Re-thinking the 2X2 scenario method: grid or frames?

Technological Forecasting and Social Change

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Abstract

Is a well-accepted method widely used by practitioners unproblematic? We here suggest that this is not the case. The 2x2 matrix approach has been stated by researchers to be the 'standard' approach in scenario planning. However, as we show in this paper, interpretations of this method vary significantly, even within the same 'scenario school' – in this case, the intuitive logics - plausibility based scenario tradition. We explore both the highly attractive, apparent simplicity of the method; and its more problematic aspects by contrasting two distinct interpretations used by scenario planners. We articulate the advantages and drawbacks of the 2x2 matrix method according to these two different interpretations. The paper makes two contributions. First, in rendering methodological conundrums explicit, it clarifies choices scenario planners can now explicitly make when choosing a scenario building method. Secondly, by clarifying the choices that the method offers, we contribute to make it more rigorous, debunking some of the purported ease it advertises for the unwary.

KEY WORDS

Scenario planning, 2X2 matrix; deductive scenario method

Introduction and objectives

Is a well-accepted method widely used by practitioners unproblematic? We suggest that this is not the case. There are many different methods for building scenarios and the diversity within scenario practices reflects a variety of schools of thought, with difference most notable between practices involving probabilistic and non-probabilistic futures. This paper is about one specific method and it interpretation within the non-probabilistic tradition in scenario work: the 2x2 matrix method, which is reported in literature to be the most used by scenario practitioners.

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We wrote this paper when we became aware that our interpretations (and those in the extant literature) of the so-called' 'deductive' method of intuitive scenarios building, resulting in 2x2 matrices, differed in important ways.

Our purpose is to clarify the merits of each of two incompatible interpretations of how this method works. Each interpretation of the method enables a scenario intervention to offer different things. The implications are particularly relevant to those deploying scenarios as a research method: they need to pay attention not only to their choice of method but to the practical and intellectual implications of their choice.

We've organised the paper as follows: We begin by reviewing the nature, history, and claims of the so-called "intuitive school" of scenario planning, and more specifically of the "deductive method" within this school. We then summarise and analyse each of two distinct understandings of the method, before comparing the two. We finalize the paper by proposing settings and situations where each of the two contrasted approaches might be more advisable and useful. The paper contributes to clarifying methodological choices in scenario practices, and grounding these in critical and reflexive practice.

Situating 2x2 matrix within a diversity of scenarios practice traditions and methods

Why think about the future? Today's concerns are, after all, so urgent, the pace of change is quickening and the future is so unpredictable – is there really any time or reward for such efforts? Even if one could predict the future, could one do anything about it?

Over 60 years ago, scenario planning emerged, almost simultaneously in different parts of the world, in response to challenges of decision making under unpredictable uncertainty. Increasing and more widespread appreciation of more turbulent contexts and less predictable futures have paved the way for scenarios to be deployed widely - in academic research, public policy making, corporate strategy and community planning [1] . As an approach to engage constructively with unpredictable uncertainty, scenarios expose future assumptions that would otherwise remain implicit and clarify present situations to service different purposes - learning, informing decisions, making sense, aligning values or guiding action.

2 | A c c e p t e d   f o r   p u b l i c a t i o n   i n   T e c h n o l o g i c a l   F o r e c a s t i n g   &
S o c i a l   C h a n g e   o n   O c t o b e r   1 7   2 0 1 3 .   F o r t h c o m i n g .   D o   n o t   c o p y
o r   r e p r o d u c e   f u r t h e r .

Van der Heijden [2] suggested the role of scenario planning in the institutional dilemma of group think and fragmentation is that they are a 'natural thinking tool for use in strategic conversation' [3 p. 41].

Scenario practices have continued to evolved and coevolved over the decades and, as a result, there is diversity of and within methods that leads to misunderstandings and methodological confusion, which Martelli [4] called methodological chaos'.

Schoemaker [5] noted that three prime characteristics set the scenario approach apart from the then traditional planning tools: (1) it is an approach centred on a script or narrative; (2) it places uncertainty across rather than within individual models, and (3) it chunks out complex future possibilities into discrete states that are easier to assess, use, and compare. When exploring the intellectual roots of scenario planning, he examined organizational aspects that would welcome it. These included an acceptance of a diversity of views. He was the first to suggest that a key psychological benefit of scenario planning rests on exploiting one set of biases (e.g., conjunction fallacies) to counteract others (such as overconfidence) to enhance decision-making. Yet he found that doing scenarios was not straightforward: "To a large extent, scenarios require creativity and intuition that is difficult to systematize" [5, p. 212].

Marshalling this creativity and/or intuition, in combination with rigorous analysis to produce scenarios has over several decades led practitioners to mobilise techniques and tools which over time and with reflective practices [6] have coalesced into more or less stable methods. This development is consistent with how Feyerabend [7] suggested 'methods' have been developed in the physical sciences.

This paper focuses on one particular tradition of scenarios, the so-called Intuitive Logics tradition. This tradition of practice rejects predictability and probability and uses a concept of plausible, alternative, futures. It combines critical thinking with rigorous analysis and narratives and numbers in a process of disciplined imagination. Plausibility-based scenarios can enable a more multi-disciplinary approach in research – bridging natural and social sciences, with history and humanities to help develop shared and systemic understanding across different communities, forge new common ground, and overcome inertia and group think when change is called for [3, p. viii-ix].

