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Emerald Article: The current state of scenario development: an overview of techniques

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Abstract

Purpose – *The paper aims to review all the techniques for developing scenarios that have appeared in the literature, along with comments on their utility, strengths and weaknesses.*

Design/methodology/approach – *The study was carried out through an electronic search using internet search engines and online databases and indexes.*

Findings – *The paper finds eight categories of techniques that include a total of 23 variations used to develop scenarios. There are descriptions and evaluations for each.*

Practical implications – *Futurists can use this list to broaden their repertoire of scenario techniques.*

Originality/value – *Scenario development is the stock-in-trade of futures studies, but no catalog of the techniques used has yet been published. This list is the start at developing a consensus list of techniques that can be refined as the field matures.*

Keywords *Futures markets, Research methods, Management techniques*

Paper type *Literature review*

Introduction

The scenario is the archetypical product of futures studies because it embodies the central principles of the discipline:

- It is vitally important that we think deeply and creatively about the future, or else we run the risk of being surprised and unprepared.
- At the same time, the future is uncertain so we must prepare for multiple plausible futures, not just the one we expect to happen.

Scenarios contain the stories of these multiple futures, from the expected to the wildcard, in forms that are analytically coherent and imaginatively engaging. A good scenario grabs us by the collar and says, ‘‘Take a good look at this future. This could be *your* future. Are you going to be ready?’’

As consultants and organizations have come to recognize the value of scenarios, they have also latched onto one scenario technique – a very good one in fact – as the default for all their scenario work. That technique is the Royal Dutch Shell/Global Business Network (GBN) matrix approach, created by Pierre Wack in the 1970s and popularized by Schwartz (1991) in the *Art of the Long View* and Van der Heijden (1996) in *Scenarios: The Art of Strategic Conversations*. In fact, Millett (2003, p. 18) calls it the ‘‘gold standard of corporate scenario generation.’’

While the GBN technique is an excellent one, it is regrettable that it has so swept the field that most practitioners do not even know that it is only one of more than two dozen techniques for developing scenarios. There are so many approaches and techniques that go by the term scenario that Millett (2003, p. 16) says that ‘‘resolving the confusion over the definitions and

DOI 10.1108/14636680710727516

methods of scenarios is the first necessary step to bring the value of scenario thinking and development to a wider audience.'' A number of overview pieces have been published recently that respond to Millett's requirements. First, we will address the confusions and definitions, describe our research approach, then review the overview pieces, and finally move into the analysis of the specific scenario techniques.

Confusions

This section addresses three primary confusions in the scenario literature[1]:

1. Perhaps the most common confusion when discussing scenarios is equating scenario development with scenario planning. We suggest that ''scenario planning'' has more to do with a complete foresight study, where scenario development is concerned more specifically with creating actual stories about the future. Scenario planning is a far more comprehensive activity, of which scenario development is one aspect.
2. A more subtle confusion is equating the term ''scenario'' with ''alternative future.'' In other words, all descriptions of alternative futures are deemed to be scenarios. A more narrow definition of scenario would focus only on stories about alternative futures. With this narrow definition, other forecasting methods might produce alternative futures, but not scenarios. In practice, however, the broader definition of scenario as alternative future, whether they are in story form or not, has prevailed. Thus, the complete collection of methods for scenario development includes almost all forecasting methods since they also produce alternative futures. In fact, very little is said about the actual creation of the stories in most methods. More attention is paid to generating the scenario kernel or logic, which can be done by any number of methods. We decided that it does not make sense to fight the battle for a narrower definition, and thus our list of methods is based on current practice and includes the incorporation of forecasting methods whether or not they produce a story.
3. The third confusion involves equating the terms methods and techniques. These terms are used interchangeably in the literature and in practice. There are subtle differences in the terms, with method being focused more on the steps for carrying out the process and technique focusing more in the particular way in which the steps are carried out. As above, however, we bow to the practicalities that the terms are used interchangeably, and do not see it useful to try and make the distinction at this point.

Definitions

Being a new field, futures studies is blessed with an abundance of creative and entrepreneurial practitioners who develop excellent approaches and methods to suit the needs of their clients. After a while, however, the growth becomes chaotic. One solution, as noted above, is to focus on one technique and stick with that. While that solution does reduce the chaos, it does not make the best use of the techniques that others have created and are using.

However, even the most basic vocabulary is used every which way in this field. Therefore, before beginning our review of scenario techniques, we have to decide on what a *technique* is in the first place, as opposed to an approach, or a method, or a tool. Therefore, we offer the following (small) glossary to distinguish these terms from each other so the reader knows what we are talking about and in hopes that others might use the terms in a similar fashion.

We begin first with a *project*. The futures project is the largest unit of professional work. It includes the sum total of the objectives, the team, the resources and the methods employed in anticipating and influencing the future. Projects may be simple, involving just one product and technique, or complex, involving many steps each of which produces one or more products and uses one or more techniques.

The process that one employs in conducting a project is the *approach*. The approach consists of an ordered series of steps to accomplish the objectives of the project. Every project has an approach, whether it is explicitly articulated at the beginning or not. Some approaches are widely practiced, such as the approach to develop a strategic plan.

A generic approach to a comprehensive foresight project is outlined in the six steps shown in Table I.

This approach was used to classify best foresight practices in a forthcoming publication (Hines and Bishop, 2006).

There are many other examples of comprehensive approaches to foresight. At the Association of Professional Futurists' 2004 Professional Development Conference, two of these were described:

1. The Futures Lab in Austin, Texas uses an approach to product and business development that they recently described in *Futures Frequencies* (Woodgate and Pethrick, 2004).
2. The Futures Management Group in Eltville, Germany uses a ''lenses'' approach to strategy development, as described in *Der ZukunftsManager (The Future Manager)* (Micic, 2003).

In fact, most professional futurists and consultants use a favorite approach that they have honed over time.

Each approach produces one or more *products* or *deliverables* that satisfy the objectives of the project. The product is the final result of the work done in the approach – as a report, a database of trends, scenarios in various forms, a strategic plan and many more. Usually each step in the approach generates a product and together they form the deliverable from the project.

