iit perspektive

Working Paper of the Institute for Innovation and Technology | Nr. 19

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Horizon Scanning: A Methodical Glance at the Uncertain

In contrast to detecting and describing "megatrends" (meaning clearly dominant, longer-term developments with lasting impacts that strongly influence a society's future), "horizon scanning" strives to identify weak and diffuse indications of still hazy emerging trends so that they can be examined in terms of their social relevance and potential consequences, both positive and negative. This lets the conditions and foundations underpinning new developments be brought to light, to keep them from otherwise disappearing unnoticed into the "background noise". Therefore, the main objective is to enhance sensitisation towards developments of likely importance, which may manifest themselves in the early stages as initially inconspicuous, thus leaving them undiscovered for a long time.

Expanding the focus from megatrends to horizon scanning

When the idea of megatrends was first introduced around thirty years ago, it provided a major impetus to the strategic planning of companies, organisations and governments, because it offered a kind of universal "roadmap to the future" against which future-oriented processes and decision-making could be oriented. The ten megatrends originally articulated by John Naisbitt in 1982 (see Box 1) have now become around twenty in today's analysis (see Box 2), the best known being globalisation, demographic change, urbanisation, migration, climate change and environmental impacts (see http://www.z-punkt.de/megatrends-overview.html). Even though there have been many attempts, especially more recently, to propose an additional number of (ostensibly) new megatrends, thus greatly increasing the overall total to include smaller trends too, there has been a very consistent core group of overarching developments that take place on a global scale with impacts that last many years, even decades. Due to their fundamental nature, megatrends are generally characterised by a great deal of ambiguity, offering a lot of room for interpretation and contradiction when addressing particular questions. Therefore, megatrends can only rarely be used to make absolute judgements (and thus a list of possible actions) in regards to quickly developing current events.

The challenges presented by particular megatrends have long since become widely accepted topics for political action. The parliamentary debates on these issues are well documented by numerous commissions of enquiry into subjects like demographic change or climate change, for example (similarly to the work of the TAB office on subjects like bionics, converging technologies, internet and democracy, etc.). They are also reflected on a (research) policy level, for example in the "social needs and challenges" and "Hightech Strategy 2020" of the German federal government, as well as in the European Union's "Horizon 2020" Framework Programme for Research. What these and comparable research agendas have in common (on both national and international levels) is that they – similarly to megatrends research – are generally oriented towards the "long waves" of a development.

The outlining of future developments, as well as the reliability of the underlying information and assumptions, plays a crucial role in the formulation of strategic measures. The making of

Megatrends (1)

The ten megatrends originally articulated by Naisbitt (1982) are:

- From Industrial Society to Information Society
- From Forced Technology to High Tech/High Touch
- From National Economy to World Economy
- From Short Term to Long Term
- From Centralization to Decentralization
- From Institutional Help to Self-Help
- From Representative Democracy to Participatory Democracy
- From Hierarchies to Networking
- From North to South
- From Either/Or to Multiple Option

future projections has improved considerably, especially within the last fifteen years, from a hard "forecast" with sometimes linear extrapolations of past and present trends, to a softer "foresight" with descriptions of various possible futures (Warnke/Gransche 2012). Today, almost every European state is driving corresponding processes, as prominently exemplified by the United Kingdom (see www.bis.gov.uk/foresight). In Germany, the main actor on the governmental level in terms of foresight research is the BMBF (the Federal Ministry of Education and Research) with its numerous future-oriented activities, such as its "Technologies for the 21st Century", its Japanese-inspired Delphi studies with occasional comparative aspects, its strongly participatory "Future Process", and its currently running "BMBF Foresight Process" (now in its second cycle).

Horizon scanning performs a complementary function alongside other instruments for projecting future developments. While the latter are more focussed on long-term and clearly materialising developments, horizon scanning also take in short-term and medium-term developments that may not yet be so obvious. It therefore represents a tool for broadening the search – opening up the thematic "radar" – by offering mechanisms for qualitatively detecting the weak or diffuse signals of still developing emergent trends while also quantitatively structuring them as much as possible. This process of gathering and organising information is designed to expand the options for political decision-making while opening up possibilities for early intervention and management. Horizon scanning also includes "minority reports" among its sources, in order to also take in the trends and signals that operate outside the established concerns of the relevant scientific communities. This orientation allows for a broader spectrum of subjects to be detected, structured and evaluated.

