

FORESIGHT TOOLS –SCENARIO PLANNING

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UNIDO - Technology Foresight for Practitioners

Training course, 6-10 October 2003, Prague, Czech Republic

Day 2 – Tuesday 7 October - 11:00-18:00 (with breaks)

Abstract

The term "scenario" is used to cover a wide range of different activities, even within Foresight programmes. Scenarios may be used as **inputs** to kick-start discussion and idea generation in panels, as **tools** for working groups to marshal their arguments and test the robustness of policies, as **presentational** devices that can communicate Foresight results to wider publics. They may be used more as an element of the Foresight **process**, with their major contributions involving the exchange of visions and thus the deepening of linkages in networks, or as **products** of the activity that can be circulated to broad audiences. They may be **exploratory** focusing on what might happen under various circumstances, or **aspirational** asking how specific futures can be achieved (or avoided). And the ways of producing scenarios vary immensely - from the outputs of simulation models, through the work of small expert teams, to the undertakings of workshops and the delineation of different views in even wider samples of expertise.

This paper explicates some of these issues, and examines some examples of how scenarios have been used in (technology) Foresight. It will indicate the methods used in main approaches, and then focus more specifically on the approaches used in scenario workshops. A comparison between two main types of workshop will be undertaken (one more exploratory, one more aspirational), and the sorts of technique used to mobilise participants and structure inputs and outputs. Finally, lessons will be drawn as to the application of scenarios within Foresight exercises. What sorts of scenario approach might be used effectively in different contexts, and what sorts of planning, capability, and resources could be required? What are the pitfalls and problems, as well as the advantages and utility, of these approaches?

Introduction: Scenarios

Definitions

The term “scenario” has many uses. A google search using the term will come up with many hits before we get anywhere close to the origins of the word in theatrical scene-setting. We immediately find large volumes of usage referring to computer-related applications (e.g. "*Scenario 4: Use user-defined SQL Step 1: Edit the file user.sql and add your personal SQL statements...*"; "*as a partner of ENHANCE (Enhanced Aeronautical Concurrent Engineering – an EU project), IBM is helping to implement a scenario defined with SNECMA ...*"), and in financial and other professional service applications (e.g. "*The following picture gives an example of a volatility scenario for a yield curve..... To modify an already defined scenario you click on the target scenario in the left canvas with the left mouse button*"; "... 4. Identify Sales Forecast Exceptions Scenario A. ..., Sales Forecast Exception Criteria are established and defined in the Front End Agreement...") This mainly serves to confirm our existing knowledge of who the heaviest users of the Internet are (for some reason pornographers and music "pirates" do not seem to have picked up on the term "scenario" much). It also demonstrates that such users are finding it helpful to wield a term that allows them to outline sets of options or sets of alternative possibilities, which is not so far from our sense of the term.

Scenarios are used in this paper in the sense of *visions of future possibilities* – and particularly, visions (a) that have been derived and presented in a fairly systematic way and (b) that strive for some holistic sense of the circumstances in question. The term is sometimes used to refer to quite restricted visions (e.g. the effects of running a narrow econometric model with assumptions of 2% as opposed to 5% growth rates). However, the sense used here is one in which we go beyond simply profiling the future in terms of one or two key variables, to present a more fleshed out picture, linking many details together. Typically there will be a mixture of quantifiable and non-quantifiable components. They may be presented in discursive, narrative ways (illustrated with vignettes, snippets of fiction and imitation newspaper stories, etc.) or tabulated in the form of tables, graphics, and similar systematic frameworks.

Such scenarios have been used widely in futures studies from the 1960s on (e.g. in the work of Herman Kahn, Michel Godet, etc.) The methods used in scenario generation vary, the static or dynamic emphases of the scenario receive more attention, the uses and styles of presentation vary considerably. Here we shall examine some of the main varieties of scenario in use in Foresight work today.

Histories and Images

An important distinction may be drawn between scenario visions that are more or less dynamic or static. The former concern events or trend developments (“future histories”), whereas the latter are more focused on a point in future time (“images of the future”). We can find whole books, for example, that present a view of a future without a great deal of explication of how we got from here to there - when I was reviewing Gerard O'Neill's 2081 two decades ago, I was struck by how perfectly the technological elements of this visionary future all worked together. There was practically no hint of the failures, errors, disasters that almost inevitably dog any large-scale human enterprise - and this in a future of space colonies, automated vehicles, and the like. It is rarer to find studies that emphasise the history without spelling out the type of future that might be arrived at, but a case in point from the dim past may be Freeman and Jahoda's 1978 study, World Futures: The Great Debate which started with a set of alternative futures (some more desirable, some less so) and examined the paths which might lead to them in some detail.

Normative/Exploratory and Inward/Outward Bound Scenarios

A long-established distinction in futures and forecasting studies is between more or less "exploratory" and "normative" approaches. The former methods essentially involve starting from the present and posing "what if" questions: What if the growth rate is x% or y%? What if events W or Z happen? What if we pursue one or other strategy? In contrast, the latter methods can be seen as starting from a point in the future, and asking "how" questions: What would it have taken to have reached a future where the parameter of interest is x% greater than its current value? What would have led us to situation Y? .

Because all scenarios are full of normative content - including the choice of "what if" and "trend rate" variables - I prefer to term these two orientations "outward-bound" and "inner-directed", respectively. It is unlikely that decades of usage will be shifted overnight, however.

Both orientations can be used in scenario analyses as suggested above. I have found variations of each to be very useful in fairly similar situations, and indeed, recent workshops that use inner-directed approaches ("success scenarios") intensively to formulate priorities, targets and indicators, are usually preceded by some development of outward-bound scenarios. The aspirational scenario is worked up in a workshop, on the basis of workshop participants' views of what are feasible and desirable developments given the range of possibilities explicated in the previous work.

Single or Multiple scenarios?

Singular Visions

Some scenario studies are focused on a single vision of the future. O'Neil has his own "hopeful view" - explicitly a critique of the "limits-to-growth dogma, which would suggest that we must deny freedom to individuals and accept a narrow, regulated existence".¹ The book expands upon this vision, and does not explicate alternatives. The discursive discussion of issues frames an extended vignette in which the protagonist journeys from a space colony to Earth, encountering various technological marvels to do with computer and communication systems, energy sources and delivery means, and so on.

The singular scenario can be useful as a means of:

- illustrating and communicating features of forecasts and future-relevant analyses,
- providing a framework in terms of which views of different aspects of future developments can be integrated and their consistency or otherwise examined.
- structuring and guiding discussion so that visions, elements of visions, and the assumptions that underpin such visions, can be explicated and elaborated.

¹ From the book's dust jacket. In this unregulated future we can all be tracked all the time by position monitoring equipment, and the life of many inhabitants of developing countries does not display much opportunity to exercise freedom... Carping aside, the study does provide both rich detail of a techno-optimistic vision with partisan but generally well-informed discussion of the technological challenges involved.

Scenario workshop methods are particularly relevant to this latter objective. The process of dialogue can be used to generate organisation-relevant scenarios (products that can be used later and communicated to others), and also to support a creative exchange of views and information among workshop members. The scenario workshop process is one that can yield benefits to participants in terms of improved understanding and networking, as well as providing products such as reports and priorities.

