FINLAND FUTURES ACADEMY 1.12.2009
Asiantuntijat tulevaisuuden tietäjinä? -opintojakso

Essay: Designing the future: use and evaluation of knowledge about the future

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1 Introduction

This essay is a part of the Finnish Futures Academy post-graduate course “Asiantuntijat tulevaisuuden tietäjinä” (engl. Domain experts as seers of the future).

Discussion about the nature of knowledge and knowledge of the future is in the heart of the discussion about futures research as a scientific discipline. The assumptions derived from this discussion to the practice of futures research are accordingly embedded in futures projections as a form of knowledge about the future. Expert knowledge has had a special place in futures research as a source of knowledge of the future or as a basis of developing such knowledge. The Delphi method (Linstone and Turoff, 2002; Helmer, 1967), for example, is one of the better-known and well-used futures methodologies especially when there is a need to develop a view of the futures drivers based on a variety of expertise.

The purpose of this essay is to discuss the nature of knowledge of the future in general and use of expert knowledge in futures research, as well as evaluation of futures knowledge. The contribution of this study is to add to the conceptual discussion by introducing a more practical dimension, that is, evaluation of knowledge of the future.

Following Niiniluoto (2009) perspective of future knowledge as science of design, we will introduce elements from the design science framework from the information systems field to frame the discussion on evaluation of future knowledge.

The theoretical lens we employ in the analysis is based on realist ontology and positivist epistemology. We will be focusing on explorative mode of foresight instead of normative, or backcasting type.

The essay is structured to four main sections. The introduction lays out the themes in the essay. The second section discusses knowledge of the future and its evaluation. The third discusses the design science perspective in evaluation of futures knowledge. Finally the fourth section presents the implications and outlines directions for further inquiry

2 Perspectives on knowledge of the future

2.1 Realist ontology and epistemological viewpoints

We can more or less assume that research is in any case based on some philosophical assumption on ontology and epistemology, be they explicit and critically built or implicit and emergent. We adopt the common-sense realist viewpoint originally introduced by Moore (1959). In terms of ontology we follow the 3-world framework discussed by Popper. Poppers “worlds” later rephrased by Habermas are perhaps the most influential ontological structure in late 20th century. Differing from earlier views of empiricists later known as positivists, Popper (e.g. 1978) presents that three worlds exist, world one (W1) that is ‘real’ in the traditional sense, a world of physical objects and events: immutable, unchanging and independent of the observer. The second world (W2) is of human observations, emotions, a kind of representation of the first world, and the third world (W3) is a world of the artificial (to use Simon’s 1996 word). The third world contains the product of human mind, such as language, ontologies and theories, and foresight for that matter.

The Popperian ontology highlights challenges, or even paradoxes in futures research or studies: if we adopt the view that there is an immutable reality and our inner worlds are connected to it, we have to be interested in what happens in the world (W1) because it links us and our inner worlds (W2) to other thinking entities. If there is nothing else than a "phenomenon" of interaction between our inner worlds, we can further argue that the effort of trying to foresee the future become a moot point, as we cannot be sure whether there is anything outside us. However, there is the challenge of acquiring reliable information or knowledge of the world (W1) because of the limits of the human condition in observing the real world and translating our knowledge of either one of the worlds to representations of the artificial world (W3) that are able to convey the knowledge between the senders' and the receivers' inner worlds.

A further challenge highlighted by Poppers ontology is the application of Hume's truism to futures studies (see e.g. Lee and Baskerville, 2003). Namely, by nature the knowledge of the future is often based on analysis of the past and present and extrapolation thereof, which is made redundant by Hume's critique that observation of a recurring phenomenon alone does not guarantee that it will also work in the future. Successful generalization or extrapolation basically demand that we know the underlying causal laws and can guarantee that the they are unchanged for the period of interest, which can be interpreted that we need sufficient knowledge of the world (W1) so as to be aware of the boundaries of our knowledge and validity of our predictions.

2.2 The nature of knowledge of the future

Von Wright (2009) presents Laplace's Demon, a hypothetical omniscient observer who can based on its perfect knowledge of predict the state of the world exactly at any given time, in relation to any set time t in the future. The prerequisite for this predictive power is full knowledge of the properties of the world and processes that shape it. To relate to the ontology, the demon knows the exact properties of W1 can predict it based on this knowledge. It is often supposed that this implies that the world is predetermined or bound and that the knowledge of the demon is limited to W1 instead of W2 and W3. Even though it may seem that this Laplace' Demon is the philosophical precedent to the forecaster, who based on the analysis of historical development and the present, gives an estimate of the future, von Wright argues that determinism and thus such an extensive foreknowledge is impossible.

