The depth of the horizon: Searching, scanning and widening horizons

Article *in* Foresight · November 2012

DOI: 10.1108/14636681211284953

CITATIONS
22

READS
162

2 authors:

Ian Miles
The University of Manchester - & - Higher School of Economics, Moscow
286 PUBLICATIONS **4,323** CITATIONS
SEE PROFILE

Ozcan Saritas
National Research University Higher School of Economics
95 PUBLICATIONS **1,035** CITATIONS
SEE PROFILE

foresight

Emerald Article: The depth of the horizon: searching, scanning and widening horizons

Ian Miles, Ozcan Saritas

The depth of the horizon: searching, scanning and widening horizons

Ian Miles and Ozcan Saritas

Ian Miles is based at Manchester Institute of Innovation Research, University of Manchester, Manchester, UK, and National Research University Higher School of Economics, Moscow, Russia. Ozcan Saritas is based at Manchester Institute of Innovation Research, University of Manchester, Manchester, UK, and National Research University Higher School of Economics, Moscow, Russia.

Abstract

Purpose – *This essay aims to introduce horizon scanning as an approach fundamental to most foresight studies.*

Design/methodology/approach – *The essay combines a general review of the topic with an overview of a range of horizon-scanning approaches that are in use in the UK health system.*

Findings – *Different approaches – shorter as well as longer-term, searching as well as broad scanning – are appropriate in different circumstances. In times of systemic change it is necessary to combine approaches of all types.*

Research limitations/implications – *Only a small sample of the huge range of horizon-scanning exercises has been studied, and the essay has not gone far into the question of how horizon-scanning relates to other elements of the foresight process.*

Practical implications – *The implication is that horizon-scanning should be undertaken on a routine basis, and should be integrated into planning activities from the start.*

Social implications – *Horizon-scanning is a tool needed in activities such as planning for the workforce, and for health and safety issues.*

Originality/value – *The essay covers a wide range of activities with real-life illustrations in addition to overall assessment.*

Keywords *Forecasting, Forward planning, Health services sector, Human capital, Plans, Strategic planning*

Paper type *Conceptual paper*

The sailor perches in the crow's nest, scanning the blue horizon for sign of friendly or threatening craft, for approaching storms and signs of land – or even for monsters. A radar operator watches the green scanning line sweep around the screen, waiting to interpreting blobs and blotches as clouds, flocks of geese – or incoming aircraft and missiles. Astronomers gather to apply the most advanced short-wavelength radio telescopy systems to examine the event horizon at the ''edge'' of a black hole . . . .

In foresight exercises, horizon scanning (HS) has features similar to these activities, though the nature of the ''horizon'' is rather mutable. What do we mean by HS? We can begin with a definition of HS established by the UK government and used widely in this country and Europe:

> . . . the systematic examination of potential threats, opportunities and likely future developments including but not restricted to those at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues as well as persistent issues or trends[1].

Let us unpackage this statement:

- *Systematic* – This term implies a structured process for locating emerging issues, exploring sources of information that are sufficiently wide-ranging to give as comprehensive a view as possible.

The title is an allusion to: ''The moon went slowly down in loveliness; she departed into the depth of the horizon, and long veil-like shadows crept up the sky through which the stars appeared. Soon, however, they too began to pale before a splendour in the east, and the advent of the dawn declared itself in the newborn blue of heaven'' Haggard, (1951, p. 44).

- *Examination* – An interesting choice of words. Examining issues is typically a matter of specifying how, and how far, they may be relevant to the topic of concern. In order to examine issues, we first have to identify them (even if this is rather a fuzzy sort of specification). The identification of the issues is a matter of scanning for emerging phenomena (including potential transformations of quite familiar things) that are likely to be of importance to the topic of concern. This may be a matter of direct or indirect influence (the latter involving influence something that is directly relevant). As suggested below, this involves more than ''searching'' the horizon for things we know we should watch out for – emerging phenomena may well be ''unknown unknowns''[2].
- *Potential* – This term implies uncertainty: we do not know for sure whether the issues will be threats, opportunities, or something more or less than these. The issue may just peter out, or turn out to be of no significance. It may be so dramatic that in the near future we will be amazed to think that this was an issue whose outcome or implications were unexpected.
- *Threats and opportunities* – This is a couplet made common in SWOT analysis, of course. Things are seen as threats or opportunities in relation to the topic of concern and the interests of horizon scanners and their clients and audiences – for instance, policymakers, entrepreneurs, or other stakeholders. One person's threat is famously another's opportunity (Godet, 1985). Furthermore, whether we perceive an issue as a threat or opportunity is a matter of mindset; strategy analysts suggest that we should strive to be alert to ways in which notionally unwelcome developments may be seen as opening up promising prospects.
- *Likely future developments* – These are presumably phenomena that cannot be confidently seen as opportunities, threats or mixtures of the two: it may be that there is too much work to be done exploring the issue to begin to outline what the major threats and opportunities may be, and how the phenomena may interact with our topic of concern.
- *The margins of current thinking and planning* – Use of this term means more than simply that these issues are not being taken into account (sufficiently) – it means that we need to do more than search for issues that we already know to be of potential importance (for instance, major breakthroughs in areas where we see ourselves as facing technology bottlenecks – what about a major breakthrough in photovoltaics, meaning that we can generate electricity from sunlight far more effectively than has been the case to date?)[3]. There may be specialists or advocates who do take account of these issues, but they will not have (yet) penetrated mainstream thinking and planning. We need a scanning process that takes us beyond search, to capture issues that could be relevant to the topic of concern, even if they have not yet been labelled and discussed. The term ''novel and unexpected issues'' confirms this, and suggests that we should be open to ''wild cards'', whose development we may infer from ''weak signals'' or more speculative reasoning.
- Finally, *persistent issues or trends* are also relevant. Quite possibly they may be connected to unexpected or neglected phenomena. It is not uncommon for a persistent issue to change its nature when we consider its evolution into the long term; few trends will not run up against ceilings, many quantitative trends imply qualitative change at some point, and the factors that underpin stable phenomena or trends are liable to move in various ways. A good approach is to ask what might lead to trends being accelerated, decelerated, or transformed. But there are also things that are so familiar that we do not question their persistence and stability. Early balloonists were unaware that the air would become thinner as they ascended, to the point that lack of oxygen could be fatal. Similarly our social history is littered with examples of the upturning of long-lived traditional assumptions about the natural or god-given order of things. The current debates about gay marriage can be seen in this light, as part of a long process of rethinking received wisdom about gender and sexuality; definitions of life and death are thrown into confusion by advances in medical technology; the era of artificial intelligence will no doubt shake assumptions about the nature of personhood[4]. One of the hardest tasks for HS is to uncover and challenge conventional and deep-rooted expectations, without being dismissed by all key audiences as wild or dangerous.

