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Scenarios and the growth of knowledge: Notes on the epistemic element in scenario building

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Abstract

Scenarios raise a very remarkable challenge. They are a special category of thought experiments and as such they deal with the domain of the "possible" and "probable", i.e. with the world of speculation. Nevertheless they are of a crucial practical importance for public policy, management and strategic thinking in general: any premeditated significant action has to be preceded by such a thought experiment that anticipates the possibility of its outcomes and its implications. The question is then, how could speculation have such a crucial epistemic role? What kind of knowledge, if any, do scenarios produce? What is the epistemic role of scenarios? The objective of this article is to discuss the controversial but crucial issue of the epistemic functions of scenarios and to outline several possible approaches to it. The article explores the relevance in this respect of the research that has been already done on thought experiments, de-biasing, deductive arguments and uncertainty—and complexity—coping cognitive devices while indicating the potential contribution of that literature to the further development of the scenario building practice and of the futures methodology.
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1. Introduction

Despite its achievements in the practical world of business and public policy, the scenario method felt short of a similar success in the academic world. It is intriguing that given their crucial role in management, public administration and decision-making in general, and the fact that they are practiced

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on such a large scale as a necessary condition for social action, scenarios have been so marginal to academic interest in social sciences, even after their firm establishment as a significant forecasting practice and as a basic tool in the future studies toolbox [1–3]. One reason for this situation might be due to the fact that scenarios have a puzzling nature. On the one hand, they are conditional counterfactuals that deal with the domain of the "possible" and "probable", i.e. with the world of speculation. On the other hand, scenario analysis, scenario building, and scenario planning are indispensable for any social activity based on choice and deliberation: political, business or military. Many users and devisers of scenarios have implicitly, by the very act of using or devising them, accepted that these cognitive constructs yield valid, important and useful knowledge. The question is then, how could speculation have such a crucial epistemic role? What kind of knowledge, if any, do scenarios produce? The reluctance of the academic world to embrace scenarios might be a result not only of the epistemological rigidity imposed by the long dominance of logical positivism in social sciences but also of the fact that the answer to such questions is not at all easy. The objective of this article is to discuss this controversial but crucial issue of the epistemic functions of scenarios and to outline several possible approaches to it.

2. The paradoxical epistemic nature of scenarios

Scenarios are a natural reflection of human nature, of the fact that, as Nicolas Rescher put it, "*homo sapiens* is an amphibian who can live and function in two very different realms—the domain of actual fact which we can investigate in observational inquiry, and the domain of imaginative projection which we can explore in thought through reasoning" [4,p,31]. Scenarios are a heterogeneous class. Not all scenarios function in the same way. Not all scenarios seek to do the same thing. Not all scenarios have a similar structure [5,6]. However at a sufficiently abstract level, they share enough ground to be amenable to a common theoretical treatment. A "scenario" is an attempt to draw instruction from a process of hypothetical reasoning that proceeds by drawing out the consequences of an hypothesis which, although may be anchored in well established facts, refers to future (that is possible) developments. Thus it consists in reasoning from a supposition whose truth status is uncertain but is assumed provisionally as certain in the interests of developing a broader image of its implications, consequences and assumptions [7,2,8,3]. In this respect it is important to note that the scenario is a special instance of thought experiments, as thought experiments scenarios belong to the realm of imaginative projections. Nevertheless they are of a crucial importance for the domain of the actual: any deliberate real action of importance has to be preceded by a thought experiment that anticipates the possibility of its outcomes and its implications. Hence, although epistemologically weak and dubious, the elaborated imaginary projections called scenarios have a major role in business and public life as the less sophisticated and intuition based forms of such projections are routinely used in daily life with more or less sophistication by each social actor.