2025

More recently, in 1998 Joseph Coates and his colleagues presented the slightly more modestly titled 2025: scenarios of US and Global Society reshaped by Science and Technology - similarly to O'Neill this is oriented around the implications of "enabling technologies" - though the four in question include new materials and biotechnologies, and they also treat environmentalism as the "fifth primary driver of change". At first glance the volume features 15 scenarios. But these are really different slices of (more or less) the same evolving future. Each focuses on specific topics, e.g.:

- Harvesting the fruits of genetics
- Working toward a sustainable world
- People and things on the move
- Balancing work and leisure.

Each of these areas is described in various ways. There are fairly detailed accounts of circumstances in the US and "World 1" (affluent countries), "World 2" countries (the bulk of the global population), and "World 3" (destitute nations and regions). There are vignettes describing everyday life or other case studies, which help to bring the scenarios to life. There are suggestions of unrealised developments ("hopes and fears") which might have made the scenario quite different had they happened. And there are elements of the history of the future - lists of possible events, with suggested dates.

This latter feature means that it is possible to use this material for studies with a shorter time-horizon than the relatively remote 2025. Examples of a few of the developments (and their effects) within the timespan to 2010 are:

- Late 1990s – flat screens introduced, changes the use of computer screens from(?) office to domestic furniture and to decorative tool for work & entertainment.
- 2000 – International Global Warming Federation forms, transfers technologies in response to global warming.
- 2001 – breakthrough in battery technology for electric vehicles, giving range of 250 kilometres per charge.
- 2001 – US Retooling Manufacturing Act, and (with change in antitrust rules) establishing formal industrial policy and promoting greater industrial concentration.
- 2001 – Virtual reality industry surpasses \$2bn in annual sales, covering entertainment, military, simulation and business training applications.
- 2002 – collapse of derivatives market, SEC intervention to severely restrict derivatives.
- 2002 - US Energy Transition Act, mandating reduced energy use and providing tax incentives for switch to renewables.
- 2003 - Human genes and functions fully matched, testing of people for susceptibility to genetic-based traits and diseases (of which many more are

located than anticipated) with near certainty is possible, eventually becomes routine.

- 2004 – Genetic Recording Act, safeguards for people's genetic information reduce social resistance to genetics testing.
- 2006 – Authentication and Certification Act, requires certification of images with respect to authenticity or extent of doctoring.
- 2007 – Lima Space Weapons Treaty, preserves space as a weapons-free zone.
- 2009 – adoption of global patent system.
- 2009 – ISO establishes materials characterisation standards covering composites and other advanced materials, enabling greater recycling and reclamation, easier materials choice and development of new applications..
- 2010 – Recognition of prenatal psychology as a scientific discipline, establishment of practices of prenatal intervention for mental stimulation and personality shaping.
- 2010s – Rise of the Quality of Life movement, emphasising improved everyday life, aesthetics and amenities of home and community.

In addition, Coates presents an inventory of 83 high probability developments by the year 2025. Some of these concern science and technology (“Genetically engineered micro-organisms...used in the production of some commodity chemicals as well as highly complex chemicals and medicines...in agriculture, mining, resource upgrading, waste management and environmental cleanup”; “...world-wide, broadband network of networks based on fibre optics...communication satellites, cellular and microwave will be ancillary. Throughout the advanced nations...face-to-face...[etc.]... communication will be available to any place at any time from anywhere.”) Others involve socio-economic factors (“World population will be about 8.4 billion people”; “...world-wide unrest reflecting internal strife, border conflicts and irredentist movements... peaking between 1995 and 2010”.) Finally, another 24 likely, but less probable developments (e.g. “Mastodons will walk the Earth again and at least 20 other extinct species will be revived”; “Privatisation of many highways...tied to the evolution of an intelligent vehicle-highway system”) are indicated.

Coates' work constitutes a very rich - if not infallible! - source of informed speculation and provocation about developments that are largely framed in terms of the evolution of science and technology. In many ways, he is shouldering the techno-optimist banner earlier carried by Herman Kahn, though Coates' work is more sophisticated in many ways. Some forecasts have a technological fix flavour; he is rather sanguine about prospects for managing the global environment; his views about the development of genetic engineering and medical practice are likely to raise hackles in some quarters. But he is hardly an unqualified techno-optimist, anticipating that, for example, widespread contamination by a nuclear device on a scale significantly greater than Chernobyl is highly probable, in this timescale, that epidemics and mass starvation will persist, that impacts of global warming will be experienced. Among his concrete speculations, for example, are rather scary stories about genetic screening and about the eco-collapse of Haiti.

UK2010

The "scenarios" in this volume could certainly be used to provoke debate, and thus be the seed for true alternative scenarios. The work was produced as an output of multiclient studies, and draws on years of working and networking within the US futures community. A rather less ambitious study that uses one scenario (and describes the various vignettes located within it as scenarios) has been conducted

within the context of the UK's Foresight Programme (2nd cycle).² Scase (1999) presented an analysis of *Britain towards 2010* that set out to map major social and demographic developments (a demand from several of the Panels).

The three "scenarios" here presented the stories of different individuals, selected so as to illustrate how UK society might look like a decade from now, simultaneously highlighting specific trends in British society (e.g. greater individualism, personal mobility, individual freedom and choice, and use of information and communication technologies) and the persistence (or worse) of a society divided by economic, educational, social and cultural inequalities.

The study addresses a series of major social topics, within each outlining - sometimes on the basis of statistical data, sometimes using literature sources - what major trends seem to be at play. For example, in the sphere of politics, these trends include:

- The end of political ideology
- A cynical electorate
- 'Me' politics grow
- A global economy places limitations on governments
- Demographics place greater demands on the State
- ICTs have the potential to revolutionise government
- Civil Service cultures present barriers to change
- ICTs offer both opportunities and threats
- Lack of computer literacy places a brake on virtual government

The "scenarios" really serve to explicate some of the human implications of these trends, and to illustrate the huge diversity that can underlie averages. Studies such as these discussed above show that not all scenario studies feature multiple alternative scenarios, and that effective use can be made of a single scenario - to present an ideal vision, or to highlight the major trends in a best-guess future.

Multiple Scenarios

But most authors discussing scenario analysis recommend the use of multiple scenarios. The future is uncertain, and analysis of just one scenario does little to communicate much about the range of opportunities and challenges liable to confront us. Often scenario analysis is identified with **multiple scenario analysis**, and the use of several alternatives is held up as offering opportunities to:

- Challenge received wisdom by demonstrating the plausibility of several diverse futures.
- Give more sense of how different trends and countertrends might unfold and interact, what the implications would be of variations from the standard account of these developments.
- Allow for some test of the robustness of policy and strategy conclusions across different paths of development, and possibly yield some guidance as to signals that we are on one or other path.
- Introduce substantially different "worldviews" concerning what drivers of change are and how they are related together, and allow for dialogue among proponents of different viewpoints as to the results of, or the requirements for, various events materialising.