There is some confusion about the relationship between HS and environmental scanning (ES). HS is a subset of environmental scanning (ES), though it is a subset that is quite often not included to any great extent within ES activities, since these are often more focused on the short term. Again ES is rather an ambiguous term, not least because it is often taken to refer exclusively to natural or geographical environments and ecosystems (which have very literal horizons when viewed from ground level!). Taking our cue from the definition of HS used above, we can define ES as:

> The systematic identification, monitoring and examination of issues of relevance to the topic of concern.

Note that these need not be emerging or unexpected issues. ES may be very short-term in focus – often this is what is known as ''competitive intelligence''[5]. Thus in corporate environments the focus may be on what competitors and regulators are doing or preparing to do next, how markets are responding to their activities, what they are stressing in press releases and trade shows, and the like. Well-informed managers naturally monitor many key issues on an ongoing basis, and large organisations will often have several departments that feed relevant information they have picked up to senior managers. The focus is often on changes that are evidently underway or the subject of controversy or speculation, matters that are entering into immediate and short-term decision-making. Sometimes there will be surprises – perhaps especially when new entrants are appearing with disruptive innovations – but frequently the developments will already be subjects of some concern within the organisation and its networks[6].

HS is that branch of ES that more typically stresses phenomena with novel features, or whose relation to the topic of concern is novel to the audience in question. This is not to say that HS is always about obscure, unrecognised topics. There may well have been considerable discussion of future contingencies within organisations that are focused on the topic, or that are charged with more general responsibilities for risk management and resilience. Sometimes an attention-grabbing issue will surface in the mass media, though this is no guarantee that it will be taken seriously by decision-makers. The sorts of issue typically addressed by HS will normally only pass through the filters of an ES process when the threats in question start to become manifest, or when the organisations in the environment of our scanner are engaging in activities connected with the risk.

The distinction was drawn above between scanning and searching. In some activities that are described as HS (some of which we discuss below), the distinction is blurred. We may be engaging in HS to see what new drugs may be coming into the health system, for instance, and the technique used may be searching research reports, press releases, and the like, asking expert informants about breakthroughs, etc. These are known unknowns – we are fairly clear about the sorts of issue that are being searched for. We will not find radical approaches like gene therapy being captured in such a HS system (or is it really more of an ES system?). This is not to say that the framework is not fit for the purposes intended, for instance if these are overwhelmingly to do with short-term management decisions. But it should not be confused with broader HS, which should be open to unknown unknowns – especially since it is often these that are the really game-changing phenomena.

But how do we recognise unknown unknowns, especially when they are still nascent? This does involve some searching, but in this case the searching is not for specific sorts of issue *per se*, but for claims that novelty or substantial change is (liable to be) underway. In this approach, the assumption is that the ''future is unevenly distributed''[7], that there are likely to be people who have recognised and are commenting on issues relevant to the topic of concern. The challenge is to define appropriate methods for finding such commentary. For example, the UK's Defence Science and Technology Laboratory has been ''scraping'' web pages to see whether words such as ''new'', ''innovation'', ''breakthrough'', and the like are being used, and can be employed to find examples of technologies (or other phenomena) relevant to their HS needs.

Another approach is to see whether new patterns of behaviour can be spotted. If scanning texts, we might look for new words being employed, new authorities being cited. One

promising technique, that to date does not seem to have been taken up on a large scale, is to look for new ''hot spots'' of activity. For example, the research literature can be searched to see what clusters of co-citations are growing in strength (see Katz *et al.*, 2001). Again, there is a search process, but what is looked for is rather open – so open, in fact, that such a study requires much use of expertise to interpret the sorts of cluster that it uncovers.

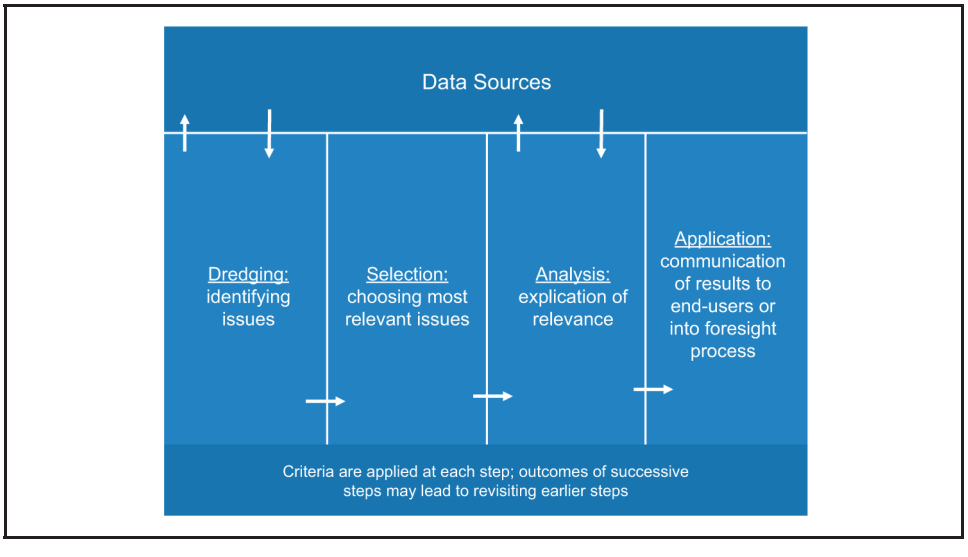
Approaches to HS

HS, and ES more widely, may be undertaken as more or less systematic, and more or less specialised, functions. Just about everyone in decision-making positions has to pay some attention to the wider context of their work, and the trends within that context. Sometimes such individuals will be immersed in the practical details of a specific decision or its implementation, or dealing with the interpersonal issues that emerge in all organisations. But when they are less focused on immediate concerns, they raise their eyes more widely. Many will read the magazines and websites dedicated to their industry or profession; some will even be reading books about megatrends, black swans, and the like. Larger organisations may well have in-house groups who undertake HS and other forecasting/futures functions, or they may buy in HS along with other such services (including broader competitive intelligence.

There are some futurists who develop HS – especially in the form of ''technology watch'' – for a wide audience of people interested in the future (often for personal or professional planning purposes, sometimes for entertainment). Much HS is tailored to specific users, however. There are many ways of conducting HS, and these have evolved over time, not least as new information technology has meant that piles of newspaper clippings can be replaced by files of downloaded web pages. The essential steps remain the same, even if some of the processes can be automated. They are as depicted graphically in Figure 1:

- Application of one or more scanning processes to identify relevant issues from some source(s) of data. The quality of the HS will depend upon the efficiency of the scanning process, the adequacy of its tailoring to the needs of the intended users, and the appropriateness of the data sources. (Each of these points can be harder to execute well than might be expected!)
- Appraisal of the large number of issues that are initially identified, so as to select those that are most liable to be of substantial significance to our topic of concern.