Thus scenarios are defined by a double paradox: on the one hand, they are part and parcel of any form of deliberate social action. On the other hand, they are conditional counterfactuals that deal with the future. As such they deal not with the realm of "is" but with the realms of "will be" and "possible", i.e. with things that do not exist and may never exist. From an epistemological standpoint this predicament is highly dubious. Yet scenario development, scenario analysis and scenario planning are decisive in any strategic activity: political, business or military. The question is then, how is it possible that this kind of intellectual exercise has a cognitive contribution? How can scenarios guide action in the real world if

they deal in fact with only with the realm of the possible? Do scenarios change the epistemic situation? What is the epistemic role of scenarios? Do scenario have a knowledge production role? What kind of knowledge, if any, do scenarios produce? Scenarios deal with the domain of the possible and probable, that is with the world of speculations. How could speculation have a cognitive function? These are very important questions. Dealing with them is a necessity especially now that the role of the notions of "empirical" research or "hard" evidence in science are reconsidered, and the tendency to relegate outside the sphere of serious scholarly considerations inquiries that are deviating from the positivistic standards is fading away. That is the main reason why scenarios, indispensable as they are in practice, still need a justification in the epistemological court. This tension between the epistemological status of scenarios in theoretical context and their practical meaning and importance is crucial, and requires a careful consideration.

The reservation towards scenarios generated by the questioning of their cognitive efficacy outside the Futures Studies discipline has generated a defensive or at least an ambiguous position towards them in this respect, within the discipline itself. Many users and devisers of scenarios have implicitly, in the act of using or devising them, accepted the validity, importance and usefulness of the knowledge they generate. However, many, in their eagerness to distance from the claim of being able to generate prediction, tacitly shunned the notion of a knowledge-production capability of scenarios. Instead they displayed a non-commitment to epistemological claims and emphasized the scenarios' role of "mental gymnastics": their "propaedeutic" role in aiding decision-making. To avoid the frustrating effort of justifying the epistemic claims on behalf of scenario building, they tended to stress the instrumental value of the procedure.

The ambiguity of this status is obvious: On the one hand a "scenario" is defined as "a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out" or as "a set of organized ways for us to dream effectively about our own future" [9,3]. However, at the same time, the cognitive element is strongly implied: although scenarios are not predictions because "it is simply not possible to predict the future with certainty" they are "vehicles for helping people learn" [9,3]. Learning involves by definition a growth of knowledge and thus on the one hand, a claim to knowledge is softly downplayed while at the same time another identical claim is made in a disguised form.

Given these circumstances it is evident why exploring the epistemic–cognitive functions of scenarios and to illuminate and explain them is a priority of Futures Studies scholars. Scenarios are an unmistakable cognitive procedure that is practiced in intuitive and unsophisticated forms as a necessary condition for social action on a very large scale, formally and informally, with great dedication and versatility by millions of individuals and corporate actors on a daily basis. Due to its importance, it is legitimate to ask what is the nature and content of this procedure. Scenarios even in their most embryonic forms change the epistemic situation and that change represents in most cases an epistemic value-added. The rest of the article is an attempt to elucidate the notion that scenarios have important epistemic functions and to outline some of the main facets of those.

3. The epistemic facets of scenarios

The strength of scenarios and their utility is mainly deriving precisely from their ability to marshal and project into the future scanted and frail cognitive resources and thus to offer a decisive support for

decision-making. A closer analysis of the scenario practice reveals that there is a lot of epistemic content that the scenario process deals with and marshals. The epistemic dimension is essential and in fact, the scenario practice and its methodology are directed precisely at this element. If that is the case, the practice of scenario may be based in imagination, but its substance and final target are of a cognitive nature. Left without the cognitive dimension, scenarios remain just pale psychological exercises meant to alleviate fear, to motivate and to please imagination and esthetic urges about the future.

The importance of dealing with the epistemic dimensions of scenarios is double: a "positive" or "descriptive" one and a "normative" one. The positive aspect is a reflection of the need to understand more exactly what is going on in the innumerable cases when social actors marshal evidence, check it and try to project the knowledge gained as coherently and reliably as possible into the future in order to form expectations and strategies for action. The normative aspect refers to the very method of scenario building and the importance of trying to be as effective and realistic as possible in this respect. In order to get maximum effectiveness in scenario development, as in the case of other future studies methods and approaches, it is mandatory to construct a method that is not purely intuitive but which is defined by clear procedures, standards and criteria [7,10–12]. Neglecting the cognitive dimensions could lead to an unwarranted relaxation of criteria and standards and in the end to less reliable and useful scenarios. Understanding the nature and limits of that dimension could indeed improve the value of the process.