The so-called 2x2 scenario matrix method is well established in scenario planning. Various scenario reviews highlight the popularity of the method. For example, in a review of 35 sets of scenarios [8],

over 24 (68%) are noted as being developed using the 2x2 method. van Asselt et al [9, p. 61] pronounced it to be 'widely referred to as 'standard' by practitioners and scholars' and Ringland [10, p. 174] proposed that 'the standard tool used to sort out ideas and factors is the two-dimensional matrix'.

In the 2x2 matrix method two contextual factors, which are considered to be causally independent from each other, are used to structure possible future contexts . The most reported criteria for choosing these two factors over many others is based on a process in which the factors are ranked in terms of highest uncertain and greatest potential impact over the time horizon selected as relevant for the scenario building agenda [11: method appendix]. The top two high impact-high uncertainty and independent factors are combined to create a 2x2 scenarios matrix.

An advantage of the 2x2 matrix is a clear, memorable and easy to communicate structure that allows the subsequent scenario storylines that are produced to be compared –even contrasted- with each other. That is not to say that deeper insights are immediately self-evident; but the quadrants provide a clear frame to distinguish and locate scenarios in relation to each other, and helpful starting points for develop each scenario in the set.

Scenarios built with the 2x2 method are clearly differentiated from each other with virtually no overlap amongst them. Bradfield et al [12] named the approach that yields this 2x2 matrix the 'deductive' version of what they termed the Intuitive Logics scenarios school.

Is a 'standard method' important?

But is the 2x2 approach to defining scenario sets a stable and/or standard method? And, if not, does this matter? Published studies of scenarios produced using the 2x2 matrix method vary in the methods used to identify the two 'critical and uncertain' factors that structure the scenarios and distinguish them: these can be deducted from quantitative analysis, inducted from a qualitative inquiry process, or identified from an iteration of both quantitative and qualitative inquiry.

We decided to write this paper when we realized through our exchanges in teaching scenarios, that each of us -and our students- were interpreting the 2x2 in different ways. In our teaching programmes, we help practitioners to navigate the choice of methods and effectively attend to their procedural details by focussing on what would be most useful for the intended users. In this paper, we share the insights we have developed on the basis of our exchanges and classroom conversations

with the wider community. In doing so we build on the earlier contributions by others, and clarify some of the confusions we have inherited from them.

Van't Klooster & van Asselt [13; see also 9] already highlighted through their ethnographic research into scenario practices that very different interpretations of the 2x2 matrix are evident when the deductive building method is used. We consider the two interpretations of the method we offer to be useful. But our deliberations made us realize that if the distinction we here offer explicitly is not made clear, confusion can arise.

The purpose of the paper is to clarify each of the two approaches we present, distinguish them from each other, assess the advantages and disadvantages of each, and to suggest situations in which the other or the one might be most helpful. This clarification will contribute to help prospective scenario planners in the 'orientation to scenarios' phase to prepare their work [14].

The Intuitive Logics School of Scenarios and its methods

To analyze the two different interpretations of the deductive building method and associated 2x2 matrix, we first situate this method within the broader choices alternative scenario building methods entail.

Building on earlier work by Huss & Horton, Bradfield et al [15, 12] traced three almost simultaneous origins of scenarios in the 1960s. They called these approaches the Intuitive Logics (plausibility based), La Prospective (preference based), and the Probabilistic Modified Trends (PMT: probability based). They suggested the Intuitive Logics School is more process- focused and less outcome-focused than the La Prospective and PMT approaches, which include retrospective verifiability evaluation. As they put it "The hallmark of scenarios developed under intuitive logics approaches is that all scenarios presented are equally probable. Consequently, while 'coherence', 'plausibility', 'internal consistency' and 'logical underpinning' are the common baseline criteria by which all scenarios are evaluated regardless of developmental methodology, unique to the intuitive logics model is the additional criteria of equal probability of all the scenarios within a set" [15, 12, p. 810-811].

As the probability of each scenario is irrelevant in the intuitive logics school [16], scholars have instead focused on how they work with plausibility [17]. Attending to plausibility recognises reflexive attention to the logic of what might be emerging described in the scenario. Plausibility seeks to

relate novelty in a productive tension with assumptions derived from historical determinism. Plausibility emerges from and supports strategic conversations that question whether that which has been impossible might become possible; and which investigate how that which has been possible might end.

The history of the intuitive logics approach can be traced even further back to the work of Kahn & Wiener [18] who suggested that "clearly one can write many scenarios here, with many different branching points. These quandaries may be resolved ultimately by at least partly intuitive and subjective judgements; the most one can claim for such speculations is that no alternative possibility seems much more likely" [18, p. 194].

Ducot & Luben [19] appear to have been the first to contrast probabilistic and non-probability approaches, defining intuitive logics as the latter. They also distinguished between two concepts they termed 'trend' versus 'peripheral' and differentiated between descriptive and normative scenarios. Peripheral or critical scenarios may in their view include situations that are contradictory to the mainstream.

 Later, Huss & Hornton [15 p. 23] distinguished between three generic methodological approaches to generate scenarios, which they called intuitive logics, trend impact analysis and cross-impact analysis; noting that since "the intuitive logic approach is not tied to any mathematical algorithm, it can, with careful tailoring, adjust to the particular needs and political environment of the company. The approach relies strongly on the reputation and communication skills of the team members and is less likely to be successful in a modelling or scientific environment which would require a more quantitative approach."

Examples of practitioners in the intuitive logics school include the work of van der Heijden and Schwartz [3, 11], as well as a majority of the work carried out in the scenario planning at Royal Dutch Shell [12]. Wright et al [20] reviewed augmentations of the intuitive logics scenario methodology concluding that use of these extensions helped expand effectiveness in terms of better understanding reality and / or challenging conventional wisdom.