A *method* or *technique* is the systematic means that a professional uses to generate a product. We found that method and technique are used rather interchangeably in the literature so it is hard to pick just one. Method carries a solid, organized, even an academic connotation where technique seems to relate more to style than to substance. In a review of terms in articles about scenarios published in *Futures* over the last few years, authors used both terms although they used *technique* quite a bit more[2]. So we will go with that for this review.

A *tool*, another term often confused with method or technique, is more concrete. A tool is a device that provides a mechanical or mental advantage in accomplishing a task. Tools are things like video projectors, questionnaires, worksheets and software programs. By the same token, scenarios and plans are not tools. Some of the best known tools in the field are Godet *et al.*'s (2003) Toolbox and the Parmenides Foundation's Eidos tool suite – formerly Think Tools (Lisewski, 2002).

Finally, an *exercise* or *activity* is a unit of activity within a lesson performed for the sake of practice and to acquire skill and knowledge. It may be, of course, that the skill or knowledge is applied right away in the same workshop as part of project work.

Table I A generic approach to a comprehensive foresight project

Step	*Description*	*Product*
Framing	Scoping the project: attitude, audience, work environment, rationale, purpose, objectives, and teams	Project plan
Scanning	Collecting information: the system, history and context of the issue and how to scan for information regarding the future of the issue	Information
Forecasting	Describing baseline and alternative futures: drivers and uncertainties, implications, and outcomes	Baseline and alternative futures (scenarios)
Visioning	Choosing a preferred future: envisioning the best outcomes, goal-setting, performance measures	Preferred future (goals)
Planning	Organizing the resources: strategy, options, and plans	Strategic plan (strategies)
Acting	Implementing the plan: communicating the results, developing action agendas, and institutionalizing strategic thinking and intelligence systems	Action plan (initiatives)

So much for the general definitions; now we define the topic of this paper – the scenario. Despite its ubiquity, or perhaps because of it, we found more than two dozen separate definitions of scenarios in the literature, and that is probably not all. Suffice to say that a scenario is a product that describes some possible future state and/or that tells the story about how such a state might come about. The former are referred to as *end state* or even *day in the life* scenarios; the latter are *chain* (of events) *scenarios* or *future histories*.

Research approach

The starting point for this research was collecting descriptions of the methods we had amassed over the 30-year history of teaching scenarios in the Master's program at the University of Houston. We then supplemented our list with literature and web searches to identify methods that had escaped our attention.

Surveying the scenario development field is no mean feat, but we believe we have captured most of it. The literature contains overview pieces that review the field (e.g. Van Notten *et al.*, 2003; Bradfield *et al.*, 2005; Borjeson, in press) and methodological pieces that describe a specific scenario technique.

We began by scouring the key methodological publications in the field to see what they said about scenarios. Among the sources of this material were:

- Books – Schwartz (1991), Van der Heijden (1996), Ringland (1998), Bell (2003) and Cornish (2005).
- Collections – Fowles (1978), Fahey and Randall (1997), Slaughter (2005) and the Millennium Project Methodology CD and its Global Scenario collection (2003).
- Journals – *Futures*, *Foresight*, *Technological Forecasting and Social Change*, *Futures Research Quarterly*, *Journal of Futures Studies* and *The Futurist.*
- Abstract and citation indexes – Future Survey, Business Academic Premier and the Social Science Citation Index.
- The world wide web.

As one might suspect, this approach generated a number of additional methods, many of which were closely related to methods we had already identified. We revised our initial list and posted queries to several listserves that discuss futures topics, including those of our academic program, the Association of Professional Futurists, and the World Futures Studies Federation. We also asked for general advice about our project, and were very pleased to receive a great deal of helpful feedback and, of course, more methods to consider!

These sources yielded dozens of methodological pieces and cases in which a scenario technique was used and/or in which one or more scenarios were produced.

Overviews

Three articles have appeared recently with a similar purpose – to review the field of scenario development and, if possible, bring some organization and understanding to the field. They do an admirable and useful job of proposing different ways to think about scenarios at a high-level. Our purpose here goes a level deeper to provide further assistance by outlining specific methods/techniques that fit within the high-level categories. We summarize below the excellent contribution that each of these overviews has made to the literature, noting areas we will build on.

Van Notten et al. *(2003)*

van Notten and his colleagues from the International Centre for Integrative Studies in Maastricht have created a typology of ''scenario types'' (Van Notten *et al.*, 2003). In the end, they propose three major categories or overarching themes, based on the ''why'' (project goal), the how (process design) and the what (content). They identify 14 specific characteristics to characterize scenarios (Table II).

Table II Van Notten scenario typology

	Overarching themes	Scenario	Characteristics
A	Project goal: exploration vs decision support	I	Inclusion of norms?: descriptive vs normative
		II	Vantage point: forecasting vs backcasting
		III	Subject: issue-based, area-based, institution-based
		IV	Time scale: long term vs short term
		V	Spatial scale: global/supranational vs national/local
B	Process design: intuitive vs formal	VI	Data: qualitative vs quantitative
		VII	Method of data collection: participatory vs desk research
		VIII	Resources: extensive vs limited
		IX	Institutional conditions: open vs constrained
C	Scenario content complex vs simple	X	Temporal nature: clean vs snapshot
		XI	Variables: heterogenous vs homogenous
		XII	Dynamics: peripheral vs trend
		XIII	Level of deviation: alternative vs conventional
		XIV	

Source: Van Notten *et al.* (2003, p. 426)

Their contribution is notable, and it could well be used to study the field of scenario development further. Their attributes, however, relate more to the overall scenario *project* than to the specific scenario *technique(s)* used. Process design contains four attributes that are closer to the techniques employed, but they are general and do not call out the specific techniques. Characteristic VI data, for instance, classifies scenario designs as either qualitative or quantitative; but that is still very general since there are many ways to conduct qualitative and quantitative scenarios. They have created a comprehensive and useful mechanism for analyzing and comparing scenarios. As valuable as this contribution is, it does not review the actual techniques that futurists use to generate scenarios.

Bradfield et al. *(2005)*

Bradfield and his colleagues propose ''to resolve the confusion over 'the definitions and methods of scenarios,''' (Bradfield *et al.*, 2005) or at least begin to do so. Their approach is historical, tracing the evolution of three schools of scenario development from their origins to the present day. Two of these schools originate in Anglophone countries (US and UK) and one in France.

