The Delphic Oracle and the Progress of Mankind Then and Now

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The Delphic Oracle and the progress of mankind then and now - what kind of contribution to an international symposium on technology, economy and policy might this be? If you permit, I will answer this question in some detail.

The last five years or so in this country and elsewhere have witnessed an upsurge of interest in technology foresight. Prior to 1990, there was comparatively little technology foresight in the United States, Germany or other European countries. Together with Germany's unification the situation began to change. The first foresight initiatives were taken in collaboration with Japan, which was then in the process of carrying out its fifth thirty-year survey. Among several possible scientific methods in technology foresight, the so-called Delphi Survey is only one. But in the eyes of many observers, the Delphi technique seems to be more prominent than other, comparable approaches. This might be due to the magic word 'Delphi' and the association with the ancient Greek oracle. I have come over numerous press releases that guide the reader to serious results of Delphi foresight results by introducing the Delphic oracle first. So do I today.

I first want to start with hindsight and consider briefly what the function of the priestess in the old Delphi temple was, whether historical research found any impacts on politics or society in those days and whether there was a lasting impact on the progress of mankind in prehistory. I will then pose the same queries to our present society, *'what is'* or better *'what could be* the function of technology

foresight on our economy, policy and technology development'? I will conclude by discussing possible benefits of technology foresight for our societies, that march soon into the next millenium.

Benefits of the Delphic oracle

The foundation of Delphi and its oracle took place before recorded history. Thanks to archaeologists and historians we have extensive knowledge on the functions and benefits of the oracle. As I am not an expert in history, in the next few minutes I will - among other things - present some deliberations of Herbert William Parke, professor of ancient history at the Trinity College in Dublin, which he published in the fifties. I will then return to my own field of expertise, innovation economics.

For a thousand years of recorded history the Greeks and others, sometimes as private individuals, sometimes as official ambassadors, came to Delphi to consult the prophetess, who was called Pythia. Her words were taken to reveal the wills of the Gods. These prophecies were not usually intended simply to be a foresight of the future as such. The Pythia's function was to tell the divine purpose in a normative way in order to shape coming events. To put it briefly and coarsely: Professor Parke is convinced that the mystery of the oracle can only be accounted for on two extreme spheres or a blend of them. According to the first, the priesthood and the Pythia were deliberate charlatans who worked a traditional 'hocus pocus', because it paid them well. According to this view the Pythia's role was simply play-acting on her part, traditional and effective in impressing the credulous. The opposite view would be to suppose that the priesthood and the Pythia were perfectly sincere. Instead of being the deceivers they were the deceived.

Are the extremes really different? Is it a blend of them that is most likely? One should consider that the Delphic monastery was one of very few spots on the earth where knowledge was accumulated, ordered and preserved. The information came in from the ambassadors through their queries and the answers were written down on metal plates, several of them found by archeologists. The temple was the locus of

knowledge, or, if we put it more mundanely, the Delphic oracle was probably the largest data base of the ancient world. The priests could read and write; who else could do so in Greece? If due allowance is made for these circumstances, modern psychology will find no special difficulty in accounting for the operations of the Pythia and of the priests interpreting her utterances. Knowledge was used and disseminated to make the world better.

Certainly, the consultations were religious in form and not mere inquisitive speculations on the future or attempts to obtain practical shortcuts to success, but at least in earlier periods religion entered into every aspect of Greek life and there were few subjects on which the advice of Apollo was not sought, to quote Parke's book 'The Delphic Oracle' again. There ist no doubt, the oracle acted as an international arbitrator. It shared the rise of hellenic civilisation to which it contributed no small part. It is no wonder that a witness of that time, Socrates in his 'Phaidros', around 400 years before the year zero, judged: 'The prophetess at Delphi (...) turned many good things towards the private and public affairs of our country'.

Thanks to the oracle the Greek people learned over many generations to abstain from bloody vendetta, to apply to courts when quarreling in private life occured and to solve disputes in a fair way. It can be traced back to the oracle that one should not poison the well of one's enemy and should take care of the olive trees in war. Thus the idea of the long-term oriented development of landscaping achievements we owe the Delphic oracle.

Based on this impressive historic material the first part of my answer is clear: Mankind benefited from the oracle in the old days. Let us turn now to the roots of modern foresight.

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On the history of modern foresight

The main initial work was performed at the RAND corporation, Santa Monica, in the years following 1948, the pioneers being A. Kaplan, O. Helmer, N. Dalkey et al. 'Forecasting', as it was known then, was motivated by Vanevar Bush's book 'Science the endless frontier', advocating the transformation of the US military economy research during World War II (e.g. the Manhattan project) into long-term civilian research and commercial exploitation. The early attempts were also spurred by the amazing scientific successes of the Soviet 'planned economy' (e.g., the hydrogen bomb or the launch of the Sputnik). In the context of forecasting work at RAND, also a new innovation economics developed (including work by Arrow, Winter, Nelson et al.; compare Hounshell, 1996).