Megatrends (2)

More recent studies (e.g. at http://www.z-punkt.de/megatrends-overview.html) have produced a more comprehensive list, which still has many links to the original set of megatrends:

- Demographic Change
- New Levels of Individualisation
- Social and Cultural Disparities
- Reorganisation of Healthcare Systems
- Changes to Gender Roles
- New Patterns of Mobility
- Digital Culture
- Learning from Nature
- Ubiquitous Intelligence
- Technology Convergence
- Globalisation 2.0
- Knowledge-Based Economy
- Business Ecosystems
- Changes in the Work World
- New Consumption Patterns
- Upheavals in Energy and Resources
- Climate Change and Environmental Impacts
- Urbanisation
- New Political World Order
- Global Risk Society

Two examples of the institutional incorporation of horizon scanning

Horizon-scanning methods have been a firmly established component of forecasting processes for several years now. The findings of national horizon-scanning programmes are often available to the public, and commercial services like "Shaping Tomorrow" in the UK have also been established. The United Kingdom's cross-departmental Horizon Scanning Centre (HSC) has existed since 2004, tasked with assisting in strategy development and priority setting. In addition to its fundamental forecasting function, the HSC also acts as a cross-departmental coordinating instrument, enhancing the government's ability to prepare for probable future developments. Beyond the HSC, many governmental departments – including the Departments of Health, Environment and Business, and the Ministry of Defence – also have their own horizon-scanning programmes (Habegger 2009, p. 13ff.). To assist these departmental programmes, the HSC (which reports directly to the Prime Minister's office) has developed a toolkit called "Exploring the Future: Tools for Strategic Thinking" (see http://hsctoolkit.bis.gov.uk). The HSC also operates the Sigma Scan tool on behalf of the Government Office for Science.

According to Alun Rhydderch of the HSC, a major aspect of this work is the resource-intensive identification process that occurs before scan issues are finally described. In the case of the Sigma Scan, the process begins by brainstorming with various research groups, such as the Institute of the Future (www.iftf.org) in the USA and the Ipsos MORI Research Unit (www.ipsos-mori.com). The topics found through brainstorming are then categorised according to the STEEP classification system (i.e. social, technological, economic, ecological and political factors) typically used in foresight research. This is followed by the content analysis of some 2000 to 3000 documents. The goal of this labour-intensive document analysis, whose primary focus is on gathering indications that speak for or against the importance of each topic identified by the brainstorming process, is to compile a list of validated topics. These are then subjected to an additional round of discussions with various groups, including those from governmental circles. This pares down the number

Coding scheme for horizon scanning: the coding cascade

From a general view …

a) Overarching subject field (technology cluster, trend, thematic search area)
   ▶ e.g. human-machine cooperationb)

b) Branches of that subject field
   ▶ e.g. social robotics, ambient intelligence, intelligent prosthetics

c) Type and class of source material
   ▶ e.g. specialist literature, popular-science article, expert statement, minority report

d) Date of source material

… to a detailed view

e) Central aspects of that branch
   ▶ e.g. brain mapping, bidirectional organic-technological interface

f) Assigning identified aspects to one of four categories within a robust and universally applicable roadmapping matrix (Kind et al. 2011; see illus.):
   (1) socioeconomic influencing factors (e.g. demographic change, liability laws)
   (2) enabling technologies (e.g. imaging techniques, distributed artificial intelligence, affective computing)
   (3) development of products and services (e.g. biofunctional implants, bidirectional organic-technological interfaces)
   (4) economic and social consequences (e.g. human-machine teams, human-machine culture)

g) Prospective timing for taking effect with regards to the assigned category
   ▶ specifying timeframes, e.g. one to five years, five to ten years

of topics yet again. A discussion process is then launched with experts from the fields of science, technology, business and venture capital, as well as with business journalists. These people are generally invited to participate in several workshops. The discussion process is accompanied by a wiki environment where experts can debate which developments in their own specialities are most likely to become reality in the future. This process with multiple rounds of validation ultimately results in 100 topics for the Sigma Scan to continue monitoring and tracking (Rhydderch, undated).