Recent research suggests however that the name 'intuitive logics' for this approach is not unproblematic: the validity of intuition has been found to be difficult to apply to the situations in which scenario planning is called for. Kahneman & Klein, "starting from the obvious fact that professional intuition is sometimes marvellous and sometimes flawed", attempted "to map the

boundary conditions that separate true intuitive skill from overconfident and biased impressions", concluding that "evaluating the likely quality of an intuitive judgment requires an assessment of the predictability of the environment in which the judgment is made and of the individual's opportunity to learn the regularities of that environment. (They found) that subjective experience is not a reliable indicator of judgment accuracy" [21, p. 515], parentheses added).

Despite these doubts academics have regarding intuition, huge sums of money are invested depending on it. For example in December 7 2011, the Financial Times [22] reported that banks and other investors put US $505 million on a venture initiated by John Fredrikson, founder of a large group that includes Frontline, the world's biggest tanker operator. Paul Slater, a veteran shipping financier, is quoted as contrasting Fredrikson's 'instinct' –honed in a lifetime in the business, including several cycles of depressed business- with that of another shipping magnate who entered the business from an earlier career in investment banking.

Our understanding is that what the intuitive logics school of scenario planning does when it engages in intuitive inquiry is to help reveal assumptions about the future that would otherwise remain implicit in judgement and subsequent decision making. Scenarios provide a pragmatic means to surface, test and contest these assumptions through conversations and rethink plausible developments and options for action. This distinguishes the role of Intuitive Logics scenarios as helping to reframe plausibility, rather than forecasting on the basis of past knowledge. Intuitive logics scenarios contribute to the quality of judgment, they are not an extension of decision making as such. After all, prediction is impossible in the highly uncertain turbulent environments in which scenarios are most usefully deployed [1].

The Intuitive Logics approach articulates the view that strategic foresight in the turbulent, highly uncertain conditions in which it is most useful –where forecasting based on the repetition of events and historical data becomes unreliable - is rendered through strategic conversations [2]. Strategic conversation is a process of future oriented sense -making that attends to cognitive, psychological, and social aspects to surface the biases inherited from past or extant cultures and institutional norms and preferences in preparing options for choice in decision-making.

Productive interpretations of the insights that 2x2 matrices yield should avoid unreflective methodological fetishism [23]. Instead, by critically assessing the role the 2X2 offers, as we attempt to do in this paper, scenario planners and scenario planning users will obtain richer value and more

nuanced insight by critically appreciating the roles scenarios play in engendering a better quality of strategic conversation. These conversations in turn enable more courageous foresight.

The Alleged Dominance of the Deductive Method

The deductive building method has been in the scenario planning literature referred to by several names, including the '2x2 or 'scenario matrix' method; "The standard tool used to sort out ideas and factors is the two-dimensional matrix' [10 p.174]; and 'The scenario logics are built by choosing two critical uncertainties and plotting them in a 2x2 matrix' [24 p. 141]. Curry & Schultz [25] highlighted "its dominance in the northern hemisphere and prevalence in the world of business-oriented futures" and Bradfield et al called it 'a golden tool' [12].

The 2x2 matrix has also been mistakenly referred to as the "Shell method" [26]. While a Shell guide to building scenarios does mention the deductive method as one of several approaches to building scenarios: "Pick out two critical uncertainties and describe the extremes of each in a matrix, then develop storylines for paths into each quadrant of the matrix and descriptions of how the world could shift from one quadrant to another" [27, p. 46], none of the long term energy and global scenarios published by Shell over the past 15 years involves a 2x2 matrix [28]. Those Shell scenario sets contain only two, or occasionally three, but never four scenarios.

Confusing the 2x2 matrix as the Shell method might be a simple case of mistaken identity. Peter Schwartz, a former head of the Shell scenario team and one of the co-founders of the now defunct but for decades influential US-based Global Business Network (GBN) consulting firm, suggested (p. in his book 'The Art of the Long View' that the critical uncertainties that 'dance' (p.122) with predetermined elements can be grouped as a single main axis, as a 2x2 matrix, or as a volume (3 axes) and noted 'The point is to identify the two or three factors or trends that are most important and uncertain', [11, p. 228] and 'Determining these axes is amongst the most important steps in the entire scenario-generating process', [11, p. 229]. The training programmes that GBN offered focused for many years on the deductive method and many of the published scenarios developed with the involvement of GBN showcase scenarios tend to be depicted as a 2x2 matrix. An example was the 2007 "Energy Strategy for the Road Ahead" scenario set [29].

The deductive scenario generation process

In the deductive method presented by Schwartz and his GBN colleagues, the scenario generation process typically commenced with the definition of the scenario agenda i.e. a focal issue or key decision – not typically with a central actor's business idea as is the case in van der Heijden [30]. The next step was the identification of key factors that influence the development of the focal issue. These factors were located in the contextual environment i.e. beyond the direct control or influence of the scenario client or user: contextual factors are those with which the user does not and cannot interact. Once these contextual factors had been identified the next step was to identify two causally independent "key driving forces" by prioritising the list of factors in terms of impact and uncertainty.

The structure of the scenarios – or scenario framework – was developed in the form of a 2x2 matrix; and the matrix was derived from the choice of the two causally independent, key driving forces. Some commentators have suggested that it might be more useful to distinguish the two structuring factors not by uncertainty and impact but in terms of how uncomfortable they are to the status quo of the user and the relative ignorance about the nature or timing of that impact for the user community [31]. If the two factors, which make up the 2x2 axes are not casually independent, the two-dimensional possibility space they map collapses.