After describing how Herman Kahn originally introduced the concept of scenario development during his time at RAND, they describe two Anglo schools of scenario development with radically different approaches. The first is the ''intuitive logics'' school described above as the Shell/GBN method that now dominates scenario development in the USA and many other countries. The second is the ''probabilistic modified trends'' school, originated by Olaf Helmer and Ted Gordon. That ''school'' is actually an amalgam of two quite different techniques: Trend Impact Analysis that Ted Gordon used at The Futures Group and Cross-Impact Analysis that has been used in many different contexts. Both of these techniques are quantitative, as opposed to the Shell/GBN technique, and they were developed by the same people, but that is pretty much where their similarity ends.

Continental Europe uses a different approach originally developed by Gaston Berger and Bertrand de Jouvenel known as ''La Prospective'' and now carried on by Michel Godet among others. Godet *et al.* (2003) has developed a number of useful computer-based tools to analyze structural conditions and stakeholder positions. He also has two tools that generate scenarios – MORPHOL and SMIC PROB-EXPERT. MORPHOL is a computer version of morphological analysis (as described below), and SMIC PROB-EXPERT is a form of cross-impact with some variation.

So Bradfield's analysis proposes a useful framework for thinking about scenarios at a high level. Van Notten's taxonomy proposes attributes of scenarios where Bradfield propose actual high level categories. Their three macro-categories are conceptually useful, but do not do justice to the range of techniques available for scenario development.

Börjeson et al. *(in press)*

The final review will be coming out in 2006. Börjeson and her colleagues from Sweden create a typology of scenario techniques based on Amara's classification of different types of futures – the probable, possible and preferable futures (Börjeson *et al.*, in press). Predictive scenarios answer the question: ''What will happen?'' Exploratory scenarios answer: ''What can happen?'' Normative scenarios answer: ''How can a specific target be reached?'' They divide each of these into two sub-categories to make six types of scenarios, as depicted in Figure 1.

Within their categories, they classify scenario techniques – the focus of our analysis – according to their purpose:

- Generating techniques are techniques for generating and collecting ideas, knowledge and views regarding some part of the future, consisting of common data gathering techniques such as workshops and surveys.
- Integrating techniques integrate parts into wholes using models based on quantitative assessments of probability or relationship, such as time series analysis and systems models.
- Consistency techniques ensure consistency among different forecasts such as morphological analysis and cross-impact analysis.

The latter classification comes closest to serving our purpose here since it identifies some specific scenario techniques although it treats them at a general level that does not allow an analysis of the advantages and disadvantages of each.

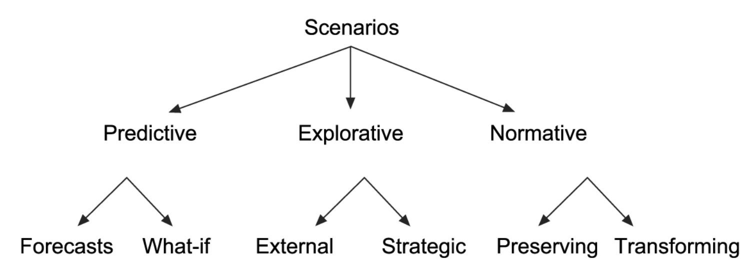
In the end, therefore, we still have more work to do, to identify the specific techniques that futurists use to generate scenarios and give some sense of their advantage and their use.

Scenario techniques

Now onto the key purpose of this article – the categorization and discussion of scenario techniques. While authors, such as the ones above, have characterized techniques according to some high-level attributes, none has actually classified the actual techniques in use. That is the purpose of this section. Based on our review of the literature, we have discovered eight general categories (types) of scenario techniques with two to three variations for each type, resulting in more than two dozen techniques overall. There are, of course, variations of the variations. Some techniques are also hard to classify because they contain processes from different categories. Despite these difficulties, we believe that having such a list is a good step toward alleviating the confusion over scenario techniques.

The rest of this section describes each of these categories and the specific techniques in it, noting how each one varies from the pure type.

Figure 1 Borjeson scenario typology



Source: Börjeson *et al.* (in press, p. 3)

1. Judgment (genius forecasting, visualization, role playing, Coates and Jarratt)

Judgmental techniques are the easiest to describe and probably the most common since what most people, even professional futurists, generally assert what they believe the future will or could be without much if any methodological support. As the name implies, judgmental techniques rely primarily on the judgment of the individual or group describing the future. While they may use information, analogy and reasoning in supporting their claim, pure judgmental techniques have none of the methodological scaffolding that appears in the other categories. Unaided judgment is probably used most often, but judgment aided with some technique also appears:

- Genius forecasting comes from Herman Kahn, the original scenarist, is also the archetypical genius forecaster. Blessed with high intelligence, an assertive personality and the research capabilities of the RAND Corporation, Kahn (1962) was the first person to encourage people to ''think the unthinkable,'' first about the consequences of nuclear war and then about every manner of future condition.
- Visualization is the use of relaxation and meditative techniques to quiet the analytical mind and allow more intuitive images of the future to surface. Individuals typically use a calming narrative, called an induction, to promote relaxation and gently direct the mind to different aspects of the future. Markley promoted such techniques, first with Harman at SRI in the 1970s and then by teaching and practicing the technique for 20 years at the University of Houston-Clear Lake (see Markley, 1988).
- Role playing is a form of group judgment. It puts a group of people into a future situation and asks them to act the same as those in that situation would. The original role-playing scenarios were the war games conducted by the USA and (probably) the Soviet militaries in the 1950s, simulating the tensions and negotiations leading to a nuclear attack. Today role playing is common in emergency preparedness and for those preparing for dangerous technical missions, such as pilots, astronauts or nuclear operators (see Jarva, 2000).
- Coates and Jarratt shared the scenario technique that they used in their highly successful consulting practice. It contains elements of more formal techniques described below, but it is basically a more complex, but straightforward form of judgmental forecast. Briefly, the steps involve identifying the domain and the time frame, identifying conditions or variables of concern in that domain, generating four to six scenario themes ''that illustrate the most significant kinds of potential future developments,'', estimating the value of the condition or variable under each theme, and, finally, writing the scenario (see Coates, 2000).