Methodological starting points were systems analysis, operations research and comparable procedures. After early successes, many serious misconceptions of what 'forecasting' ought to be arose. In the sixties and early seventies, the mechanical 'prognosis' or 'trend prediction' type of work based on 'linear', i. e. sequential, models ceased to look interesting and the related forecasting activities fell into oblivion. This coincided with the end of the long growth euphoria following the War heralded by the first oil price adjustment; or the 'Limits to Growth' report of the Club of Rome. Although the 'linear' models of thought were discarded (e.g. by the project 'Hindsight'), some science policy communities further supported them for their legitimating power on research spending with no priorities (e.g. the project TRACES by the NSF 1968).

With the new evolutionary economics coming up with selection procedures and the notion of variety generation by new products, and the sociology of science working on the functions of social systems in science as opposed to technology or the economy emphasising the 'bounds of rationality' and 'negotiating systems', it became clear that there may be a new, different use of forecasting methods. Martin and Irvine (1984) coined the term 'foresight' and pointed to the communication or procedural power of it. The modern perception is that the actions of social systems, in particular science communities, cannot be predicted in terms of 'natural' laws, and

that future events in science and technology cannot be determined by extrapolation, but are shaped by these communities and a negotiating system.

However, this present understanding of foresight was available in the literature from the very beginning and, though less-well pronounced than nowadays, may have been found already in one of the earliest papers in the field: 'Policy making rests in part on anticipation of the future (...) and of the consequences of and responses to alternative lines of action. Many policy decisions require *foreknowledge* of events which cannot be forecast either by strict causal chains (...) or by stable statistical regularities (...).' A. Kaplan et al., 1950, p. 93 (emphasis added by H.G.). Even the forerunner of the term 'foresight' was coined in 1950! 'Verification' or 'falsification' of foresight results are, thus, meaningless ends.

Functions of modern technology foresight ...

There is constant temptation for foresight to restrict itself to describing the potential supply of scientific and technical solutions and the study of their impact. However, it must do far more than depict the supply factors. The potentials and the risks of technology in the future depend just as much on the pressure of the social, ecological and economic problems expected to arise and make important demands on science and technology. For this reason, any discussion of problems must focus increasingly on factors relating to demand. How one might determine which basic values for innovation activities might be adopted world-wide in the medium and long-term perspectives, and forecast the resulting problems, of course, has no satisfactory empirical answer.

Because of many supply-demand mismatches, initially euphoric expectations of a new technology (mostly on the part of the scientific community) tend to be followed by increasingly cautious developmental phases before the market is finally satisfied. The use or rejection of innovative products often leads to new demands on research and technology, which is why it generally makes sense to speak of 'feedback processes'. Foresight has to incorporate aspects of industrial research and pure

research, and consideration must also be given to institutional support. These deliberations also call into question the possible expectation that a technology needs no more than a single action to regulate its impacts. Any hopes of being able to drop the accompanying pure research once the applied objectives have been achieved, will meet with disappointment; tomorrow's science-based technology is shaped continuously through targeted basic research.

... and the modern Delphi method

In foresight studies, the Delphi method is considered especially useful for long-range aspects (20 - 30 years) as expert opinions are the only source of information available, as in the ancient times. The Delphi method is one of those methods developed during the fifties at the RAND Corporation to make better use of the knowledge potential through group interaction. A questionnaire sent to experts more than one time is the medium for group interaction (Martino, 1983). The panel members will usually have widely varying estimates on each question in the beginning of the process and do not always shift their opinion under the influence of the assessments given to them by the other panellists. The main advantage of Delphi is that panel members can shift position without losing face if they see convincing reasons for doing so. The main problem remains, that the issues asked must be generated elsewhere; they do not originate from the panellists, they must come in by some ambassadors, as in the Delphic temple.

Most recent foresight surveys were undertaken by government agencies. Yet enterprises may also make effective these approaches. One pharmaceutical company in Germany has just concluded its own Delphi investigation on the future of general practitioneers (i.e.physicians in residential areas) and their ability to follow modern trends both in medical technology and in pharmaceuticals assuming an increasing use of information technology in the health care system.

An important function of modern foresight, in particular the Delphi technique, is moderation between different sectors of the economy, different disciplines in

science and different departments in politics and the public. How can one communicate in the best way on the future across these boundaries? We have very well established peer review systems to judge on priorities and on quality within scientific disciplines. Strategic business managers normally know enough in their core business. But we are now in the decade of transdisciplinary matters, the hyphenated technology areas herald the future such as bio-sensors, micro-systems, opto-computers, neuro-informatics, bionics.