It is worth noting that more than two uncertainties can be used to form the space of possibilities that the scenario set explores e.g. a 3x3 matrix can be used to create a volume of possibility, according to Schwartz [11, p. 229]. Examples of work he was involved in that used this approach was the work with Cisco on the future of the internet and the work with the World Bank on its future contexts [32] derived from three positions among 8 in a cube made of three sets of bi-dimensional factors. Such 3D possibility spaces can in principle be also produced using multivariate, cross impact balance calculations of course, and are not unique to the deductive approach [33, p.10; 34].

The axes are derived by converting the two higher priority factors (from the context) into 'driving forces' (driving the future of the transactional environment or of the focal issue) and then giving them dimensionality or calibration so that they can be represented as either as 'either/or' choices along a continuum or as ordinal or cardinal measures. The choice of the nature of these metrics (ordinal or cardinal) is, as we show in this paper, important and carries substantial implications for how to scenario sets thus produced are interpreted, used, and assessed.

Strengths and Weaknesses of the Deductive Method

The existence of a 2x2 matrix method in scenarios should come as no surprise given the common use of the prevalence of 2x2 media in representing and sharing information [35]. Using two dimensional (2D) representations in a matrix manifests opposition and creative tensions, which often helps to get to the heart of puzzling situations and archetypal dilemmas. Lowy & Hood (2004) noted the power and popularity of 2x2 matrix thinking in terms of reframing situations and in enabling a metaphoric capacity to envision whole, complex situations and scenarios that allows a vast array of possibilities to be seen quickly [36]:

The scenario literature includes the following advantages of the deductive method:

- It provides an intellectual feel to address problems [25, p. 57]
- It avoids the reductionist extreme of rationality implied in a single forecast that offers the most probable projection among a set depicted as low, best case, or high projections which assume continuity in systemic conditions. In effect, any forecast implicitly assumes a scenario but without revealing and testing the assumptions associated with it
- It clarifies or clearly models a complex situation in a way that enables consideration of alternative perspectives and new solutions
- the clarity of the 2x2 matrix is easy to communicate to those not involved in the scenario building process
- the structuring the 2x2 matrix using polarised outcomes for each key driving force encourages consideration of more "extreme" futures outcomes [37].

Drawbacks of the deductive building method can be that the resulting scenario set is considered too obvious or simplistic; for example assuming independence between variables rather than exploring more interesting challenges implied by their co-evolution. Thus one choice of one axis might be the emphasis on policy making versus environment, thus removing the future possibility space in which there a progressive role for markets and enterprise in achieving environmental improvements. Another shortcoming of this deductive building method, in terms of appreciating and understanding complex, adaptive systems, stems from the limiting selection of only two top-down, driving forces to shape a whole set of possibilities that can be seen only through a bi-dimensional (two axes) topology [38].

Whilst the classical way of producing the deductive method in the form of a 2x2 scenario matrix will produce four distinct scenarios, the time and resources needed to use four scenarios in a scenarios-to-strategy process need to be borne in mind. An organisation should avoid building more scenarios than it can use. Furthermore, and perhaps because of the latter point, the resulting four scenarios are not always perceived to be equally plausible, leading to one quadrant being 'air brushed' out rather than the whole set rethought in equally plausible terms [17]. An example is the scenarios the WEF conducted on the future of India in the early part of the century [39].

The focal issue/question-led nature of the Schwartz-inspired deductive method can also result in premature closure of the problem space, in contrast to inductive and abductive [40] scenario generation. Thus organisational processes can with this method all too easily and too quickly rush to reduce anxiety associated with uncertainty and move participants too early to get to solutions by using either probability or plausibility to stop rather than to further inquiry; before or even instead of engaging in a deeper understanding of how the context of the focal issue may re-define the problems that need to be solved [17].

Reviewing the Nature and Role of the Axes in the 2x2 Approach

The axes 'determine the story's outcome' according to Schwartz [11, pp.101-102]. The role these axes play in the construction of the end scenarios, however, depends on the choice of two methodological alternatives he did not consider. The axes can form the basis for the structure around which the entire process takes place – as he suggested – but also and instead as positioning devices in different imagined, plausible, future timescapes [41].

Van Asselt et al.[9] uncovered four different functional meanings that different uses of the 2x2 matrix approach they studied through extensive ethnographic research of actual practices of the deductive building method and a review of the relevant scenario literature. They used metaphors to describe each of four distinct functions that the 2x2 approach has been found to have in practice, each with its own distinct meaning [9, p. 75]:

- Backbone: here the 2x2 matrix plays the role of a positivistic tool in which the two driving forces are taken to determine the four possible scenarios that will be used. The two axes provide the backbone defining the distinction among the four produced futures, and from which each of the four possible futures are told.

- Foundation: here the 2x2 matrix is taken to be a procedural device or 'frame'. This foundation is considered as the conceptual bedrock upon which the both the set of four scenarios yielded by 2x2 matrix, and each of them. The axes are the foundations of considering the future in a 2D possibility space. This –we propose- matters as the media in which the scenarios will be manifested, and with which they will be communicated, shared, tested, and contested are 2x2 media such as paper sheets, computer screens, and overhead projections.

- Scaffold: here the 2x2 matrix is taken mostly as an ordering device and transitional [42] object. This means that the framework that sustains the scenarios –even the scenario set itself- is designed to be used (to build a courageous strategic conversations), and once this conversation has taken hold, the framework and the scenarios have served their purpose and can then discarded. Scenarios are in this view not ends in themselves but means to something else.