2. Baseline/expected (trend extrapolation, Manoa, systems scenarios, trend impact analysis)

The second category produces one and only one scenario, the expected or baseline future. We call this scenario the baseline because is the foundation of all the alternative scenarios. Futurists often discount the expected future because it rarely occurs in its full form. In fact, they make their living pointing out that surprising developments are common and are, in fact, more likely than the expected. Herman Kahn reportedly captured this principle in his often-quoted phrase, ''The most likely future isn't.''

Nevertheless, the expected future is a plausible future state, and so the description of this state qualifies as a scenario. In fact, it is the most plausible scenario of all because, even though surprises will surely change the future in some ways, it will not change it in all ways. In fact, one of the most surprising developments to futurists, steeped in change and uncertainty, is that things do not often change as fast or as surprisingly as they anticipate. One who takes stock of the world today must admit that it is more like the world of the 1950s than futurists expected, despite the appearance of nuclear power, spaceflight, cell phones and the internet.

The modal technique in this category is simply to measure existing trends and extrapolate their effects into the future. One can do this by judgment or, if empirical data is available, by mathematical techniques. Next to pure judgment, trend extrapolation is the most common scenario technique – more people, more cars, more computers, more wealth, more liberties, etc. In fact, Kahn (1979) made the rather outlandish claim that he had identified the 15 trends that he believed drove most of human history. His multifold trends included such undeniable trends as the accumulation of scientific and technical knowledge, the greater military capability of developed nations and the growing dominance of Western culture throughout the world. Though surprises are perhaps inevitable, most trends will describe most of the future into the medium or even the long term.

We have identified two variations on trend extrapolation, one that elaborates the baseline scenario using futures techniques and one that adjusts it given the occurrence of potential future events:

1. The Manoa technique was invented by Wendy Schultz and other students at the University of Hawaii at Manoa while studying with Jim Dator. It is a concatenation of futures techniques to explore the implications and interconnections among trends. The technique requires an individual or group to work with three strong, nearly indisputable trends. Those trends are elaborated in two ways. The first way is to discover the implications of each of the trends separately using a futures wheel. (A futures wheel is essentially a mind-map where each trend forms the center and successive levels of implications are brainstormed from that.) The second way is to discover the interactions among the three trends using a qualitative cross-impact matrix. (A cross-matrix is a square matrix, in this case with one row and column for each trend. The cells are filled with the impacts or effects of one trend (the row) on another (the column).) After these exercises, individuals are left with a rich store of material from which they can answer specific questions about this future or even write a complete scenario. Schultz used this technique with the Hawaii Services Council in 1993 (see Schultz, 1993).
2. Two of Dr Schultz's students, Sandra Burchsted and Christian Crews, also developed a variation of the Manoa technique that they call Systemic Scenarios (Burchsted and Crews, 2003). Rather than use the cross-impact matrix as a way to identify the interactions among the trends, they show the relationships among the implications from different trends using a causal model which shows the dynamic interactions among the implications and hence the trends (see Burchsted and Crews, 2003).

3. Elaboration of fixed scenarios (incasting, SRI)

The third category begins the explicit consideration of multiple scenarios. Most scenario techniques develop the scenarios from scratch, but these begin with scenarios that are decided ahead of time. The intention then is to elaborate the scenario logic or kernel, the simplest statement of what the scenario is about. The advantage is that participants do not have to struggle with the uncertainties of the future. All they have to do is articulate the implications of given alternative futures:

- Incasting is a simple matter of having participants divide into small groups and read a paragraph that describes a rather extreme version of an alternative future. Examples would be a green future, a high-tech one, or one dominated by multi-national corporations. They are then asked to describe the impacts on a series of domains, such as law, politics, family life, entertainment, education, work, etc. One interesting variation during the debrief is not to tell the other participants the nature of the underlying scenario, but rather have them guess what is from its effects. Incasting is a good technique to illustrate how the world could be different given paths that the world could take (see Schultz, n.d.a, b).
- The SRI matrix was one of the first explicit scenario techniques following Kahn's introduction of genius forecasting and trend extrapolation. It was developed at the Stanford Research Institute (now SRI) and used by Hawken *et al.* (1982) in their late 1970s book *Seven Tomorrows.* The SRI technique also begins with a fixed number of scenarios, usually four, but they are not expressed as paragraphs. The scenarios are identified as titles to columns in a matrix, such as the expected future, the worst case, the best case, and a highly different alternative. The titles vary by practitioner and by engagement. The

dimensions of the world are then listed in the rows, such as population, environment, technology, etc., or other domains that are more specific to the engagement. Participants then fill in the cells with the state of that domain in that scenario. The whole scenario is elaborated in each column, and the differences for a specific domain across the scenarios are elaborated in each row (see Hawken *et al.*, 1982).

4. Event sequences (probability trees, sociovision, divergence mapping)

Most people think of the past as a series of events, in one's life or in history. So we can think of the future that way too, except that we do not know which events will occur and which ones will not. Each event then has a probability of occurrence. If a potential event happens, the future goes one way; if not, then another. The future branches at each of those points depending on whether the event occurs or does not. In fact, more than one thing can happen in which case the future has three paths from that point. String a number of those branches together, and one has a probability tree. Two variations of probability trees were discovered: one uses the branches to create scenario themes and the other builds the sequences after developing the events (Lisewski, 2002; Buckley and Dudley, 1999; Covaliu and Oliver, 1995):

- Probability tree has the same form as a decision tree, except the branches in a decision tree are not what could happen, but what decisions we will make at each branch. The tree ends at different future conditions depending on the path. And if one knows the probability of each branch, one can calculate the probability of arriving at that final state as the product of the probabilities of the branches that occurred along the way. Those probabilities sum to 100 per cent since one of them is bound to occur. Probability trees are used in risk management, particularly when risk managers and planners have to assess the probability of multiple risks happening in the same time frame. The Eidos tool suite from the Parmenides Foundation (formerly ThinkTools) contains a tool for building and evaluating probability trees.
- Sociovision begins with a standard probability tree. Examining the tree, however, may reveal certain branches that have a common character. Perhaps many of them are less likely or more preferred, or they may be driven by one particular stakeholder or condition. Gathering those branches together creates a coherent scenario of how the future might develop, complete with the events that make up the story. The probability tree then acts as an input that reveals some overall macro themes that might not be apparent to the participants at the beginning (see De Vries, 2001).
- Divergence mapping was described by Harman (1976) in his book *An Incomplete Guide to the Future*. It consists of brainstorming a set of events that could change the future. His ''map'' allows for up to 22 of those events, but more are clearly possible. These events are arrayed in a fan-life structure with four arcs, each of which represents a longer time horizon. Events from earlier time horizons are then linked with later ones in a plausible sequence that forms the storyline of a scenario (see Harman, 1976).