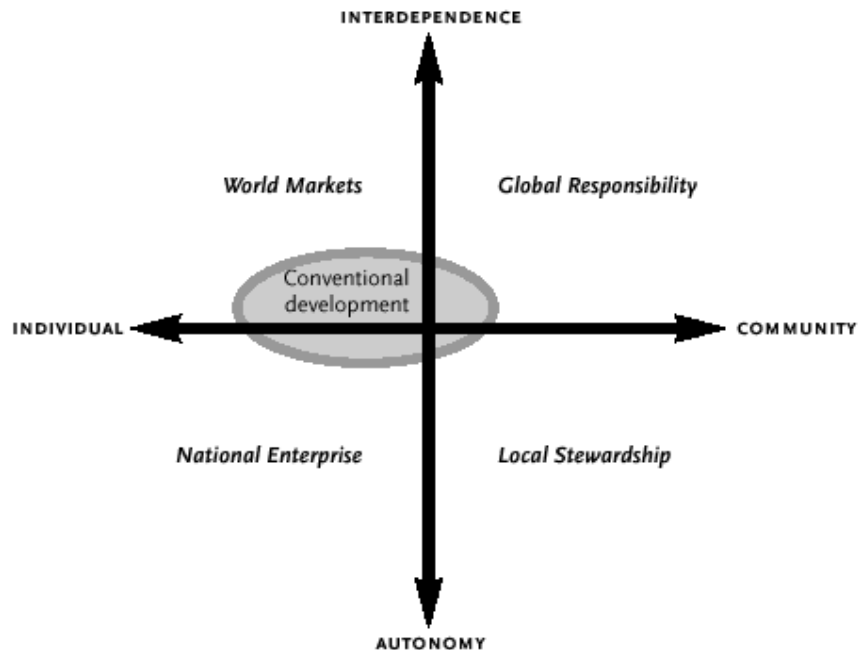
UK Foresight "Environmental" Scenarios

² For a discussion of the three cycles of the UK Foresight Programme see Miles (2003).

There are many studies involving multiple scenarios. Perhaps the best-known scenario analysis in the UK Foresight programme is one designed initially to be able to deal with environmental issues, though it has been used in a much wider range of contexts. The discussion below draws on a summary of this work by Berkhout and Hentini (2002).

This study elaborated scenarios on the basis of two dimensions, concerning social and political **values** and the nature of **governance** (see the [Figure 1](#) below). The 'values' dimension reflects underlying principles driving the choices made by consumers and policy-makers. At the 'individual' end of the spectrum private consumption and personal freedom dominate. Governance is mainly limited to regulating markets and securing law and order. At the 'community' end of the spectrum, more concern for the common good, the future, equity and participation is the norm. Civil society is strong and resources are allocated through more heavily regulated markets. The 'governance' dimension captures structures of political and economic power. At the 'interdependence' end of the spectrum power to govern is distributed away from the national state level. The 'autonomy' end of the spectrum retains high levels of economic and political power at national (*National Enterprise*) and regional (*Local Stewardship*) levels.

Figure 1 UK Foresight "Environment" Scenarios



Brief histories of the future (called "storylines" in this study) and a fairly elaborate tabular comparison of the four cells formed by these two dimensions are developed. Berkhout and Hentini summarise a wide range of studies and policy activities in which these scenarios were used, and the present author can testify to their continuing resonance within such UK policy bodies as the Environment Agency. They also seem to have had some impact on scenarios developed in later projects - for

instance those developed in workshops by the FUTMAN project in 2002³ have considerable similarity to the ones described above.

World Futures

A multiple scenario analysis that explicitly worked with "normative visions of the future is the Freeman and Jahoda (1978) analysis of *World Futures* mentioned earlier. This is unusually explicit both in its normative orientation, and in its use of divergent worldviews as a tool in scenario analysis. Usually the theoretical standpoint of the researcher or scenario team is left obscure, and we simply have references to the "plausibility" of various future possibilities; but in this study it was asserted that plausibility is in part a function of worldview.

As for the normative element, two values informed the study: material welfare (people's basic requirements for food, shelter, clothing and security should be met) and equality (in the sense of reducing the grosser disparities between and within nations, that lead to vast differences in the life prospects of different people). This meant looking at the question of economic growth: what levels of economic growth are required to meet the needs of the human race? Are these sustainable? And then, are inequalities functional or inevitable components of the world system? How far can human needs be met in futures largely created by a minority of the world's inhabitants?

These values were built into four alternative "profiles of the future", where higher and lower levels of economic growth and of international equality, are realised over coming decades. Examples of such futures were located in the contemporary futures literature. Despite the pessimistic assumptions of some earlier studies, it was concluded that food, energy, and materials resource availability was not the major impediment to realisation of any of the four profiles. Differences among earlier futures studies in part reflected Malthusian approaches – but other areas of dispute among social scientists and policymakers and activists about how the world works were also important. Thus the Freeman/Jahoda study grouped worldviews into three major sets on the basis of viewpoints articulated in the social science literature - especially the macroeconomics and world development literature. It considered what possibilities exist for moving towards each profile if the world were actually to operate along the lines these suggest. The upshot was the generation of twelve histories and images of alternative futures, explicitly related to assumptions of fact and value. These were related together through tabular comparisons and more discursive accounts.

Twelve scenarios are considerably more than are generally recommended in multiple scenario analyses. (In this case it finds some justification in enabling users to pull out the normative assumptions behind specific futures studies as well as to contrast different routes that are liable to be advocated as ways of reaching a specific future.) There are studies that present considerably more scenarios, but most commonly practitioners recommend the use of no more than three or four main scenarios in the output of an exercise (a few minor variations may also be covered). The idea is that this is the number that can most readily be absorbed by readers who have not been part of the scenario generation process.

³ See http://europa.eu.int/comm/research/industrial_technologies/27-03-03_futman_en.html

The big challenge, then, is selecting three or four scenarios that can do a good job of explicating the range of alternatives that may be confronted – or of highlighting the paths of development of underlying drivers and other factors. (Variations and additional scenarios may be located in appendices or on the web for the particularly interested reader to pursue.) The task now is to use appropriate criteria for selection among these scenarios. Again, several criteria (not always easy to reconcile in practice) can be suggested:

- Avoid a “most likely” middle-of-the road scenario, since decision-makers are liable to treat this as **the** future to plan for.
- Be careful with scenarios that are liable to be too “way out” for the audience and thus liable to discredit the exercise. Either find ways of presenting them in sufficiently qualified form that their salient messages are apparent without raising hackles, substantiate them with effective argument; or find ways of incorporating these messages into other scenarios (or, indeed, other analyses).
- Attempt to select scenarios which encompass all or most of the issues arising from the wide range of scenarios developed in earlier phases of the study, and that also illustrate something of the range of variations that may emerge across key parameters.
- Grab attention with provocative and interesting speculations and examples.

Different scenario methods approach this problem in different ways. Commonly, as in the Freeman/Jahoda or Berkhout study, we begin with a set of profiles of the future that are derived from dichotomising underlying dimensions. The trick, then, is to select such dimensions that either go to the heart of clusters of driving and shaping forces, or that can be conveniently used as pegs on which to hang contrasting sets of development.

