2f applications typically end when the colaboratory is completed, GIV/GV applications extend in time, making it much easier to re-engage, re-organise or take action later when certain social circumstances call for the revival of the goal.

12 | SUMMARY AND CONCLUSIONS

12.1 | GI to GII: pros and cons

Early applications (GIa) of either Fitz's 'Technology of Social Learning' or Warfield's 'Interactive Management' relied on either experimental algorithms or precursors of

Warfield's ISM software running under DOS. According to Warfield's (1979) review of applications, the first computer-assisted ISM process took place at the Kettering Foundation in Dayton, Ohio, in 1974. The transition to GIb was marked by the establishment of Warfield's ISM for DOS as the first standard. Many applications, including Broome's applications in Cyprus (Broome, 1997, 1998, 2002, 2004), were conducted using that software also because it was offered for free through the George Mason University website. The structure of the software has imposed, to a large extent, also the flow of the process. Among the notable weaknesses, Warfield (1976) also recognises the lack of a graphical interface and especially the lack of a feature for automatically generating the influence MAP. Broome and Hogan's ISM for Windows extended the usability during the early windows era, but these weaknesses remained. Both Warfield's software packages were deprecated after Windows 98, but Broome and Hogan provided an upgrade in 2020. The introduction of CS1 provided, for the first time, a visual interface depicting the stages of the process and also an algorithm for an automated generation of the influence MAP. The algorithm still lacked a feature to minimise the number of lines crossing each other. Still, the accompanying MAP analysis provided tables with the assignment of factors into levels and their interconnections. The graphical separation and visual organisation of the stages have greatly facilitated learning and compliance with the process. CS2, an updated version, offered some additional features, which, however, were not used extensively. These included, for example, the possibility of connecting an Obstacles' with an Actions' MAP and highlighting flows, a feature called tie line-scenarios.

12.2 | GII to GIII: pros and cons

Most of the applications to date can be clustered within these two generations. The transition to Generation III was marked with the development and wide application of new tools including CogniScope v3 for which practitioners from across the globe shared their requirements. The first web-based tools, Concertina and Logosofia, also appeared within this window. The distinguishing characteristic was however the utilisation of new technological advances in video telecommunications. Many dialogues were conducted using teleconferencing and video conferencing, which required the process to be distributed in shorter sessions using time between sessions to improve clarifications and collect preference votes and multi-parameter scores. Google docs were used to host ideas/clarification, discussions, results of stages including votes, and relevant documents. Finally, within this period, the process was extended with the inclusion of more tedious stakeholder identification and analysis prior to the SDD and multi-scoring after the mapping.

12.3 | GIII to GIV: pros and cons and challenges of scaling up

The transition from GII to GIV is marked by asynchronous, distributed implementations of the so-called sensitive phases of the process, that is, the clustering and the mapping. Conducting these stages individually and asynchronously requires developing new tools, such as the Concertina tools. The number of applications conducted is still small to allow a critical evaluation. One can, however, recognise one significant advantage and one potential threat. The advantage is that once this approach is fine-tuned and validated to result in dialogues of equal or comparable quality as face-to-face, synchronous dialogues, the potential for scaling up to include thousands of participants is evident. In his seminal paper 'Past, present and future of problem structuring methods (PSM)', Rosenhead (2006, pg. 6) identifies large group interventions as a possible area of expansion of methodologies like IM/SDD. The aim of a large-scale process is to support the group in developing shared understanding and shared vision and ultimately to generate collaborative action towards a desired future. Laouris (2022a, 2022b) presented two models of large-scale interventions. In the first model, the same type of intervention is delivered more or less synchronously to multiple distributed groups. The second model begins with one intense focal intervention and a process design that allows it to replicate and expand by creating spin-off agents or communities of change. To accelerate positive social change in a fraction of the time, we need more work on the theoretical grounding, which is currently only scarcely discussed (e.g. Laouris, et al., 2014, pg. 179; Rosenhead 2006, pg. 6) in the literature.