5. Backcasting (horizon mission methodology, Impact of Future Technologies, future mapping)

Most people think of the future as extending from the present, a natural extension of the timeline running from the past and through the present. But that perspective has its disadvantages, chief among which is the future then carries all the ''baggage'' of the past and the present with it into the future. The baggage limits creativity and might create futures that are too safe, not as bold as the actual future turns out to be.

An antidote to carrying too much baggage is to leap out into the future, jab a stake in the ground, and then work backward on how we might get there. The first step then is to envision a future state at the time horizon. It can be plausible or fantastical, preferred or catastrophic; but having established that state as a beachhead, it is easier to ''connect the dots'' from the present to the future (or back again) than it is to imagine the events leading to an unknown future. The technique is ''backcasting,'' (Robinson, 1990) as opposed to ''forecasting,'' for obvious reasons:

- *Horizon mission methodology (HMM).* One of the most well-known and purest forms of backcasting was developed by the late John Anderson at the National Aeronautics and Space Administration (NASA). Anderson's technique was designed to help NASA engineers decide on R&D pathways that might yield some return. Forecasting from the present, engineers were often bound by their disciplinary backgrounds to recommend incremental rather than breakthrough research. To counteract that tendency, Anderson first had engineers envision a fantastical mission (a horizon mission), one that was completely infeasible given today's technology. A favorite of his was a one-day mission to Jupiter. That trip today would take several months by the fastest route using the most powerful rockets. So a one-day trip was fantastical indeed. Having overcome the ''giggle factor,'' Anderson then asked the engineers to ''decompose'' that mission into its component parts. In other words, ''Supposing that such a mission had actually taken place, what technologies would be required?'' Given the components of the mission, he then asked them to decompose each of those components using the same question, ''What technologies would it require?'' Arriving at the present, engineers found that they had some near-term R&D opportunities that might not get them to Jupiter in a day, but they might create other breakthroughs in space exploration. Working backward got them out of the present and into the future in a big way! (See Hojer and Mattsson (1999).)
- *Impact of Future Technologies.* The IBM Corporation has developed and is now marketing a backcasting technique for the same purpose – making investment decisions in future R&D technology. The technique, called the Impact of Future Technologies (IoFT), begins at the same place that Anderson's does with a highly capable vision of the future. IoFT differs from HMM, however, in starting from multiple elaborated scenarios of the future rather than just one simple mission. Working backward from those scenarios, a team of knowledgeable scientists identifies signposts that are defined as scientific or technological breakthroughs that would be required for one or more of the scenarios to come true. IBM does not recommend that the client work to create the breakthroughs because they are so massive that even the most capable client would contribute little to their occurrence. What is more, breakthroughs are by definition unpredictable, particularly when they will occur, so that they recommend rather that the client monitor for the occurrence of the breakthrough and then deploy a contingent strategy during a subsequent window of opportunity for exploiting the capabilities of the breakthrough (see Strong, 2006).
- *Future mapping.* This was developed by David Mason of Northeast Consulting. It is a variant of the pre-defined scenario technique in which he pre-defined, not only the end-states, but also the events leading up to them. Participant teams then select and arrange the events that lead to each end-state. The technique offers participants a deeper understanding of how events can interact to create different futures and how different end-states can occur from the same set of events. (see Mason, 2003).

6. Dimensions of uncertainty (morphological analysis, field anomaly relaxation, GBN, MORPHOL, OS/SE)

The reason for using scenarios in the first place is the uncertainty inherent in predictive forecasting. We never have all the information; theories of human behavior are never as good as theories of physical phenomena, and finally we have to deal with systems in chaos and/or emergent states that are inherently unpredictable. Scenarios in this section, then, are constructed by first identifying specific sources of uncertainty and using those as the basis for alternative futures, depending on how the uncertainties play out:

- GBN matrix has become the default scenario technique since Schwartz (1991) published his best-seller, *The Art of the Long View.* The matrix is based on two dimensions of uncertainty or polarities. The four cells represent alternatively the four combinations of the poles of the two uncertainties, each of which contains a kernel or logic of a plausible future. Each kernel is then elaborated into a complete story or other presentation, and the implications for the focal issue or decision are discussed.

- Morphological analysis (MA), field anomaly relaxation (FAR) are more traditional versions of the same technique. The difference is that they contain any number of uncertainties and any number of alternative states for each uncertainty so that GBN is actually a subset of MA/FAR. The uncertainties are portrayed as a set of columns in which each column represents a dimension of uncertainty and contains any number of alternatives. One creates a scenario kernel/logic from the MA/FAR layout by picking one alternative from each column. Of course, that is easier said than done because a standard layout with five dimensions of uncertainty, each with three alternatives, generates 3^5 or almost 250 different scenario kernels. While MA and FAR are more complicated and hence less common, they do overcome the difficulty that it is devilishly hard to capture the uncertainties of the future in just two dimensions (see Coyle, 2003; Coyle *et al.*, 1994; Duczynski, 2000; Eriksson and Ritchey, 2002; Rhyne, 1974, 1981, 1995)
- Option Development and Option Evaluation (OS/OE) is part of the Eidos tool set distributed by the Parmenides Foundation that manages the complexity of morphological analysis. Option Development is the program that lays out the dimensions of uncertainty and the alternatives associated with each one. Open Evaluation uses a compatibility matrix of all the alternatives against all the other alternatives to calculate the consistency of each combination of alternatives. The program then ranks them according to their consistency.
- MORPHOL is a computer program that also manages the complexity of morphological analysis. Developed by Michel Godet, a prominent futurist in Europe, MORPHOL performs the standard morphological analysis, but it then reduces the total number of combinations based on user-defined exclusions (impossible combinations) and preferences (more likely combinations). It also provides an indicator of the probability of each scenario compared to the mean probability of all scenario sets based on the user-defined joint probability of each of the alternatives in the set (see Godet and Roubelat, 1996).