Glenn (2009, p.4) lists (philosophical) assumptions shared commonly among futures researchers. As we can see below, the three first assumptions are quite rich in philosophical terms but the assumptions envelop the discussion in Futura 1/2009 (see below). The philosophical assumptions of futures research (paraphrased from Ibid.):

1. The future cannot be known, but a range of possibilities can be
2. The likelihood of a future event can be changed by policy and the consequences of a policy can be forecasted
3. The uncertainty of foresight (-knowledge) can be appraised
4. No single method should be trusted alone
5. Humans have more influence on the future than before

The strictest definition of knowledge is based on the positivist tradition and it includes fact-based, critically built and examined, empirical knowledge, "justified true beliefs". Ketonen (2009) claims that we cannot know the future in the sense that we would have verified logical sentences or beliefs, as we cannot validate claims about the future until the future has come (Ketonen, 2009; von Wright, 2009). Malaska (2009) proposes that knowledge of the future is true, i.e. justified, if it is consistent with existing knowledge of today and/or can be (plausibly) realized by human action. Ketonen (Ibid.) further proposes that the schema for developing knowledge about the future, in so far as it is possible, follows the same logic as empirically verifying a theory, that is, we have a theory that predicts that given the circumstances the system of interest will, develop in a certain manner. Now only instead of comparing observations to predictions, we predict. To condense the discussion, essentially, what we can know about the based on extrapolation of existing structures to tomorrow. However, we must consider Hume's truism, and from this essentially follows that the knowledge of the future is probabilistic and uncertain, as we cannot be certain that the structure of the world does not change within the period of interest, effectively nullifying our knowledge.

2.3 Expert knowledge in futures studies

Going from developing and justifying future knowledge to expert knowledge, expert knowledge can have multiple functions in futures research. Different experts and domain specific knowledge is quite commonly used in futures studies as a basis for foresight. Following the discussion above, in order to gain knowledge of the future, we must know what processes are going on in the present, in order to see the range of possible futures, and appraise the effect of human action to these drivers.

Perhaps the most apparent use of expert knowledge in this context is to gather knowledge from the system and phenomena of interest, the mechanics of future so to speak. Use of experts can give insights otherwise in accessible to futures researchers, experts can be used to complement researchers own knowledge and to gain special knowledge of some phenomena of interest that would not otherwise be possible. An important, although perhaps secondary objective in terms of gaining knowledge, in use of experts is the possibility to involve the stakeholders and policy makers to gain diverse views to the issue and increase the buy-in of the study (Glenn, 2009). Another, more abstract, use of expertise has been outline by Masini (2009), as she asserts that decision making action taking needs to be evaluated in terms of the surrounding world and thus needs knowledge.

However, Sackman (1974) has written an intense critique for the Delphi method, some of which can be extrapolated to other futures research as well. Overall, it seems that large panels of non-experts behave and perform similarly to experts, which gives rise to the question is there any advantage over even harm in using experts? The most tangible risk of using experts is the “expert halo” bias, which can cloud the critical judgment of the reader because of the impressive credentials of the panel. Also, the best argument does not always win in expert panels anymore than in ordinary panels.

In terms of knowledge, von Wright (2009), Ketonen (2009) and most explicitly Malaska and Holstius (2009) outline different levels of knowledge about the future. We use the arguments to derive a framework for classifying expert knowledge (Table 1). The table positions the types of knowledge available for futures studies to their respective world and gives examples of the content. Malaska and Holstius (op.cit.) separate experimental and observational scientific knowledge to different levels in their taxonomy, but without going into the debate between hermeneutics and positivism, it seems reasonable to integrate the classes to ‘scientific knowledge’ in general. Von Wright discusses a class of knowledge that envelops much of everyday knowledge. It is knowledge, which is grounded to certain premises, to references, casual observations, but is often not based on first-hand systematic observation or research. The last class is intuitive knowledge and opinions, which in the scientific sense do not necessarily qualify as knowledge in the traditional sense.