Figure 1 Horizon scanning



- Analysis of these issues and explication of their relevance (or rather, of what is known and unknown about their relevance).
- Feeding of these results to end-users, or into other futures processes that can make use of them (for risk analysis, scenario building, etc.).

In HS we are usually looking for things that might change the situation, or change the way in which it is developing. (We may sometimes be interested in situations where the future does not change in the way that everyone anticipates.) We may talk about events, or about underlying dynamics – in either case, the interest lies in finding things that challenge the assumption of business as usual, or on occasion that challenge received wisdom about how ''everything is going to change''. Business as usual might tell us that the USA will continue to be the world's dominant power, while received wisdom may assert that China is in the ascendancy.

In futures studies, analysis of factors that are liable to take the future on a different course to that familiar or familiarly expected is often framed in terms of drivers of change. These may be the forces underpinning observed trends, or things that are anticipated to disrupt trends or establish new ones. This terminology of ''drivers'' is in wide use among managers and policymakers. However, it is one that is resisted by many social researchers. They regard it as an unscientific term, as perhaps implying a simplistic one-way and linear notion of causality. Social affairs, they are liable to argue, are better understood as emergent from systems where multiple variables (and/or actors) are linked together in a complex web of feedback loops. Additionally, the reflexive nature of social activity means that human beings can gain awareness of what they are doing and what its possible consequences are; they can conceptualise and communicate this to others; and this can lead to new patterns of behaviour. We act, though our action may involve a choice to let ourselves be driven; we never act in full awareness of the factors shaping the contexts and consequences of our actions.

In contrast, the notion of ''drivers'' is much more of a lay, everyday concept. This may be part of the reason it is used so widely in foresight and HS work, where it can be introduced (into workshops, for example) without a good deal of theoretical explication. It clearly involves oversimplification, since we are most often addressing complex systems where multiple causality and feedback is inherent. However, some simplification is always required if we are to have meaningful dialogues and appraisals of future prospects. The challenge is to employ simplification on occasion, without losing grasp of the broader, more holistic, setting, Attempting to explicate how this idea of ''drivers'' is used, we can say that:

- Drivers are major factors that are known, or believed, to be shaping or influencing our topic of concern, or to be liable to do so in the future.
- Drivers can be trends (e.g. technological progress – we can describe the evolution of IT systems in terms of Moore's Law and its many analogues, for example). They can also be the processes underlying these trends (e.g. investment in microelectronics fabrication R&D). The interplay of these processes can move trends in one direction or another. For example, if conventional silicon systems are liable to run into a ceiling in terms of the smallest sizes for etching circuits onto chips, then we may see a tailing off of the trend to cram more and more features into small areas of silicon wafers. Or perhaps the torch will be handed over to new approaches such as 3D or optical chips. Trends, too, may interact. Increasing chip processing power may be rendered less relevant as a competitive goal for IT businesses if other areas become significant bottlenecks, or even if they offer such opportunities in terms of user functionality that the gains from more powerful chips are relatively less important.
- Specific events are also often seen as potential drivers. A nuclear accident may be seen as an opinion-shaping phenomenon that sparks off a long-term move against nuclear power, for example. Some events can be seen as the outcomes of trends. An event may be purely statistical (more than 50 per cent of the population fall into a specific category, for example), or phenomena that mark step changes of one sort or another (e.g. the

introduction of a new policy in response to a trend)[8]. Other events may be more like ''wild cards'' that run counter to prevalent assumptions about trends.

- Drivers may influence the topic of concern directly or indirectly. Some drivers are outcomes of other drivers. For example, improved nutrition, public health, and treatments of common diseases, are among the factors that are leading to a growth in the elderly population, which is a major driver of increasing demand for healthcare related to this population's needs.
- Some drivers are relatively predictable (bar major wild cards). For example, we can anticipate continuing decrease in the cost, and increase in the power, of much information technology; we can forecast the age structure of the population of most countries, into the next decade or so, with some confidence. Others are much more uncertain, for example major policy changes that may result from quite small swings in electoral behaviour, or from complex trade-offs in a governing coalition.
- There can also be uncertainties to do with the actual effect a driver is liable to have on the topic of concern. This may be because the emergent issue is too novel to properly assess; because it will plausibly interact with other drivers to produce different outcomes; because we do not know what the reaction to a development will be.
- Drivers may be internal to our own organisation (e.g. ageing and turnover of the workforce), or external to it (e.g. factors restricting the immigration of workers with particular skills or capabilities).
- The sorts of influence that drivers may have can also be very varied. A driver may increase, decrease, or qualitatively change a variable we are interested in; it may set limits or thresholds to change; it may indeed inhibit change.

Some foresight practitioners have attempted to sharpen the terminology by drawing new distinctions and introducing new formulations. For instance, van der Heijden (1996), from the perspective of strategic management, differentiates between the factors in the contextual environment (which we survey and appreciate, since our ability to influence them is limited), driving forces from the contextual environment that influence:

- the transactional environment, where our organisation interacts with others (and here there is scope for influence and co-design of developments); and
- the actor (organisation) itself, where we have the opportunity of controlling choices.

Such a framework can be helpful in classifying and organising different drivers, though it is more common to use one of the all-purpose frameworks such as PESTLE and STEEPV.

Drivers are often used as the basis for construction of scenarios and analysis of alternative futures. But HS and the identification of key drivers is typically undertaken at a fairly early stages in the Foresight process. Large-scale foresight exercises (most often undertaken in policy contexts) use a range of methods. Studies that have ''mapped'' such exercises suggest that typically they are described as using 4-7 methods (see Popper *et al.*, 2007). (We have some doubts about the precision of this estimate, since the definition of a method is rather fluid – a Panel is described as a method, while some exercises mysteriously seem not to undertake literature reviews, for example.) But in any case, HS and broader ES is often a preliminary step in a Foresight exercise, undertaken in an effort to identify the major forces that are liable to shape the topic of concern, before launching more detailed studies of specific themes.