7. Cross-impact analysis (SMIC PROF-EXPERT, IFS)

One objective of identifying various future conditions, events and even whole scenarios is not just to identify their characteristics and implications, but also actually to calculate their relative probabilities of occurrence. One can judge the single probability of a condition or an event using judgmental means. But the more people making the judgment and the more expert they are, presumably the better their collective judgment will be.

Most analysts, however, are keenly aware that the probability of any one event is, to some extent, contingent on the occurrence of other events. Placing these events in a square matrix with each condition or event occupying one row and one column, one can display, not only the initial probability assigned to a condition or event, but also the conditional probabilities of the condition or event given the occurrence of any other condition or event. Using these estimates, a random number between 0 and 1 is chosen. Events with a probability above that number are said to occur; those below are not. The probabilities of all events then adjusted (up or down) based on the contingent probabilities in the matrix. Running the matrix many times produces a distribution of probabilities for each that can be used to estimate the probability of that event given the possible occurrence of the other events.

The most well-known use of cross-impact analysis was a program conducted called INTERAX, conducted by Enzer (1981) at the University of Southern California. Enzer constructed a cross-impact matrix of many global trends and potential events that participants would discuss at an annual workshop:

- SMIC-PROB-EXPERT is a cross-impact analysis developed by Michel Godet with an important variation. The cross-impact matrix of conditional probabilities is constructed by experts, but their estimates often do not conform to the laws of probability, such as $P(x)$ must equal $P(x|y) \cdot P(y) + P(x| \sim y) \cdot P(\sim y)$. SMIC adjusts the probabilities suggested by the experts so they conform to such laws. The PROB-EXPERT portion of this technique creates a hierarchical rank of scenarios based on their probability. Finally, it allows one to draw diagrams of clusters of scenarios and experts, showing which scenarios are most alike, which experts judged the probabilities most alike and even which scenarios are most favored by which experts (see Godet *et al.*, 2003).

- Interactive future simulation (IFS) was developed at the Battelle Memorial Institute to calculate the quantitative conditions associated with different scenarios. IFS begins with a set of variables, called Descriptors, that are important for understanding the future rather than with events or binary conditions as the other techniques do. It divides the range of each variable into three alternatives – high, medium and low – and assigns an initial probability to each of those alternatives. It then constructs a cross-impact matrix in which the cells are the influence of each alternative on each other alternative on a scale from -2 to $+2$. A Monte Carlo simulation runs the impacts many times over generating different combinations of scenarios with different frequencies of occurrence. The final probability of each of the alternatives (the ranges of the target variables) is then calculated based on the number of times that that alternative appears in the scenario combinations generated (see www.battelle.org).

8. Modeling (trend impact analysis, sensitivity analysis, dynamic scenarios)

Systems models are used primarily for baseline forecasting – i.e. predicting the expected future. Based on equations that relate the effects of some variables on others, the output is usually the expected value of target variables at the time horizon or graphs that show the change of those variables between the present and the time horizon. But any technique that can generate a single-valued prediction of the future can also produce scenarios by varying the inputs and/or the structure of the models that generate the prediction:

1. Trend impact analysis (TIA) is a method for adjusting the baseline trend given the occurrence of a potential future event. TIA was invented by Ted Gordon at The Futures Group. It involves a trend and a potential event that acts to perturb the original trend trajectory. Three different points of impact are identified and estimated – time to first noticeable impact (when the trend first departs from its original trajectory), time to maximum impact (when the trend is farthest from its original values), and time to steady-state or constant impact (when the effect of the event is fully integrated into the trajectory of the trend). The size of the maximum and steady-state impacts are also estimated. A new trend line is then calculated (an alternative scenario) and compared to the original baseline trajectory. TIA has been used by the Federal Aviation Administration, Federal Bureau of Investigation, Joint Chiefs of Staff, National Science Foundation, Department of Energy, Department of Transportation, the State of California, and other US agencies (see Gordon, 2003a, b).
2. Sensitivity analysis varies one of the three parts of a systems model that can be varied:
   - *The value of exogenous variables that drive model*. Exogenous variables, also called boundary conditions, influence other variables in the model, but they are not themselves influenced by those variables. In other words, they are set outside the model, in the model's environment. The interest rate set by the Federal Reserve and the tax rate set by the Congress are typical exogenous variables to the models of the US economy. One can vary each or both to see how they affect output variables like GDP or employment. The analysis then measures how ''sensitive'' the model is to changes in the boundary conditions. Each of those variations is a scenario.
   - *The parameters that define the effect of variables on one another.* The equations in the models that define future values of dependent variables (Y) are constructed from independent variables (X) adjusted by a coefficients (b) in the form, $Y = a + bX$. The value of the coefficient is based on the historical relationship of X and Y. But there is considerable uncertainty, even for the most well-supported coefficients. What is more, the value of the coefficient can change completely if the historical relation between X and Y changes. So one can vary parameters in the model to define different scenarios.
   - *The variables in the model itself.* Models consist of variables that represent the real world, but the choice of variables to include in the model is also a matter of some dispute. One can vary the actual structure of the model and its equations by adding or

removing variables to see the effects on the output variables. So each of these changes can produce alternative descriptions of the future – i.e. scenarios (see Saltelli, 2004)

3. Dynamic scenarios are a combination of scenario development and systems analysis, in that order. The first step is the ordinary process of generating scenario themes or kernels by clustering events of a similar type from a brainstormed universe of all plausible future events. Each of those themes then defined a system which is mapped using causal models. The variables that appeared in many different models were brought together in a meta-model that purported to map the whole domain. The individual themes were then elaborated using different values for the uncertainties in those models (see Ward and Schriefer, 2003).

Observations and evaluation

Having described the techniques individually, this section compares the scenario techniques with each other. Table III compares the starting point, process, and products of the different scenario techniques:

- The starting points range from completely open to beginning with draft scenario logics. The open approaches begin with an environmental scanning process to produce the raw material that will be crafted into scenario logics. The other extreme is to begin with scenario logics and either elaborate or customize them in order to explore their implications. In between are techniques that begin either with the dominant driving trends or with key uncertainties.
- The processes summarize how the methods are actually carried out. As expected, here is where we see the greatest distinctions among techniques. It is what separates one from another.
- Products also vary by technique. Most techniques produce different numbers of scenarios. Most produce kernels or logics; others produce probabilities of different alternative conditions, and still others produce elaborated stories or end-state descriptions. The common approach of about 20 years ago of producing best case, worst case, and a middle version is no longer used today. The problem with this approach is that clients almost always selected the middle ground, and were thus losing out on the value of expanding their thinking to consider a broader range of futures possibilities.