Scenarios in Foresight

Scenario analysis is a well-known method in futures studies in general - but has been far less prominent in Foresight work. Consider the UK experience. In the first cycle of activity, individual panels were circulated with a stimulating scenario essay by Oliver Sparrow⁴ - but this was barely used, since it came out of the blue and did not seem particularly relevant to many of those to whom it was provided. Each panel was requested to develop alternative scenarios for its sphere of analysis, but this task was more or less submerged by the mass of other duties given the panels, and very cursory results were obtained. The question of scenarios was raised intermittently, however. For example, when discussing the Delphi results obtained in my panel (Transport), one commentator pointed out that the pattern of answers suggested that quite distinct scenarios were implicitly being used to guide the responses of different respondents. (In principle survey data can be analysed to yield different scenarios based on viewpoints articulated by different respondents, but this was not pursued here.)

Scenario workshop methods were promoted to business users of Foresight in documentation produced for the national programme. A quite useful guidebook on conducting such a workshop was produced for consultants and industry associations. The suspicion is, however, that this was more the result of contracting out the work of preparing a small business Foresight guide to a contractor whose expertise lay in scenario methods, than in a clear strategic decision.

⁴ He had been a scenario planner for Shell, whose experience in this field is legendary (see for instance, Mendonca, 2001) For Sparrow's current activities see the Challenge Forum, <http://www.chforum.org/ohgs.html>

As we have seen, the second round of UK Foresight invested substantial resources into developing, and displaying on its website and video resources, a set of alternative future scenarios. The "environmental" scenarios are still featured on www.foresight.gov.uk as all-purpose scenarios, and have been used surprisingly widely. The social scenario study was also widely circulated, and probably proved highly satisfactory to those industrial participants who wanted Foresight to tell them about future consumer markets. But we see little systematic development of scenario approaches in the UK programme.

This does not seem to be an inherent feature of Foresight exercises, but probably has more to do with the origins of the approach out of Japanese national programmes. Whereas the current Japanese effort is intended to develop multiple scenarios, this has not previously been the case - the emphasis has been more on building consensus in industrial-scientific networks around a vision of the future. Irvine and Martin's *Foresight in Science* (1984, London: Pinter) described a range of approaches to bringing long-term perspectives into research policymaking, putting much weight on the Japanese experience. Such approaches were widely applied to improving national government decision-making (especially in the area of S&T) from the mid-1990s on. Foresight involves thinking about emerging opportunities and challenges, trends and breaks in trends, and such factors – like familiar futures studies. Systematic methods are used to develop better insights and visions concerning future possibilities. But Foresight differed from the majority of traditional futures studies in two ways (as we have described in the second edition of the FOREN *Practical Guide to Regional Foresight* (available from www.forenc.jrc.es), on which the following account draws.

1. Foresight is highly related to decision-making. It brings together key agents of change and sources of knowledge, in order to develop *anticipatory strategic intelligence*. Beyond the preparation of specific plans and lists of priorities, guiding strategic visions are elaborated. These can enable a shared sense of commitment (achieved, in part, through the networking processes described below), and should be more robust to changing circumstances than are particular plans or priorities. This strategic vision is not a utopia: it must combine feasibility and desirability, and to be explicitly related to present-day decisions and actions.
2. Foresight stresses eliciting wide participation. This may be purely a technocratic effort, in which central decision-makers are using methods such as consultations and Delphis to access knowledge that is located at a variety of locations in the society. It may be more of a democratic effort, seeking to involve a wider spectrum of the population in decision-making (or at least, in decision-influencing). And it may be oriented towards building more of a "Foresight culture". Foresight is often explicitly intended to establish *networks* of knowledgeable agents, that possess improved anticipatory intelligence – and self-awareness or reflexivity, in the sense of enhanced awareness of the knowledge resources and strategic orientations of network members. Such networks should be able to respond better to emerging challenges; and one of the objectives of some Foresight programmes has been to establish improved networks among firms, policymakers, entrepreneurs, financiers and scientific and technical experts, with the aim of revitalising national innovation systems. Thus the application of interactive, participative methods of debate, analysis and study of such developments and needs, involving a wide variety of stakeholders (often going well beyond the narrow sets of experts employed in many traditional futures studies), does not just result in better reports and policies. It should also involve forging new social networks. Foresight programmes vary in their emphases here: some use networks merely to help develop their formal products

(such as reports and lists of action points); others take network establishment to be an equally, or even more, important achievement in its own right.

The term "Foresight" is applied to all sorts of activities -, as is the fate of any popular term. Thus, we use the term "Fully-Fledged Foresight" to distinguish activities which combine long-term orientations with networking activities and strong links to planning and decision-making.

Scenario methods – especially the well-known scenario workshop approaches – can be highly relevant to the networking goals of Foresight. The process of scenario construction in workshops can yield important benefits here, in terms of exchange of views about developments, strategies, and the like. However, the origins of Foresight have meant that such methods have been used relatively rarely and unsystematically. This is changing, with, for example, the heavy emphasis on scenarios in Norwegian work and several other recent or ongoing studies.⁵ The interesting challenge is to reconcile the workshop-based development of scenarios with their wider use in a Foresight process in which numerous panels and issue groups will be active.

Scenario Generation - Methods

Scenario may be developed by an extremely wide-ranging set of methods. They may emerge from workshops or be prepared by small expert groups, derived from Delphi or other survey results or constructed on the basis of different worldviews. Practically any forecasting or Foresight approach can be the occasion for a scenario generating exercise.

- Individuals presenting their informed speculations about the future ("genius forecasters") can use scenarios as a template for illustrating and enlivening their accounts.
- Expert panels can establish a framework of scenarios on the basis, for example, of literature review or conceptual analysis.
- Survey results can be analysed to determine if there are different clusters of views about the future that can be considered representative of different scenarios.
- Cross-impact and similar methods can be used to identify the most probable of all of the scenarios logically possible from a combination of variables (again from expert judgements – or in the case of Monte Carlo simulations, for instance, from repeated runs of a probabilistic computer model).
- Workshops may be used to construct or elaborate on scenarios in a process of intra-group dialogue.
- Online methods are being explored, as are techniques using computers to support face-to-face (F2F) workshops.

The focus of the remainder of this paper is on scenario workshop methods. These methods are particularly relevant for Foresight in that:

- ◆ They allow for sustained analysis of alternative futures that are relevant to the key decisions that are confronted, and allow for the generation of reasonably articulate and consistent visions of these futures.

⁵ See, for instance, the CD-ROM produced as a result of the EC/EFTA workshop in June 2002: **The Norway 2030 Seminar and Workshop on Foresight to Scenarios - Methodology and Models** available from DG Research.

- ◆ They can be used as the trigger for such inputs to planning as identification of priorities, setting of objectives and targets, defining useful indicators of progress, etc.
- ◆ They network people together and allow for the integration of the knowledge that they possess; furthermore, by involving key actors in scenario generation, they can mean that decision-makers have deeper understanding of the underlying processes and key strategies, and a sense of identification with the choice and elaboration of the scenarios.