Table 1. Taxonomy of (expert) knowledge in futures studies (adapted from Ketonen, 2009; Malaska and Holstius, 2009; von Wright, 2009)

World	Type	Explanation	Example
W2	Opinion/Intuitive	Knowledge that is based on intuition and opinion	"I feel that…" "It seems to me that…"
W1/2	Experiential	Knowledge grounded on casual non-systematic observation, experience and common-sense grounds	"Based on my experience…" "I've been observing this, and…"
W1	Scientific/empirical	Knowledge grounded on systematic observation or experimentation	"I have been studying this issue…" "I have been reading studies…"
W3/2	Artificial/synthetic	Axiomatic systems of knowledge, i.e. mathematics and mathematical logic	"If we take that A triggers B given X, and observe A and B…"

However, opinion, judgment and casual experiences are commonplace in expert knowledge. Moreover, following the hermeneutical or phenomenological tradition we can argue that the experiences and opinions tell about the experts' inner worlds if not about the real world. The taxonomy does not include future knowledge, as a separate level even though Malaska and Holstius position it to the top level. In this taxonomy, though, the question is about expert knowledge and we suppose that future knowledge will be a derivative of the (expert) knowledge.

If we extrapolate the Popperian ontology to expert knowledge, the knowledge that can be harvested by a futures researcher is essentially a representation (W3) of the experts' internal representation (W2) of the world (W1). Thus, it is also subject to the condition called "double hermeneutic" by e.g. Klein (2004), i.e. we quickly end up interpreting someone else's interpretation of the empirical phenomenon we want knowledge of. In common sense wording: "expert knowledge" tells what the experts think of and feel about, or even know about, the topic in question, but an expert panel does not necessarily convey knowledge of the future or present. It depends on the demands of the application and the level of rigor, but generally, it seems, taking into account for example Sackman's (1974) criticism of the Delphi method, that expert knowledge is most readily suited for positioning the futures studies to existing attitude climate and power structures, and getting cues for describing the present. Whereas the use of expert knowledge in structural analysis of the world and framing the main change processes which shape the future requires critical appraisal of the input.

3 Evaluation and validation of futures

3.1 Futures as a science of design

Niiniluoto (2009) brings forth the analogy of futures research as a "design" science, which seeks answer to the question what ought to be for the person who asked the question to reach certain goals, at least in the case of normative futures. Apart from the more general meaning, Design Science (DS) is specifically an emerging research approach or even a paradigm in information systems, management science and engineering (Dorst, 2008; Winter, 2008). DS in general is about forming new, innovative and evaluated solutions to previously unidentified and unsolved (Hevner et al. 2004), possibly wicked (Rittel and Webber, 1973) problems, using previous scientific knowledge (Cross, 1993; Walls et al. 1992). The outcome is a practical and serviceable solution and a substantial contribution to the scientific understanding of the given field.

One of the most cited sources on DS has been Hevner et al. (2004). They describe a basic framework by explaining that IS research in general and DS research in particular, should be linked to both the surrounding (business) environment and the knowledge base built by previous research. They suggest that DSR builds and evaluates artifacts and theories, using applicable knowledge from the knowledge base and business needs from the environment as input for design. Hevner (2007) proposed later that DS research includes from three related cycles of activities that aim to solve the research problem. Firstly, there is the relevance cycle, which interfaces with the environment to gather the (functional) requirements and constraints for the artifact. Secondly, the rigor cycle accesses the knowledge base for theories and practical knowledge for the kernel of the artifact. Thirdly, the central design cycle builds and evaluates plausible artifacts based on the kernel theories that fulfill the requirements. Ideally, through these three cycles, DS research will produce artifacts that solve business problems. In the process, new knowledge and insights are created through design, which can be then added to the knowledge base as a feedback of the rigor cycle, and these artifacts can be implemented in the environment through the relevance cycle (Hevner, 2007).

Vaishnavi and Kuechler (2004) were the first to introduce a concrete process description (Figure 2) to operationalize this framework. For Peffers et al. (2008), the initial phase is outlining the problem, which results in a research proposal. The second phase then concentrates on suggesting solutions to the problem defined in the proposal, where the knowledge base is accessed to find feasible solutions. The third phase is effectively the design phase. Here the researchers use the suggested solutions to develop or construct the artifact. At this point, Peffers at al. (2008) add demonstration of the artifact, a sort of proof-of-concept testing or evaluation, as a separate stage. After design and/or demonstration, the artifact moves into evaluation, which we discuss separately. The purpose of evaluation is to test how well the artifact contributes to the solution of the problem.