As described in the confusions above, however, some of the products are scenarios, but not stories about the future in the narrow sense. These range from probabilities of end states to adjusted trend values to ideas for investment strategies.

Table IV summarizes the attributes of the techniques, including their basis, perspective, whether done by a group or with a computer, and an estimate of the difficulty in carrying it out:

- The two bases are judgment and quantification. It should be noted that in some cases, such as with cross-impact matrices and IFS, the quantification is simply putting a number on expert judgment. It is safe to argue that judgment is clearly the primary basis for most scenario techniques.
- Perspective has to do with whether the technique begins from the present and moves forward into the future or starts from the future and works backward to the present. The vast majority of the techniques start from the present and work forward. It is perhaps easier for clients to work this way, and thus it is more popular. It may also tend to produce more conventional scenarios than working backward, which takes a leap of intuition to begin with the unknown future rather than the known present.
- The only technique that is not used in groups is the genius forecast, which of course relies on the genius to produce it. The others can be used by groups, with some specifically designed for that. It is safe to say that scenario development is primarily a group technique.

Table III Comparing starting points, process and products of the scenario techniques

Technique	*Starting point*	*Process*	*Products*
1. Judgment			
Genius	Personal information	Thinking, imagining	One or more scenarios
Visualization	Personal information, unconscious ideas, values	Relaxation, stimulation of imagination	One or more scenarios
Role playing	Personal information, unconscious ideas, values	Act out one or more pre-arranged conditions	One or more scenarios
Coates and Jarratt	Personal or team information	Define domain and time horizon, identify conditions or variables of interest, develop scenario themes, estimate values of conditions and variables under each scenario theme, write the scenarios	Four to six scenarios
2. Baseline			
Manoa	Dominant trends	Implications, cross-impacts, elaboration	Elaborated baseline scenario
3. Elaboration of fixed scenarios			
Incasting	Multiple scenario logics	Elaboration on specific domains	Elaboration of multiple scenarios
SRI	Multiple scenario logics	Specific domains in rows	Elaboration of multiple scenarios in specific domains
4. Event sequences			
Probability trees	Branching uncertainty or choice points	Sequence, assign probabilities	Probability of end states
Sociovision	Branching uncertainty or choice points	Cluster similar alternatives into macro themes	Multiple scenarios
Divergence mapping	Multiple potential events	Place on one of four time horizons, link events in sequence	Multiple future histories
Future mapping	Multiple end states, many potential events	Sequence events to create end state	Future history
5. Backcasting			
Backcasting, horizon mission methodology	One or more end states, can even be fantastical	Steps that could lead to that end-state	Ideas for near-term work or investment
Impact of future technologies	Technology themes	Highly capable scenarios, signposts leading to scenario, cost/benefit	Contingent strategies to pursue given the occurrence of signposts
6. Dimensions of uncertainty			
Morphological analysis, field anomaly relaxation	Dimensions of uncertainty	Multiple alternatives for each dimension, link one alternative from each dimension	Multiple end states as combinations of one alternative from each dimension
GBN	Driving forces, two dimensions of uncertainty	Select two most important and most uncertain, create 2×2 matrix, title and elaborate	Four mutually exclusive scenarios
Option development and evaluation	Dimensions of uncertainty	Multiple alternatives for each dimension, rate consistency of every alternative against every other alternative, perform nearest neighbour calculation	Ranking of combinations of alternatives from most to least consistent
MORPHOL	Dimensions of uncertainty	Multiple alternatives for each dimension, link one alternative from each dimension, excluding impossible combinations and rating more likely combinations more highly; can calculate probability of combination of probabilities of	Multiple end states as combinations of one alternative from each dimension, based on exclusions and likelihood of pairs of alternatives; can calculate probability of combination of probabilities of alternatives are known

(*Continued*)

Table III

Technique	*Starting point*	*Process*	*Products*
7. Cross-impact analysis			
Cross-impact analysis	Potential future events or end states	Initial probability of each, contingent probabilities of each given the occurrence of each other, Monte Carlo simulation	Final probabilities of each event or end state
IFS	Variables of future ends states	High, medium, low values of the variables, initial probability of each range, cross-impact of ranges from different variables on each other, Monte Carlo simulation	Final probabilities of each range of each variable
SMIC PROB-EXPERT	Potential future events or end states	Initial probability of each, contingent probabilities of each given the occurrence of each other, correction of contingent probabilities for consistency, Monte Carlo simulation	Final probabilities of each event or end state
8. Modelling			
Trend impact analysis	Trend, one or more potential future events	Estimate impact of event on trend – time of initial impact, max impact, time of max impact, time of final impact	Adjusted trend values
Sensitivity analysis	Systems model with boundary conditions	Enter multiple plausible values for each uncertain boundary condition, possibly Monte Carlo simulation	Range of plausible outcome variable
Dynamic scenarios	Dimensions of uncertainty	Build system model for each dimension, combine into one overall model	Dynamic behavior associated with each scenario

Table IV Attributes of the scenario techniques

Technique	*Basis*	*Perspective*	*Group*	*Computer*	*Difficulty 1-4 (4 hardest)*
Genius	Judgment	Forward	No	No	1.2
Visualization	Judgment	Forward	Optional	No	2.3
Role playing	Judgment	Forward	Required	No	2.2
Coates	Judgment	Forward	Optional	No	2.3
Manoa	Judgment	Forward	Optional	No	2.2
Incasting	Judgment	Forward	Recommended	No	2.5
SRI	Judgment	Forward	Optional	No	2.3
Probability trees	Quantification	Forward	Optional	Optional	2.5
Sociovision	Judgment	Forward	Optional	No	2.6
Divergence mapping	Judgment	Forward	Optional	No	2.2
Future mapping	Judgment	Backward	Optional	No	2.6
Impact of future technologies	Judgment	Backward	Optional	No	2.8
Backcasting, horizon mission methodology	Judgment	Backward	Optional	No	2.3
Morphological analysis, field anomaly relaxation	Judgment	Forward	Optional	No	2.3
GBN	Judgment	Forward	Optional	No	2.6
Option development and evaluation	Quantification	Forward	Optional	Required	3.0
MORPHOL	Quantification	Forward	Optional	Required	2.5
Cross-impact analysis	Quantification	Forward	Optional	No	2.5
IFS	Quantification	Forward	Optional	No	2.8
SMIC PROB-EXPERT	Quantification	Forward	Optional	No	2.3
Trend impact analysis	Quantification	Forward	Optional	Optional	2.5
Sensitivity analysis	Quantification	Forward	Optional	Required	3.3
Dynamic scenarios	Judgment	Forward	Optional	Optional	2.8