Scenario Workshops

Scenario workshops are frequently used to build or to elaborate on scenarios. The aim is usually not just to achieve a finished scenario as a product. There are also benefits from involving members of an organisation or community in futures exercises or more specifically in a Foresight process. Such workshops bring together a range of knowledgeable and experienced participants, usually stakeholders of one kind or another, within a structured framework of activities.

This framework allows the participants to:

- ◆ exchange information, views and insights,
- ◆ identify points of agreement, disagreement and uncertainty
- ◆ create new shared understandings
- ◆ develop action plans and other instruments so as to help mobilise future activity.

Since the scenarios produced in such workshops are a product of the participants' own interactions, they are, in the management jargon, more likely to have "ownership" of them. To deconstruct this, they should:

- ◆ understand the logic much better than if presented the material in a standard report;
- ◆ have deeper insight into the considerations that have gone into the scenarios;
- ◆ be better-equipped to be "carriers" of the scenarios to the outside world.

The scenarios should also possess greater legitimacy than those produced by a smaller expert group or visionary guru, at least if the workshop has drawn upon a reasonable range of participants.

Scenarios may be generated from scratch in the workshops, or developed, in at least a rough form, in an earlier scenario generation activity. Some workshops use "off the shelf" scenarios prepared in other work (possibly even published ones) as a starting point for the workshop activity.

In scenario workshops we typically have periods of extensive exchange of ideas and debate about them, and periods where ideas are being written down and listed, where different lists are combined, and so on. The process usually involves much dialogue, and use of such instruments as whiteboards and flip charts, though computer-based ("groupware") tools are now beginning to be used effectively. Scenario workshops usually extend over at least one day, and may involve several dozen participants (with "break-out groups" of say 6 to 12 people exploring different scenarios in detail). The workshop will be conducted with inputs from at least one facilitator, and often other helpers will take notes, record material from flip charts, and deal with logistic issues as they arise. Typically such facilitators have acquired their skills through involvement in these and similar group activities; they may have received some training in workshop methods (from T-groups through management workshops to academic seminars), but to date there has been little analysis of the processes in terms of knowledge development, and the skills are typically the "task"

and “emotional” skills of classic groupwork, but this is too many to work on a scenario in detail.

Before the Workshop: Design and Background Material

Before the scenario workshop is implemented, it has to be designed - in more than a rudimentary fashion. For example, an earlier **scenario design workshop**, drawing on a range of expert and interested parties, may be constituted to help:

- ◆ identify participants for the scenario workshop – it is vital to include the right range of knowledge and expertise, and as far as possible key end-users of the results.
- ◆ determine what background research might need to be conducted, or materials collated, to provide participants with some common informational resources.
- ◆ define the workshop procedures (what scenario methodology is to be deployed; what areas of study within the domain of interest should be selected, what specific questions might be used in the workshop.)

It is typical for a scenario workshop to begin with participants reviewing some background material that has been prepared especially for it, or more generally for a larger Foresight or futures exercise it is set within. This might be a SWOT analysis of the organisation’s position in the area of concern. The SWOT or benchmarking input may involve comparing the region, country or organisation with relevant others in the various subdomains. The comparison should be able to identify trends and dynamics, and the systemic elements of the domain. It should be prepared in such a way as to indicate what informants and available literature suggest might be possible. Other inputs might include statistics of research related to this area; relevant Delphi material; results of computer simulations and econometric analyses.

Some scenario workshops are kicked off with a set of background scenarios or other forecasts prepared by an expert team. This can provide one way of presenting the results of background studies in an absorbable way: a small set of scenarios dealing with the development of the domain. This provides the workshop participants with a base against which to frame their own preferred scenario. They may proceed to elaborate these, criticise them, or use them as a launchpad for constructing aspirational scenarios.

Case Study 1: Multiple scenarios

The ESRC (Economic and Social Research Council) commissioned CRIC and the Institute for Alternative Futures (IAF) to run a workshop in January 2002, to inform its decision-making process concerning priorities for social research on genomics, and the selection of a centre to conduct such research. A set of four scenarios were presented to the workshop participants, each outlined in a couple of pages of text. This used an approach developed by the IAF, who deploy four archetypal scenarios: a “best guess” extrapolation, or “official future” scenario; a hard times scenario; and two “structurally different” scenarios (at least one of these is to be visionary, marking a paradigm change or an aspirational future). In the workshop, the four scenarios – featuring the application of genomics achieving very different degrees and patterns of success – were:

- ◆ **Genomics, Inc.** benefits primarily for the developed countries, the affluent, and corporations
- ◆ **Genomics for All** genomics applications developed to increase equity and sustainability

- ◆ **Broken Promises** genomics applications work poorly in general, failing for a variety of reasons
- ◆ **Out of Control** genomics is an international and environmental destabilising force.

An account of each was produced by the research team, and the scenarios document was one element of a package of documents supplied to participants (others included, for example, discussions of drivers of genomics applications and explication of the nature of the genomics revolution.). A set of break out groups focused on one or other of these scenarios. In line with the workshop objectives, these small groups considered the key contributions that social research might make in the event of the given future occurring. What would the critical demands for knowledge be? What sorts of pressure might social science be under?

Each group was requested to discuss its scenario, in particular, orienting its discussion around the questions:

- A. Assuming this scenario will occur, what is the optimal contribution of social science research can make (your 3 to 5 top priorities)?
- B. Signposts: What would indicate movement toward this particular scenario, expressed, for example, as headlines in the media?

This process yielded a large number of specifications of opportunities for research. It was one of a number of approaches to the question of research priorities that were employed in the workshop.⁶

Box 2 illustrates some examples of the contributions that social research might make in the different scenarios, and “signposts” that the scenarios were? on the way to realisation. The material was captured in real time by use of COUNCIL groupware – each participant was equipped with a laptop PC with wireless modem, and a technical expert managed the structuring and collation of material. A great deal of on-the-fly facilitation was required to synthesise the mass of detail that rapidly appeared.

The scenario analysis was one important step in the process used in this exercise, which took the participants through a number of exercises that led them to develop and prioritise urgent themes for social research in the genomics area. (The workshop also noted aspects of the organisation of research that went beyond topics for study – for example the need to improve interdisciplinary training and working, and dialogue between social and natural scientists.)

Case Study 2: Success Scenarios

The “success scenario” method has been applied to issues of science and technology policy in the UK⁷ - the underlying principles can be applied in many other

⁶ Full reports of the workshop are provided on the CRIC (les1.man.ac.uk/cric) and IAF (www.altfutures.com) websites. The discussion here draws on text produced by Clem Bezold and colleagues.