12.4 | GIV to GV: pros and cons

Except for a single experiment conducted in SecondLife™, there is no data available for a meaningful analysis.

12.5 | Challenges of popularising the methodology

Rendering IM/SDD virtual or asynchronous paves the road for enabling thousands to engage in meaningful deliberations. Yet, not only IM/SDD but also soft methodologies, cybernetics, and systems science and engineering tools are not sufficiently applied towards this goal. Although IM/SDD applications have reached the thousands, the methodology is still neither well known nor accessible, nor is it being used to solve the numerous global challenges humanity faces today. A seminal study by Cisneros et al. (2013) articulated a strategy of action to cope with the enormous challenges of our world. These authors applied SDD to structure the 49 continuous critical problems identified in 1970 by Özbekhan et al. (1970) and the 15 challenges to humanity identified by The Millennium Project (2009). This type of work needs to be extended urgently to bring discussions of current socio-technical challenges, especially their ethical and humanistic dimensions, into the foreground of daily political affairs. The authors believe that systems scientists can popularise their methodologies by (i) making them more accessible through streamlining; (ii) reaching wider audiences by publishing their applications in domain-relevant journals rather than those specialising in theoretical systems science; (iii) campaigning in governments and global organisations such as the UN and the IMF, using their various national and international associations as platforms rather than struggling individually; and (iv) collaborating to resolve current, intractable, persisting, complex socio-technical problems.

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REFERENCES

Beer, S. (1984). The viable system model: Its provenance, development, methodology and pathology. *Journal of the operational research society*, *35*(1), 7–25.

Broome, B. J. (1997). Designing a collective approach to peace: Interactive design and problem-solving workshops with Greek-Cypriot and Turkish-Cypriot communities in Cyprus. *International Negotiation*, *2*(3), 381–407. https://doi.org/10.1163/15718069720848022

Broome, B. J. (1998). Overview of conflict resolution activities in Cyprus: Their contribution to the peace process. *The Cyprus Review*, *10*(1), 47–66.

Broome, B. J. (2002). Participatory planning and design in a protracted conflict situation: Applications with citizen peace-building groups in Cyprus. *Systems Research and Behavioral Science: the Official Journal of the International Federation for Systems Research*, *19*(4), 313–321. https://doi.org/10.1002/sres.434

Broome, B. J. (2004). Reaching across the dividing line: Building a collective vision for peace in Cyprus. *Journal of Peace Research*, *41*(2), 191–209. https://doi.org/10.1177/0022343304041060

Christakis, A. N. (2006). Dialogue for Conscious Evolution. In J. P. van Gigch (Ed.), *Wisdom, knowledge, and management. C. West Churchman and related works series* (Vol. 2). Springer. https://doi.org/10.1007/978-0-387-36506-0_15

Christakis, A. N., & Bausch, K. C. (Eds.). (2006). *Co-laboratories of democracy: How people harness their collective wisdom to create the future*. IAP.

Christakis, A. N., & Dye, K. (2008). The Cogniscope™ lessons learned in the arena. In *Dialogue as a collective means of design conversation* (pp. 187–203). Springer.

Christakis, A. N., Dye, K. M. C., & Shearer, W. L. (1999). Collaboration through communicative action: Resolving the systems dilemma through the cogniscope. Systems: Journal of Transdisciplinary. *Systems Science*, *4*(1–2), 9–32.

Christakis, A. N., Globe, S., & Kawamura, K. (1980). Choosing topics for technology assessment. *IEEE Transactions on Systems, Man, and Cybernetics*, *10*(1), 1–7. https://doi.org/10.1109/TSMC.1980.4308344

Christakis, A. N., & Underwood, G. (2008). Virtual co-laboratories for implementing effective teaching strategies in local schools. In *International Cybernetic Society Conference*. International Cybernetic Society. https://socsci.flinders.edu.au/av/pathways/files/ISA%202008%20Aleco%20Christakis.pdf

Cisneros, R. T., Hisijara, B. A., & Bausch, K. C. (2013). *Strategic articulation of actions to cope with the huge challenges or our world: A platform for reflection*. Institute for 21st Century Agoras.