HS in UK foresight

HS in the UK has a long history, though for much of the last century it was conducted in an unsystematic and infrequent manner. The notion of systematic HS was given a considerable boost by the government's Foresight Programme. From the mid-1990s, this programme has evolved through several ''cycles'', over which it has shifted has from classic ''wide-spectrum'' analysis of practically all sectors of the economy and areas of promising technology, to a more focused approach that has dominated since 2002. The most

prominent activities have been a succession of foresight projects – these are studies that examine either important areas of technology development (e.g. intelligent infrastructures, exploiting the electromagnetic spectrum) or specific social problems (e.g. tackling obesities, flood and coastal defence) where there is scope for the application of science or technology along with other policy interventions[9]. These foresight projects typically last for around two years, with a further one year follow-up; at the time of writing only two projects are ongoing, though for most of the last decade the norm has been for four or five to be underway. More recently a new instrument was also introduced: more rapid and thus less in-depth policy futures projects. These provide cross-disciplinary analysis of evidence and future prospects aimed at filling specific gaps in policymakers' current understanding. Two of these projects are currently underway – on Improving Future Disaster Anticipation and Resilience, and The Future of Identity[10].

The aims of UK foresight have also shifted. Initially, foresight was intended to help set priorities for public R&D funding and enhance forward thinking and networking across the UK innovation system. More recently, the main function has been that of helping to coordinate the activity of different departments of government that would otherwise proceed in a piecemeal fashion (cf. Miles, 2005). In the current economic crisis, foresight activities have not been suspended, as many feared, though the scale of many activities seems to have diminished considerably, and some HS initiatives that were being developed up to 2008 seem to have disappeared with little trace[11].

Several departments and agencies of the UK government became active in what they described as HS activities in the 1990s. Sometimes these conformed to the restricted definition of HS discussed above, sometimes they involved broader futures analysis and Foresight activity (but were labelled as HS because ''foresight'' was identified with a specific department's programme). Probably the most visible activities were those undertaken by DEFRA, the Department for Environment, Food and Rural Affairs[12]. In part, this can be attributed to the series of shocks that DEFRA experienced around food safety and agricultural practice, with the BSE (''mad cow disease'') case in particular raising serious questions about the use of scientific and other expertise that include, but go well beyond, HS. While departments have their own specific interests and requirements, there was inevitably some duplication of effort. An effort to centralise HS was made by creating the Horizon Scanning Centre (HSC) in 2005. Hosted by the Foresight Unit, the HSC was intended to support appraisal of long-term issues across government, and to encourage cross-departmental activity to develop scenarios for use by government[13].

An example of this sort of cross departmental use is a study of The Future Of Ageing described in the 2008 *Annual Review* of the Foresight Unit (Government Office for Science, 2008). The HSC had been asked by the Department of Health (DH) and the Department of Work and Pensions (DWP) to help them explore how trends might interact in the future to affect the older population (people over 50 years old). Four scenarios were developed to indicate the range of possible future worlds which might be confronted, with a fifth scenario later examined to create a vision of a desirable future (whose features were: a more inclusive society valuing people of all ages for their different contributions; full realisation of the potential of the over-50s population to make such contributions; and alignment of public services with social needs). The scenarios were used by policymakers to explore the robustness of potential interventions (windtunnelling). This exercise – which sounds very much like what are now known as Policy Futures Projects – also informed the ambitious foresight project on Mental Capital and Wellbeing. HS activity is widely used in the UK health system, as we shall see later.

The HSC undertakes various types of work, with several useful guides to futures issues and Foresight methods published on its website[14]. But, of course, HS as narrowly understood has been a major activity, albeit one now supplemented by these other functions. The HS approach has evolved through a number of steps, and what is currently available is a substantial archive of ''scanned'' issues, the Sigma Scan. This consists of 256 brief papers exploring issues that could impact on UK public policy over the next 50 years. The range of issues is very wide: the last ten featured on the list of ''new and updated'' issues are:

- Supercomputing on Demand;
- To Boldly Go? Future Prospects for Human Space Flight;
- Understanding Complexity: How to Answer the Big Questions;
- We All Sign On: Could Levels of Unemployment Rise Dramatically?;
- What Replaces the Factory? Post-Industrial Britain;
- From Lone Scientists to Regional Innovation Systems;
- From the Enlightenment to ''Enlightenment'': Increasing Diversity in Religion in Britain;
- Future of Unmanned Space Exploration;
- Growing Synergy Between Biology and Mathematics; and
- Will We Have Armies in the Future? Declining Recruitment Rates for the Armed Forces[15].

The Sigma Scan was developed from reviewing thousands of documents and hundreds of expert interviews – familiar approaches to HS. Each issue is described briefly, with a summary preceding a discussion of the issue, then brief notes on broad implications, on early indicators of its possible development, what might be drivers and inhibitors, and parallels and precedents. There are references to information sources, and links to relevant websites. The material that is presented is likely to be useful to a great many people, though the precise ways it was developed are not explicated, and the text appears to be very much the product of one person's reflections, or at best those of a few people.

Some HS activity has been a common feature of many national Foresight exercises, with the Dutch experience probably being the case that rivals that of the UK in terms of a large-scale and systematic approach[16]. The FORSOCIETY initiative that brought together European Foresight Programme practitioners for several years did explore the prospects for cooperation in HS, but it is not clear that these plans actually materialised[17].

HS and health

Issues around health are a major focus of much HS. This can be readily demonstrated by recourse to the very useful Publish or Perish tool developed by Harzing. Searching for publications with ''horizon scanning'' in their titles, and then inspecting the titles and the sources of the publications, we see that over 60 of just over 140 publications feature terms such as ''oncology'', ''health technology'', ''medicine'' and ''public health interventions''[18]. Given that we are likely to have failed to spot articles dealing with health/medical issues that do not employ such terms in their titles, we suspect that practically 50 per cent of the documents captured by Google Scholar, and thus by Publish or Perish, are of this nature. The next most prevalent set of themes consists of environmental issues, where we begin to see, also, uses of the term that refer to sensor technologies more than foresight methods.

It will come as no surprise, then, that the term ''horizon scanning'' is widely used in the UK health system. This is a huge and complex system – the National Health Service employs well over a million people! – so it will also come as no surprise that its use of HS is also complex. Across the four nations of the UK there are a wide range of organisations that are engaged in HS activities. The main foci concern the impact, regulatory processes and application of new medicines and technologies, though there is also plenty of work on how health, health services, and the health workforce may be affected by social, economic and technological developments. The following discussion outlines how various leading organisations are tackling HS; it does not pretend to be comprehensive[19].