⁷ ICT and biotechnology scenario reports are reported on the CRIC (<http://les1.man.ac.uk/cric>) and DTI (<http://www.ost.gov.uk/policy/futures/ict/intro.htm> [www.ost.gov.uk/policy/futures/ biotechnology/scenario.htm](http://www.ost.gov.uk/policy/futures/biotechnology/scenario.htm)) websites as ICT in the UK a scenario for success in 2005. and Biotechnology in the UK a scenario for success in 2005. CRIC also presents the background analyses for these studies. The nanotechnology scenario report has just been placed on the DTI website, under the title: New Dimensions for Manufacturing: A UK Strategy for Nanotechnology, at <http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf>

domains. The workshops described here focused on a more short-term future than usual for such approaches – 5 to 10 years – on account of sponsor requirements, though inevitably longer-term prospects were also discussed.

The Office of Science and Technology commissioned CRIC, together with the National Physics Laboratory and the Institute of Nanotechnology, to run a workshop on UK prospects and potentials in the field of nanotechnology, in the autumn of 2001. In the OST Nanotechnology exercise, there was no overall effort to sketch out scenarios in advance of the workshop, and break-out groups were again constituted

BOX 1 Some Outputs of Genomics Scenario Workshop

- ◆ **Genomics, Inc.** *Research contributions:* “impacts” of genomics on various sectors of society, the concepts of well-being, ethics and health service use of genomics, the new industrial structure and property rights, growing and new social divides. *Signposts* include continuing mergers, increasing divide between public and private sectors, and inequalities among individuals.
- ◆ **Broken Promises**, *Research contributions:* re-evaluation of the notion of progress; reflexive social science to research alternative lifestyles and product use; better understanding of political change; the reconceptualisation of risk including the inevitability of “normal” disasters and the need to prepare for them. *Signposts* include Greens winning in an archetypically conservative UK town, a big biotech company like Monsanto going bust, and Golden Rice burned in India because of unforeseen side-effects.
- ◆ **Out of Control**, *Research contributions:* the comparative advantage and disadvantage of states and their relations to MNCs, the nature of international organisation. *Signposts* include China buying a big biotech company like Monsanto, and protestors attacking Greenpeace.
- ◆ **Genomics for All** *Research contributions:* applied research supporting the development of international institutions that can regulate bio weapons, and the identification of genomic products and applications that will support equity and sustainability. Comparative analysis of scientific and political change (e.g. comparing IT and genomics revolutions, undertaking historical research on international institutions), understanding how cultural creatives unite politically and affect corporations, developing value impact assessment for new technologies. *Signposts* as such were not developed by this break-out group, but discussion suggested some events that might be important here – for example loss of US hegemony (and possibly the break-up of the country), negative mobilising events stimulating change in trajectories of genomics use (examples included serious diseases associated with genomics innovation).

These lines of work were discussed in plenary sessions, which emphasised social science research stances and styles that are critical, visionary and historically informed; research to probe critical political and moral constructs, (e.g. the meaning of development and wellbeing); innovation studies on global issues; global actors and changing industrial structures; and ecosystem impacts of genomics and public processing of ecological knowledge.

around subdomains of the technology field. There was some background information constituting a scenario or roadmap of the most probable technology path in each subdomain.

The heart of the process is a scenario workshop. As outlined above the design of the workshop has to be carefully prepared, members recruited, and background research prepared. The design process extended over time, with a series of meetings between the sponsor and the scenario team that were extremely important for “tuning” the design and making sure that the sponsor was fully behind the approaches being used in the workshop.

There are two elements to a success scenario. It combines:

- **Desirability.** The scenario captures a vision of what could be achieved or aspired to, by the sponsoring organisation or a wider community that it represents.
- **Credibility.** The scenario is developed with the assistance of, and validated by, a sample of experts in the area, chosen to reflect a broad range of interests (and usually including both practitioners and researchers).

Each of these elements is informed by the background research, providing a common information base for the experts to work with in workshop and other settings. Developing success scenarios has a number of functions:

- The **process** of discussing research results, debating and agreeing upon goals and indicators, and identifying feasible actions is valuable for creating mutual understanding and sharing of knowledge. This can establish platforms for further interaction and efforts to put in place the actions proposed.
- The scenarios form a **stretch target**, to challenge those concerned to aim for excellence, to think beyond the boundaries of “business as usual”.
- The development of **indicators** moves the scenarios beyond vague aspirations, and allows for clarity as to what precisely is being discussed and whether and how far goals are being achieved.
- Finally, **action** points are developed and priorities may be established, with the merit of having been derived from a participative process.

An interview programme was carried out to benchmark UK activity in various application areas against the experience in competitor countries. There was no effort at modelling or substantial statistical analysis, due to the relatively novelty of the technology, and similarly there is little by way of serious social science to draw upon that deals with nanotechnology. Six application areas where it was accepted that nanotechnology would have a major influence, were focused on, namely:

- drug delivery,
- informatics,
- instrumentation, standards and metrology
- novel materials,
- sensors and actuators, and
-

tissue engineering and medical devices.

An effort was made to identify main trends, drivers, and the most probable future in terms of technology developments in each of these areas. Participants were allocated to areas and asked to ensure that they had read at least the appropriate part of the material.

There are many ways in which a success scenario workshop may be organised, but the approach used in these workshops involved, with minor variations, a sequence of

stages such as described below. The various stages outlined below mainly involve activity in working groups, usually constituted to cover each of the areas already identified in the domain under investigation. Plenary sessions precede, follow, and sometimes intersperse these working group sessions. The nanotechnology workshop lasted for a day, the other two for two days (presentations on background topics preceded the workshop proper.)

After various introductory matters have been tidied up – setting out the mission statement for the exercise, introducing each other, etc – the work begins in earnest. A common starting point in scenario workshops, used in the model described here, is to examine “drivers and shapers” – factors that could be critical to influencing the course of events, promote one or other sort of development, and lead to distinctive futures.

In many scenario workshops the STEEPV approach – in which people are asked to identify factors and issues under the headings Social, Technological, Economic, Environmental, Political, and Value-Based factors – is used. This can be a useful prompt and way of ensuring that a broad range of issues is considered; it is also a helpful classification framework. But in our cases the workshop itself may be asked to come up with a grouping of “shaping” factors at an early stage of its work.

The discussion of drivers is inherently interesting and its output can be usefully decision-making intelligence. But the process is equally important. What typically goes on here is that participants become more familiar with working with the background material, and with working together. They deepen their understanding (and possibly critique) of the material as ideas are chewed over, conceptual frameworks given a first airing, etc. They develop common groundrules for working, language in which to express ideas, etc.

Typically the discussion will at least in part be conducted in subgroups who are requested to work systematically through a range of factors that are liable first, to drive, and then, to shape the development of the domain. They may be asked first to concentrate on drivers, and then on shapers of the area. They may be provided with lists of potential factors as part of the background material, and be asked to critique these, add new ones if appropriate, and – especially - to indicate how important each might be, and why.

This workshop relied on paper-based rather than computer-supported methods (though some participants were spontaneously making use of laptops and even digital cameras in the most recent workshop). The groups are provided with written instructions. A facilitator/note-taker for each group was even given suggested timings for each task. The discussions were captured on posters, which are attached to the walls to provide a record of development and material for other groups to inspect at intervals. The key technique is crystallising the thinking about factors, within different subgroups (and for them to communicate among themselves) in the form of lists. The background information, participants’ knowledge, and their conceptual frameworks are brought together in ways that challenge them to develop shared understandings.