Diedrich, J., & Christakis, A. N. (2021). The Co-laboratory of democracy archetypes: Engaging stakeholders in deliberative democracy to respond proactively to diversity. In *From polarisation to multispecies relationships: Re-generation of the commons in the era of mass extinctions* (pp. 451–470). Springer. https://doi.org/10.1007/978-981-33-6884-2_19

Dye, K. (1999). Dye's law of requisite evolution of observations. In A. N. Christakis & K. Bausch (Eds.), *How people harness their collective wisdom and power* (pp. 166–169). Information Age Publishing.

Dye, K. M., & Conaway, D. S. (1999). *Lessons Learned from Five Years of Application of the CogniScope™ Approach to the Food and Drug Administration*. CWA Ltd.

Etemadinia, H., & Tavakolan, M. (2021). Using a hybrid system dynamics and interpretive structural modeling for risk analysis of design phase of the construction projects. *International Journal of Construction Management*, *21*(1), 93–112. https://doi.org/10.1080/15623599.2018.1511235

Fitz, R. (1974). Reflections on interpretive structural modeling as technology of social learning. In *1974 IEEE conference on decision and control including the 13th symposium on adaptive processes* (pp. 693–696). IEEE.

Fitz, R., & Troha, J. (1977). Interpretive structural modeling and urban planning. In *Proceedings of the International Conference on Cybernetics and Society, USA* (pp. 297–302).

Flanagan, T. (2006). Co-laboratories of democracy: How people harness their collective wisdom to create the future. *Systems Research and Behavioral Science*, *23*(6), 845–847. https://doi.org/10.1002/sres.767

Flanagan, T. R. (2020). Structured dialogic design for mobilizing collective action in highly complex systems. In G. S. Metcalf, K. Kijima, & H. Deguchi (Eds.), *Handbook of systems sciences*. Springer. https://doi.org/10.1007/978-981-13-0370-8_59-1

Flanagan, T. R., & Christakis, A. N. (2010). *The talking point: Creating an environment for exploring complex meaning*. IAP.

Greif, I. (Ed.). (1988). *Computer-supported cooperative work: A book of readings*. Morgan Kaufmann Publishers Inc.

Hays, P. R., & Michaelides, M. (2004). Constructing agoras of the global village: A co-laboratory of democracy on the conscious evolution of humanity. *Systems Research and Behavioral Science*, *21*(5), 539–553. https://doi.org/10.1002/sres.630

Hu, J. L., Tang, X. W., & Qiu, J. N. (2015). A Bayesian network approach for predicting seismic liquefaction based on interpretive structural modeling. *Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards*, *9*(3), 200–217. https://doi.org/10.1080/17499518.2015.1076570

Hussain, M., Awasthi, A., & Tiwari, M. K. (2016). Interpretive structural modeling-analytic network process integrated framework for evaluating sustainable supply chain management alternatives. *Applied Mathematical Modelling*, *40*(5–6), 3671–3687. https://doi.org/10.1016/j.apm.2015.09.018

Jena, J., Sidharth, S., Thakur, L. S., Pathak, D. K., & Pandey, V. C. (2017). Total interpretive structural modeling (TISM): Approach and application. *Journal of Advances in Management Research*, *14*(2), 162–181. https://doi.org/10.1108/JAMR-10-2016-0087

Johansen, R. (1988). *Groupware: Computer support for business teams*. The Free Press.

Kapelouzos, I. B. (1989). The impact of structural modeling on the creation of new perspectives in problem-solving situations. In *Proceedings of the 1989 European congress on systems science* (pp. 915–932). AFCET.

Laouris, Y. (2022a). Managing Large-scale Societal Change. In *Operations Management and Management Science*. IntechOpen.

Laouris, Y. (2022b). Method to integrate asynchronously produced individual influence maps into an extrapolatedpopulation influence map following the face-to-face stage of a structured democratic dialogue. *Systems Research and Behavioral Science.*, *40*, 437–450. https://doi.org/10.1002/sres.2877

Laouris, Y. (2015). Reengineering and Reinventing both Democracy and the Concept of Life in the Digital Era. In *The onlife manifesto* (pp. 125–142). Springer.