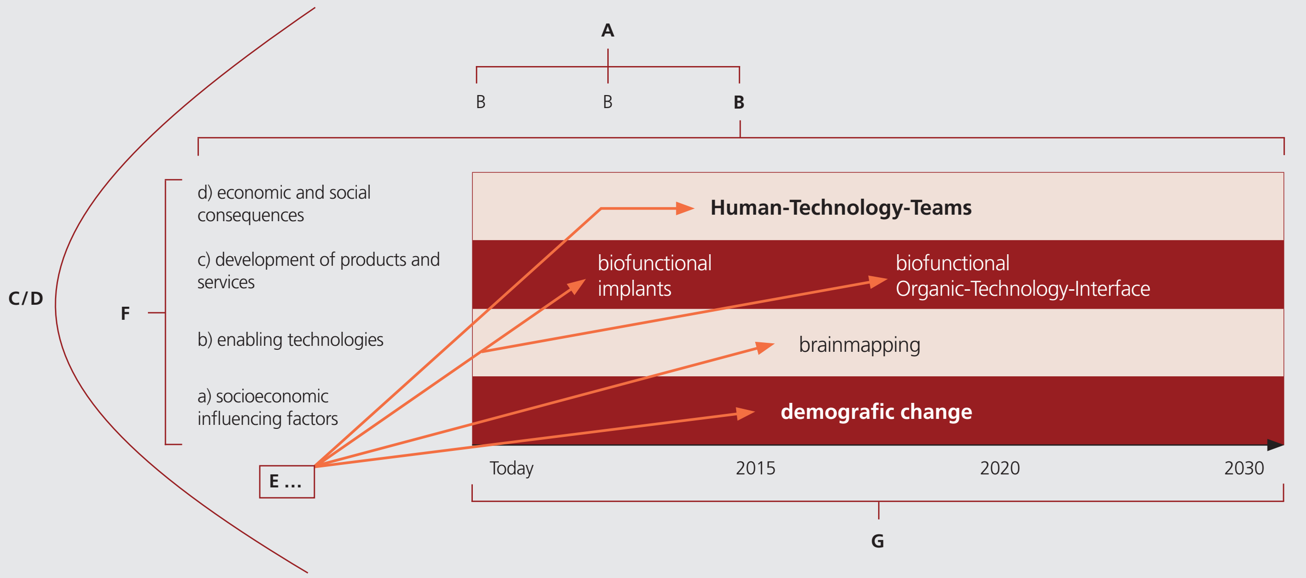
In Singapore, another country with intensive experience in horizon scanning, this kind of programme was first developed in 2004, originally for the Ministry of Defence but later expanding to other fields of interest. Within its Risk Assessment and Horizon Scanning Programme (www.rahs.org.sg), Singapore also works closely with the public authorities of other countries, for example exchanging source data as well as analyses of particular trends and emerging issues. Operational support is provided by a private service provider (Habegger 2009, p. 17ff.).

Horizon scanning at TAB: software-supported expert analysis

As part of its horizon scanning, VDI/VDE-IT examines and evaluates numerous sources, including renowned specialist periodicals (e.g. Technology Review, Nature, Science, New Scientist, Research Policy, Wired), conference proceedings, grey literature (e.g. telepolis, Heise), publications from research organisations and think tanks (e.g. Leopoldina National Academy of Sciences, acatech, OECD, JRC-IPTS, Max Planck Society, Helmholtz Association), research news from major funding agencies (DFG German Research Foundation, Volkswagen Foundation, EU Commission, National Science Foundation), respected daily papers and popular science magazines (e.g. Die Zeit, Frankfurter Allgemeine Zeitung, GEO, Bild der Wissenschaft), specific databanks, our own research, expert consultations, etc. Since it is highly exceptional for truly new developments to emerge and thus present themselves for identification, our investigations focus on filtering out the common trends from many individual and seemingly random developments. To do this, the source material is electronically analysed and evaluated through use of the ATLAS.ti software program.

A distinctive feature of the methodology developed by VDI/VDE-IT for horizon scanning at TAB is the systematic integration of a software-facilitated process, which improves not only the expert-based upstream and downstream narrowing of the topical search radius, but also the evaluation of the detected signals in terms of their projected development and consequences. The goal of this methodology (which will be examined more closely below) is to identify thematic convergences, and although these might draw upon entirely

Example showing hypothetical results of coding scheme usage



different sources and contexts, they nonetheless point to a high degree of similarity – even when not apparent to the naked eye. This methodology can deliver early clues about emerging patterns, which can then be tested through further processes of focussed research and information gathering, without thereby losing sight of their inherent complexities and ambiguities.