Table V Advantages and disadvantages of the scenario techniques

Technique	*Advantages*	*Disadvantages*
1. Judgment (Genius, visualization, sociodrama, Coates and Jarratt)	Easy to do Taps into intuitive understanding of the future Genius, Coates and Jarratt – requires no special training or preparation Visualization, sociodrama – can lead to novel insights and revelations	Difficult to do well Opaque, not transparent Genius, Coates and Jarratt – relies on the credibility of the individual Visualization, sociodrama – requires some training and experience to do well; clients may resist relaxation or dramatic techniques
2. Baseline (Trend extrapolation, Manoa, systems scenarios, trend impact analysis)	Easiest for client/audience to accept because generally expected already Manoa – highly elaborated, creative, lots of detail Systems scenarios – shows dynamic relationships among scenario elements Trend impact – links events with trends	No alternative scenarios proposed Manoa, systems scenarios – futures wheel, cross-impact, and causal models require some training and experience to do well Trend impact – requires judgment to estimate impacts, best done with group of experts, perhaps using Delphi
3. Elaboration of fixed scenarios (Incasting, SRI matrix)	Easiest for client/audience participation because scenario kernels/logics are done for them Provides in-depth elaboration of alternative scenarios	Generic scenario kernels/logics might not be relevant to client/audience; therefore less buy-in SRI Matrix – many have an intuitive sense of the best-case and worst-case scenarios already; filling in the cells of the matrix with many rows (domains) might become tedious
4. Event sequences (Probability trees, sociovision, divergence mapping, future mapping)	Tells the story in the usual way, as a series of events If probabilities at each branch point are known, can calculate the probability of end-states	Probability trees, sociovision – events/branch points usually do not follow each other in a fixed sequence Divergence mapping – events are not always easy to classify according to time horizon Future mapping – pre-defined end-states and events might not be relevant to the client/audience
5. Backcasting (Horizon mission methodology, impact of future technologies)	Creative because it decreases the tendency to extrapolate the future based on the past and the present; therefore can provide new insights Also results in a sequence of events or breakthroughs	Fantastical nature of the mission or end-state might reduce buy-in for client/audience Impact of Future Technologies – process for developing signposts and recommendations still opaque
6. Dimensions of uncertainty (Morphological analysis, field anomaly relaxation, GBN, option development and option evaluation, MORPHOL)	Best for considering alternative futures as a function of known uncertainties GBN –the right mix of technical sophistication and ease of use for a professional audience OD/OE – allows for the calculation of consistency among different combinations of alternatives (scenarios) MORPHOL – allows for the reduction of scenario combinations by the exclusion and likelihood of some pairs of alternatives; also allows for calculating the probabilities of different scenarios if the probabilities of the alternatives are known	Less creative because may not consider some novel developments that are not currently considered uncertain GBN – almost impossible to fully characterize the uncertainties of the future with just two dimensions OD/OE, MORPHOL – almost impossible to make valid estimates of the compatibility or influence of all alternatives against all other alternatives
7. Cross-impact analysis (IFS, SMIC-PROB-EXPERT)	Calculates the final probabilities of alternatives or end-states based on rigorous mathematical procedure SMIC – adjusts the matrix of conditional probabilities for consistency with the laws of probability IFS – allows for quantitative analysis of alternative future values of important variables	Almost impossible to validly estimate the conditional probabilities or impacts of all alternatives against the others
8. Systems modeling (Sensitivity analysis, dynamic scenarios)	Creates the best quantitative representation of continuous variables that describe the future state	Difficult to validate the models without complete historical data

- It is interesting to note that most techniques do not use computers to carry them out. Just a few of the quantitative methods rely on computers. It is perhaps an area of future opportunity to make greater use of software in crafting scenarios.
- The three authors ranked the difficulty in learning to do the technique and the difficulty in carrying it out well. We used a scale of 1 to 4, with one being easiest and four being most difficult. The number represents the average of the three author's combined judgments.

We initially included a column on whether the scenarios were designed for descriptive or normative approaches, with descriptive attempting to describe how the realm of possibilities, with normative focusing on how a preferred scenario could emerge. It turned out that each technique could be adapted for one or the other, although it is fair to say that most applications of scenarios in practice are descriptive rather than normative. A contributing factor is that the creation of normative futures most often is address through visioning techniques.

Table V summarizes the advantages and disadvantages of the techniques. It is intended to help both practitioners and clients choose techniques that best fit the situation. We are hoping to demonstrate that there is a wide range of available techniques and move beyond the situation today in which the very excellent GBN technique has come to dominate.

Conclusion

Scenario development is the heart of futures studies. It is a key technique that distinguishes the work of professional futurists from other professions who deal with the future. With its popularity, however, has come confusion about what exactly scenario development is, and how futurists actually produce scenarios. This catalog of scenario techniques is an attempt to lay some of that confusion to rest. We trust that it moves the discussion forward, but it does not end it by any means. In fact, we hope to be able to discuss scenario techniques in a new and more precise fashion. Eventually, we trust the field will settle on a consensus list that we can use to describe and improve our practice.

Notes

1. Thanks to the many members of the Association of Professional Futurists who participated in an online discussion of these confusions and offered suggestions for addressing them.
2. Many authors also used the term methodology in place of method. We are not going to use that term in this way since methodology, as we all know from the Greek, is the study of a method (or technique), not its application. So this article is a methodological study of scenario techniques, not a study of the scenario methodologies.

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