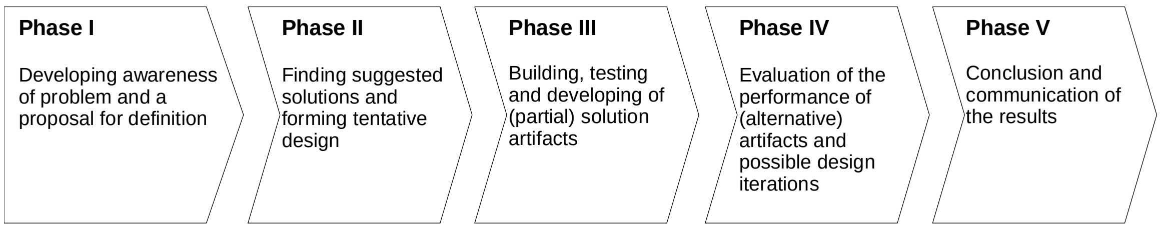

Figure 1. Process of DS research (adapted from Vaishnavi and Kuechler, 2004)

Vaishnavi and Kuechler (2004) and Peffers et al. (2008) argue that the process is not linear since evaluation may produce new insights for design and may lead to changes that call for new evaluations. Moreover, the design and evaluation may reveal an altogether different problem to be solved, which results in a completely new design cycle. For example, Markus et al. (2002) who were outlined as prime example in DSR by Hevner at al. (2004) developed a rapid cyclical development procedure, which resulted in incremental iterative development and instant evaluation of the revisions. After the artifact is stable and satisfying, the process moves to the conclusion phase where the results are communicated.

3.2 Evaluation and validation of designs

Because of the nature of DS research, the evaluation is often attached to a set of functional requirements, and the same goes for simulation models as well. However, also foresight or futures studies are usually conducted with a goal in mind; they can not envelop the whole world without becoming infinitely complex anymore than say simulation models, so futures studies are subject to similar challenges than DS or modeling projects.

The purpose of evaluation in DS is to test how well the artifact contributes to the solution of the problem. Hevner et al. (2004) that evaluation can use any reasonable empirical methodology as well as logical proof that the artifact solves the problem. The evaluation can follow established practices in IS research, including (Ibid.):

1. Observational (study of instantiations)
2. Analytical (structural and performance analysis)
3. Experimental (controlled or simulation experiments)
4. Testing (functional or structural)
5. Descriptive (plausibility of the systems in use cases)

Sargent (2005) defines validation of simulation models with a different view. As opposed to evaluating the utility of the artifact, validation of a model aims to ascertain that the model has sufficient accuracy and reliability in its intended use, and verification as appraisal that the model is implemented correctly, i.e. used as intended in the design of the model. Kleijnen (1995) clarifies the difference by writing that verification is determining that the model runs and works correctly, validation means determining whether the model is a sufficient representation of the system or phenomenon of interest. Sargent (2005) goes on to remind that a model should be validated within a given context in terms of the objectives, and that a model is valid only in that application. This means, that even though the model might produce valid results in other context and answer other question, without a proper appraisal the user cannot be certain of this validity. Balci (2009) further adds that verification and validation is or should be in fact a continuous process that starts together with modeling and continues besides the building of the model as constant incremental validation throughout the modeling life-cycle.

Sargent (2005) has identified four main verification and validation tasks to ensure validity of a model (Table 2). Structural validation is another validation task, which in short means ascertaining that the model exhibits the right behavior for the right reasons (Qudrath-Ullah, 2008), also enveloped by Sargent’s items. The list composed by Hevner et al. (2004) can be seen more in the far right column, in validation techniques.

Table 2. Verification and validation of simulation models

Form of validation	Objectives/considerations	Techniques, measures
Conceptual/structural validation	- The underlying theory and assumptions are correct and reasonable - The conceptual model represents the problem and theory correctly	- Face validation of the model structure - Testing of the modeling assumptions - Walk-through - Comparisons with other models - Black-box testing with real data
Model verification	- The underlying conceptual model is operationalized correctly in the model - The model does not have technical flaws	- Inspection of the computerized model - Test runs, tracing the intermediate outputs - Comparison with other models
Operational validation	- Validity, reliability and accuracy of output data/results/dependent variables	- Comparisons between historical data and output - Comparison with the real system - Comparison with a known analytical test case - Sensitivity/risk analysis
Data validation	- Validity of the data used to build and validate the model	- Triangulation of data - Evaluation of sources

To integrate the discussion on evaluation, validation, we can build on the view of future knowledge we discussed above. We came to assume that knowledge of the future builds on analysis of the present and finding the processes and drivers that affect the future and working out the plausible developments. The task of building this knowledge is analogous to DS but also to simulation modeling. Futures studies envelop a variety of techniques and methods, not all of which submit themselves readily to evaluation with simulation verification and validation techniques. Despite the challenges, we can gather a conceptual framework for evaluation, validation and verification, summarized in Table 3.