First, there are some bodies whose HS is rather short-term and in many ways more like ES (though the HS label is employed). For example, the NHSBT/HPA (NHSBT – National Health Service Blood and Transplant/Health Protection Agency) Epidemiology Unit describes its surveillance system, established in July 2007, in order to identify emerging infection reports of relevance to blood donation safety in the UK, as HS[20]. The scanning process here is perhaps better described as searching – a more limited form of scanning, where we are focused on particular types of threat (though the system should be sufficiently open as to

pick up unfamiliar types of development). The NHSBT/HPA reviews a wide variety of published sources, and collates information into monthly reports; these are used to assess infections and inform risk assessment (which feeds into policies and procedures concerning donor selection guidelines and other blood safety measures).

A slightly longer time scale is used by the National Institute for Health Research-funded National Horizon Scanning Centre (NHSC), which was established in 1989 and is based at the University of Birmingham[21]. The bulk of the HS conducted here deals with advances in technology and medical practice, up to three years before they are likely to be launched in the English NHS. The aim is to provide the DH and other national policy-making bodies, of developments emerging in the near future that need further evaluation, or whose implementation needs further consideration. Ongoing and routine ''horizontal scanning'' is designed to identify significant and urgent advances across all areas of clinical specialty. ''Vertical scanning'' in contrast examines specific technologies and diseases, aiming to cover all clinical areas over time, while paying attention to areas where there are known to be multiple or complex developments, or to patient groups with significant or unmet needs. Data are thus derived both from focused routine scanning of published and online sources, and from liaison with professional organisations and expert inquiry. Those innovations that have been identified are examined, so as to focus on the more substantial developments (a process known as ''filtration''). These are then the subject of reports which feature descriptions of the technology and of the nature and size of relevant patient groups; the report then outlines the current diagnostic or treatment alternatives and research evidence of their clinical effectiveness, details of ongoing or related research activities; sometimes it is able to include estimates of the clinical, service and financial impacts.

The NHSC's main outputs are these briefings on new and emerging health technologies. It has also used the information it collects to take a step back and study the broader patterns of innovation in medical technologies, as well as to provide documentation and guidance about HS methods[22]. A recent project, in association with the National Prescribing Centre in the case of medicines, has been commissioned to carry out horizon scanning on behalf of the NHS Executive, using a variety of sources including published material, contacts with similar groups in other countries, and informal contacts with clinicians and researchers, patient groups, sponsoring companies and their industry associations. Preliminary analysis drawing on the views of the Standing Advisory Committees and other experts will aim to reduce this to a standing ''short-list'' on which vignettes describing areas of application, possible benefits, and likely impact on NHS resources will be compiled and updated. In the case of medicines under development, bulletins based on these vignettes will be published by the National Prescribing Centre/Drug Information Pharmacists Group, about 6-12 months before the medicine is expected to be licensed.

Rather shorter-term activity is undertaken by UKMi (United Kingdom Medical Information[23]), which also produces a range of information on new products, from early horizon scanning intelligence on drugs in clinical development through to evaluations of medicines once marketed. This HS is aimed at managers and practitioners such as pharmacists, providing them with a New Drugs Online database, updated daily, with drugs tracked up to and for some time after the time of launch; and bulletins under the name of *On the Horizon – Future Medicines* some six months before the launch of new medicines (updated with an *On the Horizon – Rapid Review* around two months after launch if significant additional information emerges). Both *Drugs in Clinical Development* and *On the Horizon* provide intelligence to support management of budgets and planning of services. The aim is to allow for forward planning and avoid the need for panic responses. Thousands of drugs are usually under development; data from publications and experts is gathered, filtered (to give a list of 100 or so new drugs ''on the horizon''), followed up with enquiries to companies. The list is prioritised to identify drugs that will have the biggest impact.

A longer-term approach is undertaken by the Health and Safety Executive (HSE), an agency responsible for monitoring work-related health, safety and illness. The HSE has had futures activities at least since 2005, when a Futures Team was set up in HSE's Health and Safety Laboratory. This team initially focussed on HS and the emerging issues of interest to HSE this

indicated. It produces short reports on a range of such issues, together with some more detailed reports. External contractors, including HSL, are used where appropriate to provide in-depth studies of emerging issues. The team calls on a variety of sources, including the considerable numbers of skilled policy and frontline operational and technical staff in HSE who are able to identify emerging issues and evaluate their likely impact. External input is also obtained through formal and informal networks and the website. A set of scenarios for the future of health and safety in 2017 was produced and discussed with stakeholders. In 2008 the Futures Group was established, representing specialisms from across HSE. One role is to identify new issues for exploration, such as ageing infrastructures, the increasing use of hypoxic atmospheres, and intelligent sensor networks and pervasive computing. The HSE reports that its Futures Team is being increasingly used by groups within HSE to help in their planning (Health and Safety Executive, 2011).

HS is thus widespread in the UK's health system, and embedded in important practical activities – though it is often rather short-term in focus. In 2007, it was reported that the Department of Health (DH) was to set up a specialist Horizon Scanning Unit (HSU) to embed HS capabilities within its divisions[24]. Little trace can be found of this initiative, which was presumably swept up into the Foresight Unit's HSC and the DH's own NHSC; it may also have been a victim of the economic crisis and the associated squeeze on public expenditures, together with the new policy emphases that gave rise to the CfWI, as discussed below. At present, however, some HS is undertaken by many of the DH's Scientific Advisory Committees. Over 20 of these Committees operate. Thus, routine scanning is undertaken by the Joint Committee on Vaccination and Immunisation (JCVI); the Scientific Pandemic Influenza Advisory Committee (SPI) has run brainstorming sessions aimed at uncovering possible problems in emergency preparedness; and the National Expert Panel on New and Emerging Infections (NEPNEI) is described as being an over-arching horizon scanning panel to assess the threat from new and emerging infectious diseases[25].

The various health-related HS activities use a mixture of consultation and engagement of wider or narrower pools of stakeholders, with more in-depth dedicated analysis from a small team, typically producing reports that can be widely circulated to provide decision-makers with critical intelligence. Consultation and workshops can be valuable in providing stakeholders with richer understanding of the issues and underlying dynamics than is likely to be achieved simply by circulating a report. Furthermore, this is an important opportunity for cross-specialism coordination – and even the often more difficult matter of cross-departmental alignment. As with broader foresight processes – and UK foresight has undertaken several health-related projects over the last decade – HS can enable different parts of the policy and practitioner systems to share their understandings and objectives, in dialogue that makes it possible to clarify the meaning of the terminology used, the sources of evidence behind professional opinions, and the like. The horizon scanners, too, can learn more about who knows what, and about the types of information and ways of presenting results that are most effective for sponsors and other stakeholders.

Many of the health-related HS approaches discussed above are rather short-term, exploring just a few years ahead. But workforce planning necessarily takes us into the longer-term. It has to, since it can take several years just to train professional and medical staff, and they are liable to be in position for some decades. HS and more general Foresight has thus been a longstanding concern, and developments in this area in the UK are significant.