- Showcase: here the 2x2matrix is taken to act as a presentation format that positions scenarios in a 2D possibility space. Here the 2x2 matrix acts as an explanatory enabler of clarity of communication about differences. In this role, the axes do not represent driving forces as such; instead they are used to manifest the scenario set as a whole. Indeed, some scenario sets manufactured by means other than the 2X2 matrix method are represented in this manner to offer contrasting clarity among the scenarios.

Re-interpreting the 2x2 Matrix

In our exchanges with each other and with our students we found that there is a fifth possibility that Van Asselt et al. [9] did not consider, and this 5th possibility rests on a methodological choice. The choice has, we believe, never before been made explicit.

The choice is whether one deploys each of the two axes in the 2x2 matrix to represent a continuum ('grid') with more-less calibration in each axis; or if instead it represents incommensurate possibilities ('frames') with an either/or calibration in the axes.

If the metrics used in each axis dimension are cardinal dimensions – "either/or" polarised extremes – the resulting 2x2 matrix represents a set of incommensurate 'frames'. If however, the metrics are

ordinal – "more- less metrics" - the resulting 2x2 matrix offers a 'grid'- of latitude and longitude in a time-map depicting a timescape [41]. In this mode, the scenarios that the matrix maps (which can be four or fewer, or more) can coexist, overlap and are not mutually exclusive of each other.

We below validate these interpretations as existing in practice, explore each, and then compare their advantages and uses.

Incommensurate Frames: advantages and limitations

Examples of scenarios developed using polarised either/or metrics to construct a 2x2 matrix include:

- In the 2001, the International Panel on Climate Change (IPCC) developed a set of forty greenhouse gas emission scenarios. They included economic, environmental, global and regional considerations in estimating the quantities of CO_2 that humans may produce over the next 100 years. These scenarios were grouped into a 2x2 matrix of four sets of storylines reflecting the models used to develop the emissions scenarios i.e. whether the focus of the model is on economic considerations vs. focus on the environment, and, whether models focus on regional factors vs. global factors [43].

- Scenarios Compendium, Natural England Commissioned Report NECR031, 27th November 2009. This review of 32 sets of scenarios contains multiple examples of cases in which the either/or approach to developing the axis of the scenarios matrix has been followed [44].

- Consumer Futures 2020, Forum for the Future. This set of four scenarios explored possible patterns of consumption in 2020. In each scenario, the predetermined element is that consumerism will become more sustainable in the near future [45].

The deductive building method description provided by van der Heijden notes that "each axis is developed using orthogonal uncertainties, expressing each driving force in terms of their dual scoping outcomes will then create a 2x2 matrix"[3, p. 245]. Similarly, Schwartz [11, p.242] suggested the scenarios should be extreme: "they should keep the stakeholders awake at night". This terminology of polarised and even extreme outcomes hints at the value of the deductive method in defining a 2x2 matrix as a possibility space of co-existing yet incommensurate futures.

By grouping the factors hierarchically and choosing the two most important ones, the deductive method with cardinal measures aims to produce a structure among the factors that the scenarios have investigated. The resulting structure that is thus produced determines the nature, main

storyline, and contrast among each of the (typically) four possible scenarios (one per 'box') that the structure yields. As van der Heijden [3, p. 205] noted "this approach is only practical if two or three overwhelming driving forces can be identified". The scenarios are defined by the combination of the two mutually independent axes: each of the four quadrants of the 2x2 matrix contains one scenario, and by definition, they are considered to be mutually exclusive of each other, with virtually no overlap among them.

An emphasis on manufacturing scenarios with the either/or framing (approach is that framing is better suited to appreciate discontinuity. This is helpful if clarifying such distinctions is the purpose way scenarios are intended to be used. Indeed, from their analysis of scenario practice, van Notten et al [46, p.177] noted that an important feature of scenario work is this exploration of potential discontinuity which they define as 'a temporary or permanent, sometimes unexpected, break in the dominant condition in society' (p. 179), distinguishing gradual from abrupt discontinuities.

In the frames interpretation of the deductive method, the present day is represented by the cross-point of the matrix. And the present in the frames matrix can only be located in that centre. The past cannot be present in this scheme.

The advantages of selecting either/or metrics as the foundation for constructing a 2x2 matrix of four mutual exclusive future contexts, we suggest, arises as scenario practitioners seek to constructively engage with different types of uncertainty. For example:

- Ambiguity: the value of revealing, respecting and relating different perspectives and deeply held worldviews. A set of 2x2 scenarios provides a way to map out strategic framing contests reflecting different worldviews and/or navigate parallel paradigms. This can create a space for constructive disagreement about means and ends and prevent a premature drive towards consensus, in a way that enables new and different voices to participate in the strategic conversation.
- Complexity : the fuzziness of the boundary of open, complex and adaptive systems can be navigated by looking at the system from the multiple perspectives of a situation, clearly distinguished by and reflected in different scenarios.
- Discontinuity: making explicit key branching points in the evolution of a situation. These branching points can arise from the interplay of contextual factors, including policy choices where this is a relevant contextual factor.

As such, in this interpretation of the 2x2 matrix the future can unfold in any one of four directions, and each quadrant represents a different 'frame' e.g. worldview, system perspective (i.e. formal model), and/or or path dependency. The axes represent a discontinuity in logic or system evolution and thus the 2x2 matrix operates as a set of alternative, mutually incompatible frames.