The next sections of the article will dwell on the first dimension, the "positive" one. An overview of the forms of information and knowledge creation and management involved in scenario building reveals two different basic ways in which scenarios engage the problem. The first could be described as "psychological" or "propaedeutic", and it refers to psycho-cognitive devices meant to confront uncertainty and complexity and that have the cognitive function of preparing the mind to deal properly with the future. The second could be called "epistemic" and refers to the direct contribution of scenarios to the increase of the stock of knowledge of those that employ them.

3.1. Scenarios as de-biasing and uncertainty- and complexity-reduction cognitive devices

At the most elemental level scenarios have an important cognitive contribution just because they "tend to cater the human propensity to relate best to concrete, causally coherent narratives". Studies have shown that "comprehension of complex evidence relies on weaving intentional and causal accounts around strands of evidence that would otherwise seem disparate and hard to remember". This "causal tapestry" in turn provides "a basis for further inquiry and integration of new evidence" [13].

At a more complex level scenarios are tools for pre-decision analysis. This is in fact one of the original claims made by Herman Kahn, the father of scenario methodologies: "[Using] a set of alternative futures and scenarios, one may see better what is to be avoided or facilitated, and one may also gain a useful perspective on the kinds of decisions that may be necessary" [7, p.6]. By constructing a "concrete" series of "named futures" and by treating all the factors involved in an internally consistent fashion, the objective is to be better able to understand not only the separate factors and their interactions, but also those consequences "that are often overlooked in general or abstract analyses and discussions". By making potential directions and destinations clearer, the analyst may be able to get "a better understanding of the significance of current emphases, of the major alternatives, and of how different these may be" and a "feel" for events and "the branching points dependent upon critical choices" [7, pp.119–121,5, p.262]. However, despite their unique usefulness, Kahn was very keen to remind again and again of their limits and of the fact that they are "pedagogical tools rather than

instruments of rigorous analysis". They are useful to stimulate, illustrate and teach and to provide preciseness and richness to communication. In order to correctly understand them, they should be seen as part of a broader propaedeutic and heuristic methodology. Although Kahn's vision involved an entire battery of methods and analytical devices, the role of scenarios as tools to counter psychological biases stands tall.

The function of scenarios as an uncertainty-coping method aimed to counter psychological biases, has been extensively explored by Schoemaker and others [13–17]. The research done on these lines stresses the fact that in scenario development the focus is not on "single-line forecasting" nor on fully estimating probability distributions, but rather on "bounding and better understanding future uncertainties". The scenario method "caters to people's preference for certainty", by "specifying uncertainty across rather than within scenarios" [13, pp.195–196]. Scenarios constitute a form of decision analysis, which de-emphasizes probabilities and explores in detail selected states of nature. The way scenarios deal with uncertainty differs from more conventional methods which usually "present one model, with uncertainty nested within it". Scenarios instead decompose complexity into distinct states and present several alternative models. These models do not assess probabilities but "bound the uncertainty range" of the mental projections into the future. Also, the scenario method "caters to people's preference for certainty, by primarily specifying uncertainty across rather than within scenarios" [13, pp.196].

Paradoxically, building scenarios can simplify things, in spite of introducing multiple futures. The multiple causal and narrative accounts operate in this case as a complexity-reduction device. The segmentation of complexity reflects an adaptation to the human mind, which can handle only a limited amount of complexity [19]. Scenarios are thus in this respect an extension of this adaptive feature of the human mind. They are a solution to the problem of how to construct models that put order in complex systems defined by complexity and high uncertainty. Deterministic models [linear programming or econometric models] may be adequate only when uncertainty is low, but when both uncertainty and complexity are high, not even the stochastic models can cope. In this case scenarios offer a compromise between the theoretical ideal of formalism and objectivity on the one hand and factual richness and simplicity on the other [18, pp.197–198].