Conceptual and structural validation of the assumptions and conceptual model behind a futures study is as important to qualitative visionary techniques as to quantitative forecasts or models. Verification translates to futures studies as well, however usually the modeling of the system is more abstract and qualitative in nature, but verification of the operationalization and technical quality can be translated to correct technical choice of methodology in terms of goals and verification of the quality-of-execution in and documentation of the method and the research process. Operational validation in qualitative terms would in turn mean ascertaining that the predictions or foresight fulfill Malaska's (2009) truthfulness criteria, i.e. they are reasonable in terms of the assumptions and present knowledge and can be conceivably be realized by humans. Data validation is universally important and careful evaluation of the sources and critical examination of the data for possible biases is in order whatever the intended use.

Table 3. Evaluation, verification and validation of futures studies and knowledge of the future

Form of validation	Objectives/considerations	Techniques, measures
Conceptual/structural validation	- The underlying theory and assumptions are correct and reasonable - The conceptual model represents the problem and theory correctly	- Face validation of the model structure - Testing of the modeling assumptions - Walk-through of the model and assumptions - Comparisons with other models - Sensitivity/risk analysis
Method verification	- The method is consistent with philosophical and factual assumptions - The method is consistent with the set goals - The research process is correctly conducted and documented	- Comparison with other studies - Evaluation of method feasibility and fit to assumptions
Operational validation	- Feasibility and quality of the results	- Comparisons between historical/ present knowledge - Evaluation of feasibility of the results - Consistency of the results internally and with the assumptions
Data validation	- Validity of the data used to build and validate the model	- Triangulation of data - Evaluation of sources

3.3 Designing the future

To draw the discussion together, we can start by thinking of futures predictions as artifacts. Taking what Ketonen (op. cit.) wrote about the schema of prediction, it is quite natural idea to take the knowledge of the present as a kernel theory and to construct a set of alternative futures around it using a futures methodology as a design theory. In this framework, the process and resulting projection can be subjected to evaluation and validation with different means.

The premise in DS is that it involves practical interests and previous knowledge of the world, and tries to solve a problem and further the practical interest by leveraging existing knowledge. In our case, the interest to know about the future and to change it to more favorable is the problem or objective, and our previous knowledge is the knowledge of the world and the special circumstances surrounding the particular facet of the future we want knowledge of. The knowledge we have of the world has many forms and sources, such as previous research, statistics, expert knowledge, intuition and opinion, all of them different. These fragments of knowledge will be the kernel of the future that is designed. The design itself can follow the DS framework and process as a general guideline, but the actual design of the knowledge artifact, which corresponds to phases two and three of the design process (Figure 2), is usually accomplished by using a futures research method or methods in some combination.

As in all scientific activity also futures research involves assessment of validity, reliability and credibility of the results. In the DS framework, evaluation is or should be an ongoing sub-process of the design process in whole. According to the framework we proposed, also the futures projections should be evaluated on multiple levels. Firstly, the main assumptions of the projections and the structural and face validity of the kernel theory as well as the conceptual model, be it qualitative or quantitative, need assessment. Beside this, secondly, the data that is gathered and used while building the model should be critically appraised, and thirdly the process of building the model should be documented and evaluated as well, only if to raise the credibility of the results. Fourthly, the final task is to evaluate the reliability and credibility of the resulting projections, the knowledge of the future. Not to forget the evaluation of usefulness of the results, whether they solved the problem or not.

While we can quite conveniently formulate a conceptual framework for designing and evaluating the future, as we did above, the special challenge in futures studies is the evaluation, because knowledge of the future is uncertain and extrapolative/prospective (Ketonen, 2009; Malaska and Holstius, 2009). The discussion on the nature and role of expert knowledge in futures has some implications to the evaluation as well. Above we discussed that expert panel data is risky and easily biased source of information about the future or present. As long as expert knowledge is used as a kernel theory for futures, it needs to be carefully appraised in terms of biases and amount of actual knowledge conveyed. As Ketonen (Ibid.) reminds, often the most crucial things are taken for granted. This means that expert knowledge might be counter intuitively unreliable source of information also in terms of the drivers of change or the most fundamental assumptions our lives are built on.