The success scenario methodology provides an impetus for these processes. It does so by asking the workshop, and working groups within it dealing with specific subtopics, to consider what might be *realistically achieved* if the UK (in these studies) is to be *successful* in the technology and its application areas. This means, of course, asking just what success in each area might constitute. This is another topic where views may differ. There may be quite different views of relations between

means and ends, causes and effects; and also very different emphases on such values as efficiency, equity, sustainability, etc.

The next task for each working group was to characterise the scenario that they have developed; succinctly describing it in terms of what success looks like, what the main drivers and shapers are, and how they might be called into play. Since the success scenarios need to be both credible and optimistic, this part of the exercise provides a chance for the groups to consider whether the different scenario elements are consistent. A number of prompts were provided to the groups, suggesting elements of the scenarios that it would be helpful to describe. These subjects form the basis of brief presentations to a plenary session. This provides an opportunity to contrast the different groups' scenarios, and see if they are consistent or divergent – and what this implies. Knowledge cycles are thus established again, within and between subgroups.

In this session the working groups further characterise the success scenario by specifying concrete ideas about how to recognise that the success scenario was becoming a reality. Again, some preliminary ideas of the sorts of indicator that might be developed are provided to kick off the work. The groups are challenged to suggest plausible quantitative estimates of such indicators - to clarify points of agreement and disagreement, to provide tools for monitoring progress, and to suggest alternatives to the narrow set of indicators that are typically used to drive policies. Box 3 reproduces the introduction to this task as provided in the nanotechnology workshop. Box 4 reproduces instructions drafted for the facilitators and chairs of the subgroups, to guide them in the tasks they were to undertake.

The final working group task now is to provide suggestions for steps that need to be taken to maximise the likelihood of the success scenarios. This work may be conducted within the original working groups. One approach here is to use a “carousel method”, where stations are set up with wall posters dealing with specific types of action – typically different policy areas. For example, a broad categorisation of areas used in the nanotechnology workshop was:

- ◆ Research
- ◆ People
- ◆ Facilities
- ◆ Finance and taxation
- ◆ Access to technology [and international collaboration]
- ◆ Regulatory issues
- ◆ Other issues

In the carousel method, each group proceeds round the posters in turn (but starting at a separate point). It is free to read and comment on other groups' suggestions when visiting a station that another group has previously visited. (An alternative approach is to form new working groups, dedicated to specific action areas. It is possible to envisage other ways in which this task may be organised.) As well as specifying actions, participants are asked to indicate **who** might be responsible for seeing them through. The outputs of this phase of work need to be synthesised and prioritised, and plenary sessions are typically used to achieve this.

The Output of Scenario Workshops

The results of such a process can take several forms. Typically a major activity will be the production of a published report, outlining the results of the scenario workshop (and often also presenting at least some of the background research, too). This “codified knowledge” – information really – may remain with the sponsor.

In Fully Fledged Foresight such material should be used more widely. They should enter into the public domain (with necessary caveats). They can be used in the processes of other organisations, feed into the components of an ongoing Foresight exercise, and may perhaps be used in successive workshops.

The workshop may define actions to be carried out, including some which participants themselves may be engaged in. This is central to the success scenario methodology. A major task will be to move other parties through the knowledge cycles, so that they can incorporate the thinking of the workshop in their own decision making.

The workshops described above have proved useful in decision processes. There are several elements to this:

- ◆ Helping to bring a wider span of knowledge into the process, which can be viewed technocratically as increasing efficiency, or democratically as enabling wider participation.
- ◆ Providing a methodology for arriving at lists of priorities that decision-makers can rely on as more than the opinion of a few self-serving individuals. Of course, such lists are not translated automatically into policy actions –the decision makers have their own judgement to exercise and choices to make, though there is now a reference point at which the decisions can be compared.
- ◆ These inputs may serve to provide sponsors with huge amounts of intelligence which they previously lacked. Or they may serve to confirm what the policy expert already believed, but legitimise this by validating the views by reference to a wider set of experts and stakeholders.

Formally, we know that the studies described above have been utilised in funding decisions. They have helped provided intelligence, too, that can be used in debates between different decision makers. (Thus the genomics exercise could be used within the sponsoring organisation to raise awareness of the relevance of the topic more widely than just among those centrally concerned with the decision. The other exercises provided those responsible for science expenditure with a case to take to the Treasury, and with suggestions as to how financial authorities might be able to assess whether the investment was worthwhile – staving off the threat that indicators of success might be imposed from outside.)

In the cases summarised above, client involvement proved vital, in the design and conduct of the scenario workshops. Without such involvement, the exercises would not have been adequately tailored to the decision-making needs of the sponsors. And participation in the activities helped ensure, as suggested above, that there were “champions” for the scenario work within the sponsoring organisation, who could take the messages of the study further. This could be seen as a matter of disseminating the *products* of the exercise further. Equally, it can be viewed as a matter of extending the *process* of the exercise. Design to allow both of these dimensions to be maximised is needed to make sure that scenarios effectively contribute to decision making.

Box 3 Task of developing Success Scenario

Text of three PowerPoint pages used in nanotechnology workshop.

What would constitute 'Success'?

Indicators

- ◆ key products and applications
- ◆ impact of products on end-user performance
- ◆ local and global end-user markets - size and UK share
- ◆ industry structure - large firms, SMEs, spin-outs
- ◆ business model (e.g. high value added)
- ◆ where are the UK companies in the supply chain?
- ◆ effect on GDP/employment? And impact on inward investment?
- ◆ our competitors, and how we compare
- ◆ where is the leading-edge research? where UK stands?
- ◆ other features

How much change by 2006?

What Enables Change?

- ◆ Quality of research
- ◆ Ownership of research
- ◆ Availability of skilled people
- ◆ Sources of finance
- ◆ Instrumentation, standards
- ◆ Infrastructure and manufacturing capabilities (e.g. fabrication facilities)
- ◆ Structure and organisation of industry and markets
- ◆ Regulatory Environment
- ◆ Policies for Health Services and other public sector markets
- ◆ Intellectual Property Regimes
- ◆ Other issues (please add your own)

How do we know we are beating the competition?

- ◆ Relative performance with other countries:
- ◆ UK research recognised by global firms as leading edge
- ◆ UK firms assembling high value added patent portfolios
- ◆ Venture capitalists and inward investors investing in UK start-ups
- ◆ International collaborations
- ◆ End users seeking/ recognising value of UK products (market share)
- ◆ Availability/size of facilities in the UK
- ◆ Number of graduates and post-graduates in relevant disciplines
- ◆ Other issues (please add your own)

Box 4 Guidance Material Used in a Success Scenario Workshop

SESSION 2A

Building a new scenario – the Success Scenario

The scenarios we have provided are intended to provide stimulus for you to consider what might be realistically achieved if the UK is to be successful in each area of nanotechnology applications. This means, of course, considering what success in each area might be. In order to move toward more concrete and credible analyses of this, we are asking the groups to work systematically through a range of factors that are liable first, to drive, and then, to shape the development of science and industry in the UK and beyond. In later sessions we will go on to consider relevant indicators and actions needed.