The coding scheme: systematic categorisation and analysis

With the help of a unified system specially tailored to the goals of horizon scanning in how it assigns codes (i.e. keywords), diverse sources and their informational content can be evaluated, categorised and interrelated according to their relevance. This technique of processing documents through the assignment of codes is guided by the fundamental assumption that by aggregating those aspects that repeatedly appear together, patterns of converging trends will then become visible. This coding scheme functions like a "coding cascade" in which the codes of very general features (A through D) are stacked above increasingly more concrete aspects (E through G) (see Box 3).

The subsequent analysis is done analogously to the systematic, code-based initial processing of the documents. First, co-occurrence analyses are applied to the upper, "general" levels, to calculate the corresponding C-index. Simply put, the C-index indicates how often two particular codes appear together. If a high C-index is discovered, then the relevant combinations at the next level lower are also subjected to analysis.

The A through D coding levels are always assigned to the document as a whole (see illustration), while the E through G coding levels are assigned (in a cascade if possible) to individual passages within the studied document. Level E functions as the central fulcrum within this scheme. This is the level where theme-specific aspects are identified and marked with corresponding keywords (i.e. codes). Whenever possible, every E-code should also be accompanied by a suitable F-code and G-code. One should also strive for reoccurring E-codes, because this horizon-scanning system is geared towards discovering (primarily through co-occurrence analysis) any indications of emerging, increasingly significant developments. These may not be foregrounded in studied documents that broadly discuss the central topics of the future, but nonetheless reveal themselves repeatedly and consistently within certain specific contexts. The illustration shows an example of the coding scheme, along with the categories mapped to it. Here, the main result is the roadmapping matrix, with contents largely based on the results of analysing Level E. In this example, the diffuse signals as well as known influencing factors are represented by keywords, indicated by the orange arrows. These keyword placements result from an accumulation of the thematic levels A and B along with the more detailed level E (from which the orange arrows emerge), and from their correlation to the categories of the roadmapping matrix (Level F) combined with time-specific prognoses.

Software-based and expert-based evaluation

With this methodology for detecting diffuse and weak signals, and its ability to process an abundance of information through rigorous systematisation and the combining/recombining of "information splitters", it is possible to show emerging trends in technology and society while also interrelating them, and to ultimately determine the relevance of thematic accumulations. These interrelationships and keyword assignments, along with the defining of what seems worthy of coding, are accomplished by experienced professionals who – in a continuous process of reflection and adaptation – incorporate the relevant structures and dynamic changes into the coding and selection schemes. The applied software facilitates and enables (with larger amounts of source material) our access to clues that can only emerge through the processing of a certain critical mass of articles and documents on a given area of interest. In this context, particular relevance is given to the statistically conspicuous frequency of combinations that keep popping up again and again (even if only in parenthetical asides, or as part of insignificant, generally unimportant marginalia), and which could hardly come to the attention of the reader without this purely "mechanical" software-based evaluation, especially since these are generally embedded within precisely the established logic that the horizon-scanning process is meant to overcome. Therefore, the strength of this methodology lies in combining well-trained professionals with a meticulous keyword and analysis scheme implemented with the aid of advanced software, along with subsequent validation of the identified "horizon signals" (which may be weak or diffuse, but are highly likely to be significant) by experts from the relevant fields.

Methodological strengths

A significant – but not the only – added benefit of this methodology of a horizon scanning supported by software and based on co-occurrence analysis lies in its generation of unexpected findings. The identification of socially, economically and thus politically relevant future developments (along with important individual aspects and factors) is facilitated by a coding scheme that stands in contrast to the usual application of qualitative methodologies for analysing content, in that the output (C-index) is largely generated on the basis of multilayered coding (i.e. cascade coding).

Of course, the incorporation of unexpected findings into consistent wider constellations and more generalised contexts remains a task dependent on the work of participating experts. Here, it is not unusual for contradictory developments and trends – or even mutually exclusive ones – to be identified. But if these are equally evident and internally coherent, then instead of being dismissed, they are simply treated as different and competing variants of potential future paths.

The results obtained are valuable and useful for policy discussions, both in evaluating prospective technologies and in proactively shaping them: on the one hand, the described methodology is capable of solidifying weak and diffuse indications of burgeoning and increasingly important trends so that their potential relevance becomes apparent, while on the other hand, factors enabling the establishment of new fields and technologies are also brought to light, which might otherwise simply disappear into the "background noise". Therefore, the benefit lies in enhancing sensitisation towards developments of likely importance, which may manifest themselves inconspicuously in the early stages, thus leaving them undiscovered.

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iit perspektive No. 19
August 2014
Layout: Anne-Sophie Piehl, Jennifer Büttner