Besides the decomposition of complexity and bounding of uncertainty scenarios represent an alternative method of dealing with complex, uncertain situations in an additional way. Scenarios are very effective devices dealing with biases of the human mind such as overconfidence, availability and anchoring [18,20]. Scenarios reduce overconfidence by depicting futures not yet thought of and by challenging those too easily presumed likely. Scenarios can also be a very effective device in helping overcoming the so-called availability bias, according to which people undervalue that which is hard to imagine or recall from memory [20]. Finally, scenarios can shift the anchor or reference point in function of which people tend to form their views of the future. The typical mental anchor is the past or more exactly some memory of the past. Usually people do not adjust their thinking or if they do so, they tend to gravitate around the "anchor". However, the past is in many ways a highly misleading guide to the future. Alternative scenarios could challenge the past as the dominant key principle in forming the views on the future and thus lead to a better preparedness to cope with it [18].

3.2. Scenarios, thought experiments and the growth of knowledge

The fact that the broad category of thought experiments (of which scenarios are a subclass) were frequently employed in science with great impact from Thales and Newton to Einstein provides a prima

facie case for their epistemological value [21–23]. If that argument is accepted, all one has to do in order to make the case for the value of scenarios is to extend to the case of scenarios the classical arguments substantiating the cognitive value of thought experiments.

In this respect the argument made by the physicist Ernst Mach is paradigmatic. In his classical Knowledge and Error, Mach [24] dedicates a substantial discussion to the role of thought experiments. His theory tries to explain how thought experiments work and how they may carry evidential force. Their function, he writes, is to provide pictures of the new field under investigation. Those pictures are composed of representations of already known phenomena: pieces of information based on known phenomena are put together in new configurations. This reconfiguration or transformation of mental pictures or ideas is based on a natural ability that in Mach's view, is the result of an evolutionary process. In dealing with the world one construct mental models or analogies.

These have a double anchoring in experience: First they are abstracted and extrapolated from experience and knowledge of the world. Second, when those models are modified by performing a thought experiment, one transforms models in a manner that is itself realistic, since it is guided by the experience and knowledge of how the world works. The manipulations by which they are turned into new pictures, the ways in which the mind modifies these pictures—are themselves shaped by principles and logics based in physical experience. Experimenting in the mind is cost-effective and less dangerous. Chances are that adaptive success comes from being able to engage in such mental experiments before being directly and physically engaged in experimenting with the nature [24].

Thus for Mach, the use of analogy, idealization and thought experiment in science amounts to variations of one and the same cognitive strategy that has evolutionary roots. The mental models or pictures represent the world. The manipulations of the mental pictures were defined by a selective variation of one parameter that is similar to that used in ordinary experimentation. The difference is that in thought experiments the method of variation is applied to his mental pictures of the world not directly to a specific aspect of the world [24, pp.140]. However although Mach theorized the thought experiment and made clear its utility in science, he still left ambiguous the crucial details of the central epistemological puzzle of thought experiments: how they can be carried out only in thought and yet have empirical and practical relevance.

In order to find out what kind of new knowledge is produced in scenarios, one needs to look at the very foundations of the process. Seen as experiments, scenarios are thought experiments, and as such they do not directly deal with the empirical reality. Therefore in order to identify the nature of the contribution scenarios have to the increase of the specific stock of knowledge related to the issue the scenario is applied to, one has to look at the way new knowledge is produced through deductive arguments. In a deductive argument two premises with a known epistemic content are put together and lead in a necessary way in conclusion to a changed epistemic situation. A new configuration of knowledge emerges out of the exercise in spite of the fact that no original empirical findings are involved. The mathematical argument leading to "mathematical discoveries" is an example of this broader cognitive pattern. When pieces of different knowledge are blended together and a new configuration of information and knowledge is created, that may bring important new information about the phenomena in question. When knowledge about events, actors and phenomena is combined using theories, laws or common and personal knowledge about regularities and linkages, the new configuration emerging out of the mental exercise is a contribution to the cognitive stock of the actor involved in the exercise. The "new" element is conditional, not factual and empiric. However it allows to reconfigure

information about actors and phenomena in ways that instruct about the situation in question. That in itself would be enough to legitimize scenarios as a viable epistemic procedure. However the epistemic force of scenarios has additional strengths.