In the frames interpretation of the 2x2 matrix, the four scenarios co-exist only as plausible futures in the present. Once a quadrant is metaphorically 'entered' into, or once the future unfolds roughly as the quadrant would lead one to expect it to unfold, the other three scenarios cease to exist unless there is a return to the exact same state as the present day i.e. the intersection of the axes.

The frames interpretation can, in effect, represent four different path dependencies of system. Each scenario can explore alternative pasts of a system in combination with plausible, alternative future trajectories to imagine and explore tipping points and lock in. In its present form, the system can be considered to be simultaneously in early phases of all four futures, but the value of the scenarios is to help clarify and make explicit the existing path dependency and explore how and why business-as-usual outlook might not hold in the longer term.

There are several scenario planning situations where attention to incommensurate frames is an integral part of inquiry that is consistent with post-normal science [47; see also 48]. Thus, here scenarios:

- Clarify and help navigate strategic paradigms, [49], and/or
- Reveal and respect different perspectives, [50], and/or
- Clarify a new sustainability paradigm and inform transition pathways [51], and/or
- Highlight cultural assumptions and biases [52] and/or
- Attend to how issues have been framed and can be re-framed [53]

Roubelat harnessed Kuhn's [54] concept of scientific paradigms to suggest that scenario planning "plays a sensemaking role to challenge strategic paradigms of organisations and to rethink their internal and external borders" [49, p. 519]. He further noted that when "driving forces based on only on trends [rather than weak signals] the assumptions of the scenarios are often consistent with the dominant paradigm so that such scenarios rarely challenge the dominant paradigm" [49, p. 521]. Similarly, Rotmans et al. [55] highlighted that 2x2 scenarios are often developed from a narrow, disciplinary-based perspective on a limited set of standard economic, technological and, to a lesser

extent, environmental assumptions. The implication is that over time a form of conventional wisdom (established paradigm) becomes dominant and is eventually displaced by another (new paradigm). Scenarios are used to imagine how this transition might occur before it begins to.

Van Asselt & Rotmans [56] studied how the concept of pluralism considers different perspectives on uncertainty as a legitimate and even foundational concept. They coined the term 'perspectives-based' school to describe scenario work where the value of scenarios is in revealing and respecting different worldviews in environmental policy making. Each scenario is developed through a specific perspective "the perceptual screen through which people interpret or make sense of the world and its social dimensions, and which guide them in acting'' [56, p.15]. Each scenario thus reflects a 'worldview' (how the world is perceived) and a 'management style' (how people act). These perspectives encompass fundamental values, beliefs, and norms that help interpret uncertainty and inform action. In perspective-based scenario analysis, the 2x2 matrix is used to delineate how the future might unfold according to the different myths of nature and worldviews accorded by cultural theory [13; 57].

Failure to attend to incompatible paradigms and alternative worldviews can lead to big oversights in foresight. For example, in their critique of Shell scenarios, Elkington & Trisoglio [52] drew on cultural theory to offer an explanation of why Royal Dutch Shell was in danger of losing its licence to operate when it sought to identify a socially acceptable solution for its Brent Spar oil platform in the North Sea. Despite Shell's reputation for scenario planning [58, 28], these authors noted that Shell scenarios at that time failed to incorporate an Egalitarian perspective into its scenario framework at the time. Similarly, with Causal Layered Analysis Inayattullah [59] offered a way to render plausible alternative futures more understandable, and to reveal the deeply held worldviews and myths that underpin the dominant litany and would otherwise remain implicit.

The value of scenarios is not simply their role in enabling respect for different worldviews but also in helping to avoid a polarisation of perspectives or a reduction of archetypes to stereotypes. Scenarios encourage learning between worldviews. With a focus on looking beyond the still unfolding financial crises, Wilkinson & Ramirez [53] indicated the power and value of scenarios as framing (and reframing) devices. In this role scenarios reveal deeply held assumptions concerning the nature, boundaries, and nature of the financial system, the economic system of which it is a part, and the

wider contexts of which they, in turn, also forms a part. Whilst these authors do not use the 2x2 matrix approach to structure or showcase their resulting two scenarios, the emphasis on scenarios to be break established conceptual frames is consistent with the contrasts that the 2x2 matrix offers.

The above approaches show that the mutually exclusive, cardinal nature of the 2x2 scenarios matrix approach is important from the point of viewing the future in terms of incommensurate paradigms, rather than simply in terms of contrasting perspectives representing different interests but operating under the same paradigm. When one of the quadrants in the 2x2 matrix is taken up as a frame, it makes what is expressed by someone in any of the other three quadrants unbelievable. This approach to the 2x2 matrix thus invalidates an ordinal interpretation, i.e. the movement across an axis involves an ontological discontinuity rather than an incremental change.

Another interest of interpreting the 2x2 matrix as mutually exclusive scenarios is when scenarios are used to appreciate complex socio-technological systems to consider transition and its management. Transition management involves interventions that support shifting a system from an unsustainable trajectory to a more sustainable one. It typically involves path dependency and a normative future [60]. In transition management scenarios can help to clarify path dependency and explore how a system (such as transport, food or, energy) might become locked (increasing system fragility) in or be shifted onto other trajectories (maintaining system agility).   Transitions can occur at three 'levels' –landscapes, regimes, and niches; thus the changes considered are not only over time but also include interactions among levels, offering a multi-level perspective [61]. A system might shift or flip from a pathway to another path but cannot exhibit two path dependencies at the same time.