The health workforce

The Department of Health has described Workforce Planning as involving ''trying to predict the future demand for different types of staff and seeking to match this with supply. In the case of healthcare, its fundamental purpose is to ensure that there are sufficient staff available with the right skills to deliver high quality care to patients'' (Department of Health, 2001). However, this is not an easy job in a health system where the NHS alone employs over a million staff – and has over 1,200 distinct job titles – and faces changing requirements in terms of health needs, technological changes, and evolution of medical practice and philosophy (for example, there is demand to reduce the rate of hospital admissions and the

length of hospital stays, and move toward more home-based care). A leading health policy research organisation, the King's Fund noted in 2009 that:

> Securing a sufficient number of staff with the appropriate skills and deploying them effectively is a highly complex challenge, and one that is all the more important now that the NHS is about to enter one of the most financially constrained periods in its history. If it is to thrive and survive, productivity will need to make a step-change, and much of the scope for improvement lies in the workforce.

Concerning Workforce planning the argument is that:

> At its heart is an aspiration to match the supply of staff to the need for them. This is technically difficult, as the periods over which forecasts are made, and the complexity of health care delivery, make it exceptionally hard to plan for let alone deliver. At least some of the so-called ''failures'' of workforce planning in the health service have been less about problems with planning and more about unrealistic expectations on the part of policy-makers, who have not recognised the limitations of the planning process. Nevertheless, the system can be improved; in particular, a process is needed that continually and robustly identifies risks and trends, and can trigger flexible responses.
>
> Effective workforce planning is also about more than getting the numbers right. It is equally important to ensure that current members of staff have the right skills to meet future demands; most of those who will be working for the NHS in 10 years' time are already employed by it. Planning cannot therefore be solely about new recruits; it must also consider how to develop new skills and new working patterns for those who are already in post (Imison *et al.*, 2009).

This statement is well in line with the thinking behind HS. It explains that in order to plan effectively, it is important to examine a wide range of factors – many if not all of them uncertain factors – that are liable to impinge upon the things that we are planning for. Changes in demand for services, supply of potential workers, and the ways in which services can be delivered by this workforce, are all to some extent volatile. While some aspects of demographic and technological change are predictable enough, others are not – for example, policy decisions about the availability of specific treatments and through immigration policies. Workforce planning processes may have difficulties in coping with such uncertainties, especially if they rely upon business as usual or simple trend extrapolation.

Indeed, in 2007, a Health Select Committee report described workforce planning in the NHS as ''disastrous'' (Health Committee, 2007), arguing that:

> Ensuring that the health service is able to respond to future service demands will require a reformed and improved workforce planning system. Workforce planning has been badly hampered by the absence of effective long-term planning and the failure to take account of the complexity of the strategic 'big picture'. Long-term planning is important because changing the structure and make-up of the workforce takes a long time, particularly in healthcare where workers take up to 15 years to train. Strategic planning is important because the complexity of workforce supply and demand mean that a lazy or over-simplistic approach to change can have serious negative consequences, as shown by current job reductions and graduate unemployment (paragraph 235).
>
> . . . Improved planning systems, however, are useless without good quality information to support them. In the past, analysis of workforce supply and demand has tended to be limited and has failed to concern itself with wider developments such as future demographic and technological changes. In future it needs to take account of a much wider range of factors, including demographic, technological and policy trends and the interaction between them. Adopting a genuinely long-term and strategic approach to workforce planning will allow planners to anticipate the need for change rather than constantly responding to it, something which is key to the sustainability of the health service (paragraph 236).
>
> Planning must cover the whole workforce rather than looking at each staff group as a separate ''silo''. The persistent divide between medical and non-medical workforce planning must be addressed; SHAs currently pay for postgraduate medical training so in future they must have much more influence on training numbers and content. The Department should make clear to SHAs that money can be transferred between medical and non-medical training pots; there is currently confusion over whether this is the case. Analytical work by SHAs and the Workforce Review Team should focus on total workforce requirements rather than examining each profession and sub-discipline in isolation. The use of competences to measure overall workforce requirements will help to support this approach (paragraph 246).

> Workforce planning should take account of the requirements of the whole health service rather than looking exclusively at the NHS. Private and voluntary sector organisations should be more involved in planning at local and regional level and standardised workforce data should be available from non-NHS organisations. [. . .] Attempts to create a more integrated planning system must be supported by increased clinical involvement, so that workforce planning and development are not regarded as back office, managerial tasks (paragraph 247).

As a response to these persistent criticisms, and as part of a sweeping reorganisation of health and social care in England and Wales, the Centre for Workforce Intelligence (CfWI) was set up in 2010. This is a new institution, managed by a major consultancy company, that replaces workforce modelling processes previously undertaken within the DH.

The CfWI is now placing a great deal of emphasis on HS issues, using a range of Foresight techniques and engaging various stakeholders[26]. The HS work is seen as complementary to more traditional workforce modelling, and also to scenario work undertaken by the CfWI: HS, modelling and scenario work together comprise the building blocks for workforce intelligence. HS can help set the options for scenario analysis, which can then feed into the parameters for modelling. Intermediate decisions are informed mainly by short-term HS and modelling (1-3 years), while system changes are expected to be addressed in a 3-5 year horizon, and major scenario and HS efforts have to deal with periods of 5-20 years. The HS exercise involves a combination of methodologies, with a stress on identifying, prioritising and appraising drivers by means of literature reviews, semi-structured interviews, workshops and online consultations. The material is classified in terms of various challenges, as indicated below[27]:

- Demographic – Challenges here include: ageing population and workforce, long-term conditions and increasing levels of obesity, diabetes, heart and respiratory problems.
- Workforce planning methodology – challenges here include: long-term workforce planning, robust data and intelligence, understanding employer requirements and forecasting the impact of technological changes.
- Education and training – Challenges here include: providing person-centred and compassionate care, higher education reforms and student-driven market, quality of student training, development of current workforce, reforming medical training, developing public health skills and workforce, making the most of the constant system changes, creating a flexible workforce, responding to a more consultant-present service.
- System design – Challenges here include: uncertainty over whether there is a national or local system, getting the incentives right, integrating health and social care, uncertainty over funding, shifting from acute to community care.

These uncertainties are described as ''big picture'' challenges for workforce planning, which are to be investigated in more depth over the next few years. Meanwhile, they and are complemented by ''micro-level research'' on specific professions or trends, and activities such as the two scenario workshops that have been organised to focus on future medical and dental student intakes (these generated classic 2*2 scenario matrices around high impact and high uncertainty drivers of workforce supply and demand, and a Delphi exercise. The latter was used to generate consensus-based numerical values to feed into the CfWI workforce supply and demand model. This projects skills mixes across the scenarios, and can be used to explore the impact of different policy decisions.