Scenarios' value added involves not only the conclusions represented by the novel configuration of knowledge and its implications but also represent an exploratory analysis of the conditions on which the scenario is predicated. In this aspect they fully mirror the scientific thought experimentation meant as a contribution to the elaboration and refinement of theoretical models and that "involves decisions about what are appropriate idealizations and approximations to use" [21]. Scenarios do not simply and automatically employ narrative structures or conceptual frameworks as mere algorithms to be applied to a given set of data [25]. Scenarios do not emerge directly and fluently from the mind of the scenarist. The cognitive process of the scenario analyst is a very complex back and forth between different premises, frameworks and data. Thought experiments derive their epistemic relevance from the fact that they constitute, in a sense, a simulation run on mental models of real-world situations [21,26]. If that is the case a comparison between computer simulations and the special category of thought experiments called scenarios could be instructive in this respect. Similar to the simulations that explore properties of the theoretical model scenarios involve refinements of models and principles used to create them. The new knowledge that they provide involves increased understanding of the conditions under which the model holds. The basic notion is that the simulation methodology is not a mere application of a theoretical framework but also constitutes theory refinement. There is a back and forth movement in a simulation between the theoretical model and output. In a similar way in scenarios there is a back and forth between on the one side, the "possible" events, and situations and on the other side, the models and hypotheses regarding their interrelationships and the dynamics of various processes that define those events and situations. The result is a more credible and realistic image that could undeniably be accounted as a cognitive contribution. Another way of describing the result is to say that the process is better bounding the future possibilities by refining the "theory" used to bound them [18].

In other words, rather than providing immediate insight into a problem area or create imagines of the future by pure imagination, scenarios involve a process of rational assessment. An increased understanding and knowledge are produced by the refinement implicit in the development of the scenario [7,3,27,28]. This refinement, since it is itself based on explicit argumentation, is a rational process with a logical and empirical basis. The researcher involved in scenario development approaches the future with models and hypotheses about causal chains, relations, correlations, consequences, implications etc. An entire battery of theories, hypotheses and intuitions about how things are connected are employed explicitly and implicitly in scenario building. A double refinement, of knowledge and of the framework structuring knowledge takes place.

It is important to note that this emphasis on theory, models and frameworks should not overshadow the importance of data and their role in the epistemic performance of scenario building. As in the case of other cognitive processes, data are crucial. The data on which a scenario is based need to be as close as possible to the real life problems and situations. Various "unthinkable", "surprise" and "chance" elements might be factored in the scenario building process but the initial core should be solidly grounded in existing realities. The more the scenario is grounded in reality before opening in different branches, the better the scenario is. However, as noted, the issue of the issue of data is not specific to scenarios. The problem of the quality of data and how that quality contributes to cognitive efficacy is common to all types of cognitive procedures. Therefore this possible direction of inquiry

remains just mentioned in the context of an article dealing with the epistemic specificities of scenarios.

3.3. Cognitive blending and scenarios

The overview of both the heuristic-psychological and of the epistemic facets of scenarios, revealed their contribution to the cognitive and decision-making efficiency of scenario builders and to the growth of the stock of knowledge available to them. However although for analytical reasons these different mechanisms and processes outlined above could be studied in separation, cutting edge research suggests the possibility of a very effective holistic approach. Recent developments in psychology, cognitive science and philosophy open an interesting avenue of integrating the analysis of these related but distinct dimensions. This integration is made possible by the recent interest in what is revealed to be a crucial mechanism for human cognition: "conceptual blending" or more simply, "blending" [29,30]. Blending is the capacity to take two mental spaces, and connect them in certain ways such that a blended mental space emerges. In other words, it refers to the ability of the mind to take different concepts or mental constructs, form a cognitive link between them and produce a new concept or mental constructs that is a blending together of the first two or more [29,30]. Scenarios could be seen from this perspective as a special instance of blending. The study of this process is still at its beginning however several conclusions already crystallizing are extremely relevant for scenarios and the study of their epistemic content.