Here is a list of potential drivers:

- **Basic research – new knowledge, incremental and radical developments**
 - **Demand from intermediate and end-users; users' appreciation of opportunities presented by new knowledge**
- **Sources of finance for development of applications (e.g. venture capital, stock markets, government)**
 - **Instrumentation, standards**
- **Structure and organisation of industry and markets (e.g. relations between large and small firms, role of intermediaries)**
- **Entrepreneurial attitudes, visions, incentives (in research and business)**
 - **Other issues (please add your own)**

QUESTION 1

We would like you to work through and comment on each of these drivers. Please use the flip chart to identify the issues that you consider most important for each, and how they impact on your application area – how far do they promote development of applications in your areas? Are there specific applications that are promoted especially? Please indicate, too, what each of these might look like by 2006 – e.g. will the scenario be driven by large firms or SMEs?

For each driver:

1. Identify the most important issues
2. Discuss how far the driver impacts on your application area – how important is it as a driver (*could you indicate this on a scale from 1 (not important) to 5 (extremely important)?*)
3. Identify specific applications promoted by this driver
4. What might this driver look like by 2006 - would it be growing or decreasing in importance or its particular type of impact?

QUESTION 2

When discussing these issues, please:

- consider if your application area has special features here (e.g. different application areas feature very different regulatory environments)
- consider whether the UK situation is shared by other countries, or if we have specific opportunities or problems.

Continued

Box 4 continued: SESSION 2b

Further Building the Success Scenario

To further move toward a more concrete vision of what success for the UK in each area might be, we are now asking you to work systematically through a range of factors that are liable first to **shape** the development of science and industry in the UK and beyond.

Here is a list of potential shapers:

- **Regulatory Environment – Health & Safety, Environmental & Food Regulations; Competition Policy**
- **Policies for Health Services and other possible public sector markets**
- **Intellectual Property Regimes, knowledge of and support for using them**
 - **Public attitudes to Risk, to Expertise, to Technology**
- **Quality of Life issues (e.g. UK as an attractive market, base for production and research, place to live)**
- **Availability of technical, disciplinary, and multidisciplinary skills, and of management capabilities**
 - **Other issues (please add your own)**

QUESTION 1

We would like you to work through and comment on each of these shapers. Please use the flip chart to identify the issues that you consider most important, and how they impact on your application area – do they impede developments, or push them in particular directions, for example? Please indicate, too, what each of these might look like by 2006 – e.g. will the scenario feature a large number of people trained in multidisciplinary team -working?

For each shaper :

1. What are the most important issues (*again, can you rate them on a 1 to 5 scale?*)?
2. How will those issues impact on your application area ?
3. What will this shaper look like by 2006 ?

QUESTION 2

When discussing these issues, please:

- consider if your application area has special features here (e.g. different application areas feature very different regulatory environments)
- consider whether the UK situation is shared by other countries, or has specific opportunities or problems.

Continued

Box 4 continued SESSION 2c

Summarising the scenario

Here we would like you to characterise the scenario developed by your group. One way in which this can often be assisted is to come up with a “name” for the scenario.

Beyond this, how can we succinctly describe it – what does success look like? What are the main drivers and shapers, and how are they being called into play? Remember that the success scenarios need to be both credible and optimistic: this part of the exercise is a chance to see if the different elements of your scenario are consistent.

What would this scenario look like in practice? What is the industrial landscape, the patterns of supply and use of the application? Where is the action taking place? What could we hope for in terms of a UK presence? Please try to characterise the scenario in terms of such features as:

- What level of UK activity is there likely to be in this application area? How much would it have grown in value and employment terms from current levels?
- What sort of presence is this in world markets – what is the UK’s market share?
- Inward Investment in the application area: how much growth would we expect? From where, what sort of firms? To what level?
- What sorts of UK firms are involved - are the main actors large firms? How many start-ups could we expect in this area? How many SMEs involved in the supply chain?
- How big are the end-user markets, what sorts of purchasers are there, what is the impact on their performance?
- What would industrial funding of research in Universities for relevant nanotechnology look like?

You will have more time this afternoon to address such questions further, but it will help to make a start on them now to characterise the scenario – and see how far members of the group are in agreement about optimistic prospects for such issues.

Please prepare a brief presentation on this, kicking off with the name of the scenario, and then describing it in ways that the other groups can rapidly grasp. This will provide us with an opportunity to contrast the different groups’ scenarios, and see if they are consistent or divergent – and what this implies.

Continued

Box 4 continued

SESSION 5 Indicators for success

In session 2c we asked you to begin to characterise the success scenario. Could you return to the bulleted questions there, and amplify your answers if that seems necessary. Please also give us some further concrete ideas about how you would be able to recognise that the success scenario was becoming a reality. The ideas below are “off the wall”, but are intended to indicate the sorts of things you might want to suggest:

- Share of UK research in EU collaborations in nanotechnology fields
 - Number of patents taken out by British innovators in application areas based on nanotechnology
- There is considerable public enthusiasm for nanotechnology, as evidenced by recruitment for courses, media attention, etc
- The NHS (as a market), NICE and the FSA become champions of nanotechnology applications.
- Growth of high-quality dedicated nanotechnology firms supported by more venture capital, large firms and a strong science base.
- Harmonisation of the European patent system and a credible, transparent European-wide regulatory framework in nanotechnology-related areas.
- Contribution of nanotechnology applications to major users reflected in relevant processes or products constituting xxx% of their outputs/ new products.
 - Growth in UK trade surplus, reflecting nanotechnology applications.

The big challenge, of course, is to suggest plausible quantitative estimates of such indicators. The closer you can come to suggesting not only indicators, but also ballpark figures, or ranges of figures, that might apply by 2006, the more valuable the exercise will be – not least to clarify where our points of agreement and disagreement are. Another benefit of this part of the exercise is that it can, hopefully, suggest alternatives to the narrow set of indicators that are currently used to drive policies for research.

SESSION 6 Critical Success Factors and Actions

The task now is to provide suggestions for steps which need to be taken to maximise the likelihood of your success scenarios. Please do so by discussing them in your groups, and writing points down on the wall posters. We invite each group to proceed round the posters in turn – feel free to read and comment on other groups’ suggestions. Please indicate on your suggestions if they are specific to certain application areas. If there is a suggestion which divides your group, it is probably best to write it up and indicate the lack of consensus! Please try to indicate **who** might be responsible for seeing particular actions through. You might also be able to indicate what sorts of systems, indicators, feedback, etc., they could be using to see if actions are having the desired effects.

We can anticipate that there will continue to be emphasis on scenario methods in foresight exercises. It is likely that there will be further development of methods, computer-assisted and otherwise, for both "outward-bound" and "inward-directed" scenarios. There will also be exploration of means and methods for representing and disseminating scenario results, and for enabling users to build these into various Foresight processes. Hopefully, we will accumulate information as to best practice and quality issues in scenario work. Perhaps we could even generate scenarios for the future of scenario analysis!

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