Such long-term HS approaches may prove to be influential on planning within the health system and more generally in UK policymaking where such long-term issues are concerned – for example, other areas of education and training, energy and other infrastructure development, and urban planning.

Conclusions

Alongside the wider development of Foresight and other long-term approaches, and efforts to improve the evidence base of policymaking, we see HS as an approach that is becoming widely used in the UK. The cases discussed – which are by no means comprehensive –

show that while the focus may be more or less long-term, and the issues considered more or less able to encompass unknown as well as known unknowns, there are considerable similarities in approach, and a growing base of experience in HS. In a complex area such as health, where many decisions on specific issues need to be undertaken, there are requirements for HS that is relatively short-term as well as long-term, and for activities that are focused on specific issues and themes (and may even be described as searching) as well as on much broader scanning.

Like other inputs into complex policy processes, HS is subject to human fallibility and very partial knowledge, and the use of HS results is liable to be subject to all sorts of personal and political contingencies. While there are tactics that can be employed to render HS more effective and impactful, the quality of the work must be a prime consideration. If HS is not being carried out in a systematic way; if there has not been enough effort to provide those responsible for HS with adequate skills, time and other resources, access to data and key informants, and so on, then it can be easily discounted. Results may be dismissed or poorly disseminated. The HS function needs to be effectively scoped and related to other elements of the planning process, not to be taken as a stand-alone activity. This will help assist the HS team in asking the right questions and providing answers that can be used effectively.

It will also be important to present the results of HS in ways that are meaningful and cogent to the intended audience, and if possible, to involve key decision makers in enough of the HS activity that they can provide intelligence as to how to do this – and gain intelligence about the significance and scope of the HS itself.

Finally, how can we broaden our horizons, while scanning them? Here are some suggestions:

- Avoid relying solely upon expertise from within the client organisation or its immediate networks. Attempt to embed open-minded and widely experienced outsiders into workshops, look more widely than the familiar literature sources.
- Consider applying different worldviews to the topic of concern, since these may suggest quite different drivers as underpinning stability and change in the topic of concern (indeed, they may suggest different ways of defining this topic). We could ask what sort of factors might be seen as major influences by, for example, a believer in ''tech-fixes'', a techno-sceptic, an environmentalist, feminist, radical socialist, libertarian, and so on. What issues and implications would be stressed from different scholarly disciplines or practitioner professions?
- Different data and information sources may be telling us about quite different things. It makes sense to attend to a wide range of these at the outset (even if some are later filtered out from the later HS process). When we are considering the longer-term, then some things that currently seem quite outrageous may well become everyday phenomena. It is important to avoid restricting HS just to the issues that are already the topic of much discussion and debate.
- There will often be some pressure to restrict HS to fairly predictable, ''safe'' topics. In order to have the freedom to take into account the wider and wilder topics, it is important to have a sophisticated communication strategy, as well as open-minded support from legitimate authorities and senior individuals on the client side.

Notes

1. Chief Scientists Advisers (2004). Chief Scientists Advisers Committee, 09/04 – very cited, though the original document is hard to locate. A representative authoritative citation is on p. 37 of Government Office for Science (2011).
2. Wikipedia (at http://en.wikipedia.org/wiki/There_are_known_knowns, accessed 3 July 2012), tells us that this formulation was not originated by Donald Rumsfeld, but can be traced back to a 1984 essay by Lieutenant General Raymond B. Furlong, interestingly enough in the context of war gaming.

3. A relevant quote from the reinsurance industry: ''Reinsurers are anxiously scanning the horizon for black swans. They're not searching for a new strain of bird flu, but emerging risks: events and trends that are difficult – if not impossible – to predict'' (Bermuda Insurance Quarterly, 2010).
4. A rather more mundane but nevertheless telling example was provided by Daniel Bell in a seminar I attended in the late 1970s or early 1980s. He pointed out that US policymakers had been working on an understanding that ''homes'' meant houses and apartments. But this failed to take into account that large numbers of people were living in mobile homes (currently the number is estimated to be almost seven million). The implications for plans concerning housing, urban development, education, medicine and social welfare are enormous. In this case, an unremarked trend was shaking the longstanding picture, and once documented measures could be taken to improve statistics and decision criteria. This will be harder when we are working with more speculative possibilities.
5. There is a journal devoted to this topic - *The Journal of Competitive Intelligence and Management* (see www.scip.org/Publications/CIMArticleDetail.cfm?ItemNumber = 2123, accessed 2 July 2012) – and see, for example, Calof and Smith (2010).
6. In this context, and making the distinction between scanning and search, see the literature on entrepreneurial strategies, for instance Fiet (2007).
7. The quotation is probably accurately attributed to William Gibson, who is recorded by QuoteInvestigator (see http://quoteinvestigator.com/2012/01/24/future-has-arrived/, accessed 5 July 2012) as saying something similar in 1999.
8. More strictly speaking, a policy is likely to be a response to a perceived trend or perceived potential event. The perception of a trend may be based on media reportage or discussion among elites, or it may be based on or bolstered by statistical evidence. (In the UK, the 1956 Clean Air Act was strongly informed by data indicating much increased mortality resulting from air pollution – ''smog'' – over one winter in London, for instance cf. Martin, 1964). Usually policies reflect an accumulation of alarm signals and/or more routine pressures and lobbying. But there are many cases of policies that have been rapidly introduced in response to ''wild cards'' – especially particularly shocking or tragic events – with many commentators suggesting that such rushed policies are particularly liable to have substantial flaws.
9. See www.bis.gov.uk/foresight/our-work/projects (accessed 4 July 2012).
10. See www.bis.gov.uk/foresight/our-work/policy-futures (accessed 4 July 2012).
11. Thus the Strategic Horizons Unit in the Cabinet Office (see www.powerbase.info/index.php/Strategic_Horizons_Unit, accessed 4 July 2012) seems to have ceased independent existence and been drawn into more general preparedness functions – HS is now not very prominent, and is listed together with Risk Assessment on the Cabinet Office pages at www.cabinetoffice.gov.uk/content/uk-government-preparedness (accessed 4 July 2012), from which the link is to Risk Management. Likewise the Department of Health's plans for a specialist Horizon Scanning Unit seem to have evaporated, as we see later.
12. DEFRA's current activities are documented at http://horizonscanning.defra.gov.uk/ (accessed 4 July 2012), where there are numerous links to the substantial projects undertaken in earlier periods – in particular up to 2005, when the HSC was set up.
13. See www.bis.gov.uk/foresight/our-work/horizon-scanning-centre (accessed 4 July 2012).
14. Guidance on HS itself is available at: http://hsctoolkit.bis.gov.uk/About-7.html (accessed 4 July 2012).
15. From www.bis.gov.uk/foresight/our-work/horizon-scanning-centre/the-sigma-scan/scan-papers-list; the full papers outlining the issues are available at: www.sigmascan.org (accessed 4 July 2012).
16. For a brief description and links to the impressive reports produced by this activity, see www.horizonscan.nl/ (accessed 4 July 2012).
17. FORSOCIETY completed its work but failed to receive further EC funding, despite having completed a substantial body of work. Unfortunately, access to this work is now difficult. Unfortunately, at the time of writing, the original FORSOCIETY web address is occupied by an alien presence, and a search for the 2007 text ''Developing European Horizon Scanning Cooperation'' has proved fruitless. Some of the work that went into this study is however published as van Rij (2010);