Laouris, Y., Dye, K., Michaelides, M., & Christakis, A. N. (2014). Co-laboratories of democracy: best choices for designing sustainable futures. In *Social Systems and Design* (pp. 167–183). Springer.

Laouris, Y., Emiliani, P. L., & Roe, P. (2017). Systemic evaluation of actions toward developing practical broadband applications for elderly and people with disabilities. *Universal Access in the Information Society*, *16*(1), 247–255. https://doi.org/10.1007/s10209-015-0441-0

Laouris, Y., Laouri, R., & Christakis, A. (2008a). Communication praxis for ethical accountability: the ethics of the tree of action: dialogue and breaking down the wall in Cyprus. *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research*, *25*(2), 331–348. https://doi.org/10.1002/sres.890

Laouris, Y., & Michaelides, M. (2018). Structured Democratic Dialogue: An application of a mathematical problem structuring method to facilitate reforms with local authorities in Cyprus. *European Journal of Operational Research*, *268*(3), 918–931. https://doi.org/10.1016/j.ejor.2017.04.039

Laouris, Y., & Michaelides, M. (2007). What obstacles prevent practical broadband applications from being produced and exploited. *Towards an inclusive future Impact and wider potential of information and communication technologies*, (3), 281–299.

Laouris, Y., Michaelides, M., & Sapio, B. (2008b). A systemic evaluation of obstacles preventing the wider public benefiting from and participating in the broadband society. *Observatorio J*, *5*, 21–31.

Laouris, Y., & Romm, N. R. (2022b). African Youth's Visioning for Re-inventing Democracy in the Digital Era: A Case of Use of Structured Dialogical Design. *World Futures*, *78*(1), 18–61. https://doi.org/10.1080/02604027.2021.2014112

Laouris, Y., & Romm, N. R. (2022a). Structured dialogical design as a problem structuring method illustrated in a Re-invent democracy project. *European Journal of Operational Research*, *301*(3), 1072–1087. https://doi.org/10.1016/j.ejor.2021.11.046

Laouris, Y., Underwood, G., Laouri, R., & Christakis, A. (2010). Structured dialogue embedded within emerging technologies. *Emerging technologies in distance education*, 153–173.

Lee, D. M. (2007). *Structured decision making with interpretive structural modeling (ISM): Implementing the core of interactive management: An analysis & decision making method & tool for individuals and groups*. Sorach Incorporated.

Linstone, H. A., Lendaris, G. G., Rogers, S. D., Wakeland, W., & Williams, M. (1979). The use of structural modeling for technology assessment. *Technological Forecasting and Social Change*, *14*(4), 291–327. https://doi.org/10.1016/0040-1625(79)90032-5

Magliocca, L. A., & Christakis, A. N. (2001). Creating transforming leadership for organizational change: The CogniScope system approach. *Systems Research and Behavioral Science: the Official Journal of the International Federation for Systems Research*, *18*(3), 259–277. https://doi.org/10.1002/sres.356

Manifesto: Reinventing Democracy in the Digital Era. 2016. Available from: https://www.futureworlds.eu/wiki/Manifesto:_Democracy_in_the_Digital_Era. Accessed: Jan 30, 2023.

Michaelides, M., & Laouris, Y. (2023). A cascading model of stakeholder engagement for large-scale regional development using structured dialogical design. *European Journal of Operational Research*. (in review).

Özbekhan, H. (1969). *Toward a general theory of planning*. Management and Behavioral Science Center, University of Pennsylvania.

Özbekhan, H., Jantsch, E., & Christakis, A. N. (1970). *The predicament of mankind: A quest for structured responses to growing world-wide complexities and uncertainties*. *Proposal to the Club of Rome*. Club of Rome.