Another reason for interpreting the 2x2 matrix method as mutually exclusive concerns how it represents temporality in the scenario framework. We saw above that 'now/today' in this approach is positioned at the crossover of the axes whilst each quadrant represents a future possible end state. Another way to think of this is to imagine the 2x2 matrix projected onto a screen, with today located within the projector. The pathways from one scenario to another are not represented by relative positions within each quadrant, but as different trajectories connecting four different tomorrows (on the screen) to today (in the projector). This is perhaps why a book co-authored by Schwartz was called 'seven tomorrows' [62]. Moving from one scenario to another in this view requires consideration of branching points in the journey in time from the projector to discover the points in time when a scenario trajectory might tip into another [63].

17 | A c c e p t e d   f o r   p u b l i c a t i o n   i n   T e c h n o l o g i c a l   F o r e c a s t i n g   &
S o c i a l   C h a n g e   o n   O c t o b e r   1 7   2 0 1 3 .   F o r t h c o m i n g .   D o   n o t   c o p y
o r   r e p r o d u c e   f u r t h e r .

Timescape grids: advantages and limitations

We suggested above that if each axis of the 2x2 is calibrated as 'more - less' rather than as 'either/or terms, then the matrix maps future timescapes. Examples of scenarios developed in this way include:

- Scenarios for the Dutch Ministry of Justice to be able to track unfolding possibilities and avoid the urgent driving out the important [64]. In Figure 6 the unfolding of the world from 2001 to June 2007, and then the expected future, were mapped across different scenarios [65].
- Scenarios for the outcome of the economic crisis. Rather than polarising the future as top down reform of institutional power vs. bottom-up insurgency, two of the scenarios explore different patterns that might emerge from a coevolution of top-down <u>and</u> bottom up driven institutional innovation [66].
- A range of plausible futures for the rapidly changing field of biosciences which developed four alternative scenarios based upon two "meta-uncertainties": one, the capacity of science to deliver solutions; and the other, the public's acceptance of bio-pharma industry changes [67, p. 3].
- Global scenarios for 2025 exploring how the world might look like [68]

In each of these cases, the resulting grid is equivalent of spatial longitude and latitude, but in time, not space. In contrast with the 'frame' matrix construct, with the 'gird' matrix structure the present day can be located in any of the quadrants – as can be the past.

Thus, constructed in this manner, the 2x2 matrix can be used to track positions of plausible futures in a more flexible topology of possibilities over time than the limited set of only four possibilities afforded by the either/or format surveyed in the prior section.

There are several advantages to working with the 2x2 matrix with both-and axes. The first is that one is no longer 'logically put into' an automatic choice of four logically incompatible scenarios. One can choose points in the map of the future timescapes which best serve the purposes of the scenario engagement. One can choose, 2, 3, 4, or more scenarios using this approach.

A second advantage of the timescape grid approach is that it allows history to be mapped as well as possible futures in the same timescape grid representation. Facilitators using this approach can ask

18 | A c c e p t e d   f o r   p u b l i c a t i o n   i n   T e c h n o l o g i c a l   F o r e c a s t i n g   &
S o c i a l   C h a n g e   o n   O c t o b e r   1 7   2 0 1 3 .   F o r t h c o m i n g .   D o   n o t   c o p y
o r   r e p r o d u c e   f u r t h e r .

participants to position the current situation of the context of the organisation they are working within the 2x2 grid map. Often differences of where individual participants might locate their organisation's context in the grid timescape map arise. These differences provide each individual an opportunity to assess what colleagues have been assuming, and to better understand and explain what they themselves have been assuming. These conversations help them to better understand the similarities and differences in their respective appreciations. In an exchange of this kind with senior executives of a major firm supplying Fiat, the dialogue on the different positions led to a mutual appreciation of a long-lasting and to up to then troublesome misunderstanding that had affected their relationship for several years.

With this 'both - and' mode of the 2x2 matrix participants in scenario building and scenario analysis can place not only the present situation of their context in the map they have constituted, but also where they consider their context was 10, 20, or more years ago. By comparing any one position at any point in time in the past with the others in the present and expected futures, they can see the direction of travel of how the context has been understood, and is now being understood over the relevant time intervals. This can lend itself to interesting inter-generational contrasts. It allows them to consider where their existing strategy or mission implies they have actually – often implicitly – been expecting the contextual environment to be when the implementation of that strategy has been undertaken. The difference of position in the timescape grid shows the assumptions in terms of the two main drivers that have been selected in the 2x2 matrix. Other axes used in other iterations of the 2X2 can then yield other insights, until comprehension saturation is reached.

Of course, as a map of temporal possible positions in the present, past and future(s), the yet-to-happen futures could be located anywhere in the 2x2 grid map if the time horizon allows for them. An important difference between the 2x2 grid map and the 2X2 frames version of the matrix is that the grid map allows for two or more of the future scenarios it maps to happen simultaneously, but affecting different market segments or different locations. Or the multiple scenarios could happen sequentially – earlier in the future one might find oneself in one possible future context, later on in another context. This invites broader thinking of future possibilities than is the case if the axes are considered in either/or terms, with only one future possible. While possibly enabling a more nuanced and rich conversation and contrast, the contrasts are also harder to share with people who have not been in the initial conversation that defines the scenario set. Extra care must therefore be dedicated to clarifying the differences and similarities among the scenarios produced with the help

19 | A c c e p t e d   f o r   p u b l i c a t i o n   i n   T e c h n o l o g i c a l   F o r e c a s t i n g   &
S o c i a l   C h a n g e   o n   O c t o b e r   1 7   2 0 1 3 .   F o r t h c o m i n g .   D o   n o t   c o p y
o r   r e p r o d u c e   f u r t h e r .

of grids, and in the design of the engagement of the scenarios with users who have not been involved in producing them.