discussion of HS and national Foresight programmes is supplied by Habegger (2010); while a brief account of FORSOCIETY is available at: www.innformed.org/files/2nd_ForSociety_Newsletter.pdf (accessed 4 July 2012).

18. The data were accessed on 4 July 2012, using Publish or Perish (Harzing, 2007). Publish or Perish is available free of charge from: www.harzing.com/pop.htm
19. Furthermore, systematic HS is underway in other parts of government, such as the Food Standards Agency and the Defence Science and Technology Laboratory.
20. See www.hpa.org.uk/Topics/InfectiousDiseases/InfectionsAZ/BIBD/EmergingInfections/ (accessed 5 July 2012).
21. See www.nhsc-healthhorizons.org.uk/
22. See www.nhsc-healthhorizons.org.uk/outputs/research-and-publications/ (accessed 5 July 2012) for an extensive list of publications on these and other issues.
23. See: www.ukmi.nhs.uk/activities/newProducts/default.asp?pageRef = 3 (accessed 5 July 2012).
24. Reported in the Government Office for Science Review of the Department of Health (2008).
25. See www.dh.gov.uk/ab/JCVI/DH_113317, www.dh.gov.uk/ab/SPI/DH_095908?PageOperation = email and www.dh.gov.uk/ab/NEPNEI/index.htm (all accessed 5 July 2012).
26. See www.cfwi.org.uk/how-we-work/horizon-scanning (accessed 5 July 2012).
27. From the ''Briefing Note – CfWI horizon scanning of future NHS workforce'', available at: www.cfwi.org.uk/documents/cfwi-horizon-scanning-of-future-nhs-workforce (accessed 25 July 2012).

References

Bermuda Insurance Quarterly (2010), ''News Review: Searching for 'black swans"'', *Bermuda Insurance Quarterly*, January, available at: www.pwc.com/bm/en/publication/assets/BIQJan2010.pdf (accessed 23 July 2012).

Calof, J. and Smith, J. (2010), ''The integrative domain of foresight and competitive intelligence and its impact on R&D management'' R&D Management'', *R&D Management*, Vol. 40 No. 1, pp. 31-9.

Department of Health (2001), ''A health service of all the talents: developing the NHS workforce – consultation document on the review of workforce planning'', available at: www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4003182.

Fiet, J. (2007), ''A prescriptive analysis of search and discovery'', *Journal of Management Studies*, Vol. 44 No. 4, pp. pp592-pp611.

Godet, M. (1985), *Crises Are Opportunities*, Gamma Institute Press, Montreal.

Government Office for Science (2008), *Foresight Annual Review 2008*, available at: www.bis.gov.uk/foresight/publications/annual-reviews (accessed 4 July 2012).

Government Office for Science (2011), ''Sharing Experience: Improving engagement across SAC Secretariats'', available at: www.bis.gov.uk/assets/goscience/docs/s/10-1012-sharing-experience-across-sac-secretariats.pdf (accessed 12 August 2012).

Habegger, B. (2010), ''Strategic foresight in public policy: reviewing the experiences of the UK, Singapore, and The Netherlands'', *Futures*, Vol. 42 No. 1, pp. 49-58.

Haggard, H.R. (1951), *She*, Dover Publications, New York, NY, (first published 1887).

Harzing, A.W. (2007), Publish or Perish, available from www.harzing.com/pop

Health Committee (2007), ''Workforce Planning Fourth Report of 2006-7'', available at: www.publications.parliament.uk/pa/cm200607/cmselect/cmhealth/171/171i.pdf

Health and Safety Executive (2011), ''Science Report 2011'', available at: www.hse.gov.uk/aboutus/meetings/hseboard/2011/6011/pjanb1104.pdf (accessed 5 July 2012).

Imison, C., Buchan, J. and Xavier, S. (2009), *NHS Workforce Planning: Limitations and Possibilities*, King's Fund, London.

Katz, J.S., Stewart, S., Gow, T.A.K. and Martin, B. (2001), ''Science Foresight Project: Final Report. Volume 1'', DSTL Technical Report DSTL/TR01697, available at: www.sussex.ac.uk/Units/spru/foresight/index.shtml (accessed 5 July 2012).

Martin, A.E. (1964), ''Mortality and morbidity statistics and air pollution'', *Proceedings of the Royal Society of Medicine*, Vol. 57, pp. 969-75.

Miles, I. (2005), ''UK foresight: three cycles on a highway'', *International Journal of Foresight and Innovation Policy*, Vol. 2 No. 1, pp. 1-34.

Popper, R., Keenan, M., Miles, I., Butter, M. and Sainz de la Fuenta, G. (2007), ''Global Foresight Outlook 2007'', EFMN Network, available at: www.foresight-network.eu/files/reports/efmn_mapping_2007.pdf (accessed 4 July 2012).

van der Heijden, K. (1996), *The Art of Strategic Conversation*, Wiley, Chichester.

van Rij, V. (2010), ''Joint horizon scanning: identifying common strategic choices and questions for knowledge'', *Science and Public Policy*, Vol. 37 No. 1, pp. 7-18.

About the authors

Ian Miles is a Professor at the Manchester Institute of Innovation Research (MIoIR), the University of Manchester. He is also the Head of the Laboratory for Economics of Innovation, National Research University Higher School of Economics, Moscow, Russia. Ian Miles is the corresponding author and can be contacted at: Ian.Miles@mbs.ac.uk

Ozcan Saritas is a Senior Research Fellow in Manchester Institute of Innovation Research (MIoIR), the University of Manchester. He is also a Visiting Professor National Research University Higher School of Economics, Moscow, Russia.