However, if we delve into the so-called unbiased measures, we arrive at statistics, large-scale surveys, measurements and quantitative databases. The challenge with statistics is then that even the best data is mostly either an input or output proxy of a change process in the real world, it does not quite tell us what is behind the time series. The proxies need an explanation or a conceptual model to fill in the black box between the cause and effect, or input and output proxies. If we return to DS, here it seems that there indeed should be a kernel theory to base the futures projections on, instead of a theory-in-use formulated based on an expert panel. The kernel could be a theory from social sciences, such as, anthropology, sociology or economics, which explains that given this and that the society seems to evolve to this direction or it could be just as well a meteorological theory that explains weather as a function of variables such as atmospheric gas compositions and radiation from the sun. This theory fills in the back box and makes the assumptions of the futures researchers transparent, and enables the readers to learn about the supposed causal mechanism that drives the change.

4 Discussion

In this paper we have discussed a framework for designing better knowledge of future, or knowledge of better futures, if not in terms of personal preferences, than validity at least. The research topic we chose in the beginning was to examine the nature, use and evaluation of expert knowledge in futures research. We discussed the nature of knowledge of the future in general and expert knowledge in particular, and we adopted the view that knowledge of the future is rooted in the knowledge of the present. It follows that the principal reason for (explorative) foresight is to figure out how the real world is going to evolve over a given time, and form a representation of the system to communicate the expectations. After outlining the nature of knowledge of the future, we took the design science perspective as proposed by Niiniluoto (2009) and discussed how to design and evaluate futures research according to design science guidelines.

The design perspective to foresight seems to be often associated with normative foresight, in the meaning that the future is designed through planning and action taking (e.g. Niiniluoto, 2009). In normative, backcasting or visionary foresight, the foreseer pictures visions that are plausible, addresses the preferability of the visions based on a set of values, and then acts to realize the more preferable ones. In this essay, we have taken a design perspective to the foresight knowledge as representation of the world and the main artifact to be designed, not to the world itself. However, it is possible to think of foresight and forecasting as a technique to evaluate designs of the world. DS can also scale up to design normative futures as well. In fact, DS can be seen as an example of the means-ends model of justifying morals (Bell, 2009). In effect, design is about finding means to attain goals (Simon, 1996; Niiniluoto, 2009).

Another perspective to knowledge of the future that has been left to smaller discussion is what the utility of futures knowledge is. Glenn (2009, p. 3) writes that after all perhaps the most important "…reason for the use of futures methods is to help identify what you do not know, but need to know…" [emphasis by the original author]. Reflecting upon the critique of determinism by von Wright (2009), to know the future might be interpreted as knowing the forces and processes, the relevant laws that shape the future for the unit of analysis. Another perspective is the distinction between futures research as a sub-process of (business) policy making and academic futures studies. The interest of knowledge can be quite different in these outlined circumstances. Glenn (2009, p. 7) draws a distinction by proposing that the core question in policy making is "what difference does it make?" instead of "How well do you know it?" implying the difference that practical futures studies are more geared toward finding out the plausible futures and mapping the impact of the key eventualities, whereas academic futures studies are more concerned about producing reliable and validated knowledge of the future

Oftentimes validation and evaluation can feel like a burden, but Kivijärvi et al. (2009) turn the tables while proposing that scenarios can and should be viewed from multiple perspectives. The first perspective is to view scenarios as (knowledge) artifacts, and to examine the projections themselves and their reliability and utility. The second perspective is to look at scenarios as a process of learning and discussing the futures, interpreting the knowledge of the present in the light of the questions about the future, and the third perspective is to see scenarios as representation of the underlying values and ideas of the process participants. If we rephrase in light of our discussion, we can propose that the participants in the process 1) make their assumptions transparent, while they 2) (re-) interpret their observation and knowledge about the present to learn about the future, and 3) gain knowledge about the plausible futures. If we view futures research from this perspective, the process gains weight not only as a means to arrive to the ends, but also as a vehicle of learning for the participants. Sargent (2005) discussed credibility of simulation results as a special question of verification and validation, we propose that involvement in the process raises credibility as the participants see how the research is done and what data are used, and they can examine the assumptions themselves. In this new light, carefully designed evaluation and validation procedures can be a strength in a serious futures research effort rather than a necessary evil and a burden.

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