Another potential disadvantage of the grid 2x2 approach is that if it is not properly handled, the scales of the axes – and the axes themselves – need to be much more clearly determined and communicated than with the either/or 2x2 frames approach.

In short, while offering potentially richer and more nuanced possible futures, the insights the grid approach of the 2x2 matrix produces are often also less self-evident, and extra investments in clarification and communication may be required to obtain the advantages.

Concluding remarks

In the way we teach and practice scenarios we go to great length to emphasis the choice of method cannot be decided independently of considerations about who the scenarios are for (the 'user') and how exactly the scenarios will help the user create value (the 'purpose' and the 'use'). We teach that fudging either will contribute to disappointment and, quite possibly, engagement failure.

In many situations it takes a lot of effort to clarify user and purpose in scenario work; sometimes a user (or set of users) must be manufactured and supported. And often the user and the purpose changes as the engagement unfolds, and re-contracting is called for.

The challenge of identifying client(s) and purpose and use is, in our experience, often overlooked in the choice of scenario building method. Given the diversity of different traditions of thought and scenario building methods the potential for methodological confusion and misunderstandings is already considerable in the practice-led field of scenarios. This diversity can make it difficult to clarify what works in the context of claims of effective practice, unless choices of client, purpose, use, and method are made explicit alongside claims of effectiveness.

In this paper, we have highlighted how the choice between "either/or frames" and "more-or-less grids" for manufacturing the 2x2 axes has all too often remained implicit but carries significant implications for how the scenarios are used and made useful. We suggest that making the choice of whether axes are going to be constructed in an "either/or" or in a "both-and" manner matters and that making the choice explicit will help scenario practices become more effective.

If the 2x2 matrix is to become stabilised as a standard method for scenario work, then these different interpretations of choice within a method, within a scenario tradition (or school) matter. The ontological assumptions a given user will be making on what they consider the future to be, and which theories in use they deploy epistemologically to engage those futures can inform the choice. For example, in some professional or organizational cultures, it is important to choose among different futures (think of elections in democratic countries); while in others, multiple future possibilities can be entertained simultaneously as equally plausible for long periods of time.

The perceived nature of the future in the two different interpretations of 2x2 matrix discussed in this paper are not the same: the futures-to-come in the frame-based interpretation are mutually exclusive of each other; those in grid-based interpretation could happen simultaneously. In both interpretations the 2x2 deductive method of the intuitive logics school reject probability and maintain plausibility of alternative/multiple futures. Both treat the future both as a fiction (not fact) in the present, and as important guides in action in the present and near future. Both are used for prospective sense-making [69].

Our purpose in investigating and clarifying circumstances where the frame-based and then the grid-based interpretations for the 2x2 matrix might be most helpful is not to complicate matters for those that choose to produce their scenarios with the 2x2 matrix approach. Instead we seek to clarify problems that we know practitioners are encountering, problems that have not been rendered explicit and sufficiently addressed in relevant scholarly literature. As scenario planning is a practice-led field characterised by continuous innovation, diversity and methodological confusion, we aim to help reflective practitioners to understand possible difficulties when using a 2x2 set, particularly with those who were not in the room when the scenario set was being developed. It helps clarify in advance of building actionable insights whether scenario sets best help to develop new strategic options through clarifying mutually exclusive possibilities (frame) or by attending to the timing or phasing of possibilities that could all unfold (grid).

If the 2x2 matrix is indeed the most used scenario approach in the world, as suggested by the researchers we cite, further research will clarify the extent to which each of the two interpretation of method, "either/or frames" and "both-and grids" are been used.

Further research could also help determine appropriate evaluation criteria for each approach. . In either case, the criteria used to evaluate effectiveness will not be prediction, whether in terms of

21 | A c c e p t e d   f o r   p u b l i c a t i o n   i n   T e c h n o l o g i c a l   F o r e c a s t i n g   &
S o c i a l   C h a n g e   o n   O c t o b e r   1 7   2 0 1 3 .   F o r t h c o m i n g .   D o   n o t   c o p y
o r   r e p r o d u c e   f u r t h e r .

forecasts being realized, probabilistic confidence, or decision outcomes. Instead it will centre on how the scenarios enabled strategic conversation and attention to the quality of judgement of the specific client and purpose(s) they were designed for.

The table below summarises the distinctions we hope this paper has clarified for those wanting to use the 2x2 matrix approach in the future.

Comparison of two ways of using the 2x2 matrix in deductive scenario planning

2x2 matrix approach	Futures that can come about	Mutually incompatible or compatible	Position of present and past	Communicating the scenarios to those not producing them	Scenarios that result	Temporality of the scenarios
'Either/or' frames	One of four	Mutually incompatible	Present located at centre of matrix, not in any of the scenario quadrants	Clear and memorable framework that provides a structure for rich storytelling about the interplay of factors and actors in each quadrant;	4 'extreme' incompatible but plausible futures that help clarify branching points and enable comparative analysis	From now to one of four possible future contexts
'Both-and' grids	Several at once	Possibly compatible, possibly sequential	Present and past in any location on the matrix	More nuanced storytelling and contrast: extra attention and effort must be invested in comparison, communication and engagement	Small set (≥2) of plausible alternative contexts that can represent past, present & future situations	From past to present to several (≥2) possible future contexts

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