Penichet, V. M. R., Marin, I., Gallud, J. A., Lozano, M. D., & Tesoriero, R. (2007). A classification method for CSCW systems. *Electronic Notes in Theoretical Computer Science*, *168*, 237–247. https://doi.org/10.1016/j.entcs.2006.12.007

Rosenhead, J. (2006). Past, present and future of problem structuring methods. *Journal of the Operational Research Society*, *57*(7), 759–765. https://doi.org/10.1057/palgrave.jors.2602206

Sage, A. P. (1977). *Methodology for large-scale systems*. McGraw-Hill.

Simpson, J.J. & Simpson, M.J. (2018). *Open source structural modeling software*, Technical Report, SC_TR_00024, https://doi.org/10.13140/RG.2.2.31708.85121 Available online: https://www.researchgate.net/publication/327279503_Open_Source_Structural_Modeling_Software

Simpson, J.J. & Simpson, M.J. (2019a). *Detailed augmented interpretive structural modeling relationships and functions*. Technical Report. https://doi.org/10.13140/RG.2.2.18054.01601

Simpson, J.J. & Simpson, M.J. (2019b). *Applied natural language relationships*. Technical Report. https://doi.org/10.13140/RG.2.2.28252.44162

The Millennium Project. (2009). *The 15 global challenges*. The Millennium Project. Accessible online at https://www.millennium-project.org/projects/challenges/

Warfield, J. (1995). A Compressed History of the Development of Interpretive Structural Modeling. In *The science of complexity, the science of generic design, and interactive management*. The John N. Warfield Digital Collection. https://hdl.handle.net/1920/3209

Warfield, J. (1979). History and Applications of Interpretive Structural Modeling. In *Canadian operational research society, annual meeting, may* (Vol. 23).

Warfield, J. N. (1994). *A science of generic design: Managing complexity through systems design*. Iowa State University Press.

Warfield, J. N. (1973c). *Assault on complexity. Battelle Monograph, 3 April*. Battelle Memorial Inst.

Warfield, J. N. (1973b). Binary matrices in system modeling. *IEEE Transactions: System, Man, and Cybernetics*, *SMC-3*, 441–449. https://doi.org/10.1109/TSMC.1973.4309270

Warfield, J. N. (1977). Crossing theory and hierarchy mapping. *IEEE Transactions on Systems, Man, and Cybernetics*, *7*(7), 505–523. https://doi.org/10.1109/TSMC.1977.4309760

Warfield, J. N. (1974b). Developing interconnection matrices in structural modeling. *IEEE Transactions on Systems, Man, and Cybernetics*, *1*, 81–87. https://doi.org/10.1109/TSMC.1974.5408524

Warfield, J. N. (1973a). Intent structures. *IEEE Transactions: System, Man and Cybernetics*, *SMC-3(2)*, 133–140. https://doi.org/10.1109/TSMC.1973.5408494

Warfield, J. N. (1989) ISM software history. Notes by Rose: https://mars.gmu.edu/jspui/bitstream/handle/1920/3204/Warfield_24_33_A1b.pdf?sequence=1&isAllowed=y

Warfield, J. N. (1973d). On arranging elements of a hierarchy in graphic form. *IEEE Transactions: System, Man and Cybernetics*, *SMC-3*, 121–132. https://doi.org/10.1109/TSMC.1973.5408493

Warfield, J. N. (1976). *Societal systems: Planning. Policy and complexity*. Wiley.

Warfield, J. N. (1974a). *Structuring complex systems. Battelle monograph* (p. 4). Battelle Memorial Inst.

Warfield, J. N. (1974c). Towards interpretation of complex structural models. *IEEE Transactions on Systems, Man, and Cybernetics*, *SMC-4(5)*, 405–417. https://doi.org/10.1109/TSMC.1974.4309336

Warfield, J. N. (1999). Twenty laws of complexity: Science applicable in organizations. *Systems Research and Behavioral Science*, *16*(1), 3–40. https://doi.org/10.1002/(SICI)1099-1743(199901/02)16:1<3::AID-SRES241>3.0.CO;2-F

Warfield, J. N., & Cardenas, A. R. (1994). *A handbook of interactive management*. The Iowa State University Press.

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