The investigations of blends identified three mechanisms by which blends develop: composition, completion, and elaboration [29,31, pp.291–296]. These three mechanisms equally apply to scenarios and their study could disclose significant new information on the epistemic processes involved in scenario building. In the process of blending one selectively composes structure from input spaces into the blend by exploiting the connections between the input spaces. Completion provides additional structure by introducing new elements in the areas left void by the initial concatenation of the input space. Elaboration develops the blend through "imaginative mental simulation according to principles and logic in the blend" [31, p. 292]. As Turner pointed out, "some of these principles will have been brought to the blend by completion. Continued dynamic completion can recruit new principles and logic during elaboration. But new principles and logic may also arise through elaboration itself" [31, p. 292]. Some of the key features of the cognitive process and its outcomes are already familiar: "Composition and completion often draw together conceptual structures usually kept apart. As a consequence, the blend can reveal latent contradictions and coherences between previously separated elements. It can show us problems and lacunae in what we had previously taken for granted. It can equally show us unrecognized strengths and complementarity. In this way, blends yield insight into the conceptual structures from which they arise" [31, p. 293].

One crucial point is that blends are suffused with implicit knowledge: "Blends recruit a great range of conceptual structure and knowledge without our recognizing it". That knowledge is extracted, revealed and amplified by reiteration as blending is a process that can be applied repeatedly, and blends themselves can be inputs to other blends [29, pp. 291–96,30]. Blends capture not only the knowledge existent in the input mental spaces but also theories or principles that may drive the elaboration of the blend in one direction or another. Moreover, the blend "is not a simple cut-and-paste reassembly of elements to be found in the input spaces". On the contrary, blends develop structure not provided by the inputs. Inferences, arguments, and ideas developed in the blend "can have effect in

cognition, leading us to modify the initial inputs and to change our view of the corresponding situations" [31, p. 293,29].

Although the goal of the present article is not to discuss normative scenario building, it is important to note that the study of positive epistemic aspects could have direct practical consequences in the sense of revealing information on how to improve the scenario building practice. The blending literature points out in a new way important features of blends that require a special attention for scenario building: i.e. the fact that composition, completion, and elaboration tend to be selective and recruit from the most favored cognitive spaces and thinking patterns. Consequently, blending is subject to bias. Although the dangers of subjectivity and bias are not news for scenario practitioners, the observation has a very important normative or practical implication. The bias in blends is hard to identify. First, composition, completion, and elaboration operate largely "automatically and below the horizon of conscious observation". Therefore, "we rarely detect consciously the infrastructure in the blend that makes it effective" [31, pp. 293–94]. Second, "since the emergent structure in the blend comes from our favored patterns of knowing and thinking, we are likely to regard biased infrastructure in the blend as unobjectionable even if we somehow manage to detect it" [31, pp. 294]. As a consequence, de-biasing requires more than mere awareness to the existence of the problem and a sincere intention to cope with it: it requires a consistent and solid method. The investigation of the blending process may offer some new insights into the ways to develop that.

To sum up, scenarios, either in the common sense understanding (as a habitual pre-decision procedure) or in the technical understanding (as modeling using interdisciplinary approaches), operate at the epistemic level as a thought experiment and at the cognitive level as "conceptual blending". The study of blends and blending seems to integrate the psychological and epistemological analysis and to open up the possibility of a more robust understanding of cognitive procedures such as scenarios or thought experiments.

4. Conclusions

Scenarios raise a very remarkable challenge. They are a special category of thought experiments and as such they belong to the realm of imaginative projections. Nevertheless they are of a crucial practical importance: Any premeditated significant action has to be preceded by such a thought experiment that anticipates the possibility of its outcomes and its implications. A strategy to explore and illuminate this crucial cognitive procedure could be very constructively inspired by and based on the research that has been already done on thought experiments, uncertainty- and complexity-coping cognitive devices, de-biasing, deductive arguments and simulations. The recent research program focused on (conceptual) blending could provide an avenue for integrating these different literatures and approaches. The importance of these investigations goes beyond the mere descriptive and explanatory levels. These results are an important contribution to the improvement of scenario building practice and of the futures methodology.

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