How should we proceed with the long-term application-oriented basic research of the hyphenated type? I used this term deliberately, I did not make a mistake, I mean *long-term application-oriented basic research.* This is the research where one does not know what will be found out in the laboratory in the next month or year, but it is a research which does not only satisfy scientific curiosity and the enhancement of knowledge. It is a research with a definite long-term economic or social perspective. Let me mention climate research, health research, environmental research and so forth. In days of low budgets many business and policy makers think it is impossible to support each piece of interesting research only for the sake of good quality. One has to discuss the long-term orientation in which we invest our dear money. The public is convinced that science and technology are partly responsible for modern bottlenecks and problems and hence has a right to learn about priorities in technology and also the opposite, the non-priorities, what is down at the end of the list of priorities.

Consider the situation in which a company or a ministry has to decide which of two research programmes to support, A or B. Programme A is proposed from faculty A and industry A and the peers from discipline A have given their reviews. Programme B in conjunction with industry B originates from faculty B and the peers of discipline B made up their minds. Everybody did her or his best. But how to decide between them? Know the peers each other? Our science and technology system of tomorrow needs, alongside with disciplinary peers, new instruments to mediate between A and B, and here is another function of foresight, across the board.

Most sociologists of science assume that there is a positive relationship between involvement in a research area and assessments of it and that this relationship

derives from the tendency of scientists to select problems in areas where there is high pay-off for successful solutions and career. The tendency to overrate fields in which a person works may be termed 'bias'. Not only a tendency toward positive bias for fields in which researchers have beeen active was found, but also this bias to be stronger in less innovative sub-fields. As market signals fail to be useful for business strategy in the long run and expert assessment is not always objective, Delphi surveys may play a part in science and innovation management.

Let me give you only two examples from the first German Delphi: Specialist experts and thus future knowledge may not be available in some countries. The availability of experts in the case of biotechnology in Germany is mixed. Among the N=73 respondents who are all experts in biotechnology, many did not answer in particular sub-areas (most expressed for tissue and organs). The largest number of specialist experts (i.e. those working in the sub-area) among all experts in Germany is found in molecular biology but not in the sub-area of tissue and organs. An almost perfect correlation was found between the number of experts and their rating of German research performance. In sub-areas where we know more, we are good. In sub-areas where we are not advanced, we know little of the opportunities.

A test for Delphi expert bias in the energy area tends to support this view. Top experts rate the importance of their own research speciality significantly higher than the other experts - both in Japan and in Germany. At the same time the top experts downplay technical constraints in Germany (less so in Japan) in their own working area.

Challenges of tomorrow

Contemporary technology policy has moved away from the inappropriate idea that the state can direct technological developments right down to individual national innovations. Equally outmoded is the idea that the state should be satisfied with the role of a subsidiary supporter of research leaving the future control of technology to anonymous market processes. Technology policy for the start of the 21st century

requires a middle course, i. e. one in which the state plays an active role as an intermediary between social systems negotiating (companies, associations, interest groups, science, consumers, media, employers' and employees' representatives, etc.). This intermediary role also must take account of the fact that national technology policy is increasingly restricted in its scope, both from above and below. This is because of the activities of the European Union and the efforts of regional bodies such as the Federal Länder in Germany to promote research on a regional basis.

The state's new role as active moderator necessitates a policy process which is co-ordinated with industry, science and society. However, co-operation does not occur by itself, since too many divergent interests predominate. If there is to be agreement over the possibly selective eligibility for support of technology, dialogues with other social players must be initiated and pursued on a permanent basis. Otherwise, it cannot be expected that lasting co-operation can be achieved or that the platforms to be created for a subject-specific understanding will become more than simply forums for the exchange of information. Don't we need integrated technology foresight to provide the knowledge base for these platforms?

Care has to be taken so that these social negotiations on technological wants should not stray too far from what is reliably known, and wander into the realms of speculation. In view of the typical recursive phases of science-related technological innovations, it can be generally assumed that everything that will dominate technology impacts in 10 years' time is already recognisable today. However, strategic planning in enterprises is necessary, aiming towards horizons even further in the future, because new technologies - especially those which will contribute to long sought solutions to problems - must be identified at an early stage.

As far as enterprises are concerned, a considerable improvement of the intramural knowledge base through participation in foresight surveys is reported. There is sporadic evidence that in some companies, during participation in the Delphi, it was felt that too little effort is dedicated towards strategic innovation management and some remedies have been taken. Some companies engaged in own investigations in the direction of an intramural breakdown of the overall national studies towards the special interest of their business areas or establishments, both in the manufacturing and the service sectors. One large chemical company in Germany, especially,

started with topics of the Delphi survey, made their own evaluation of the topics and built up a strategy until 2010. In working groups, the information was discussed and distributed. Some smaller-scale comparisons of the business portfolios to the future-oriented areas are also being done in other companies, sometimes assisted by external consultants. These activities are largely confidential.

Opportunities of technology foresight - Scoping future applications for policy, business and society

Several lessons can be learned from the application of foresight methods. Firstly, it is important to note that a foresight activity should not be a single event but should rather become part of a broader strategy which deals with strategic orientation. Secondly, the individual results of a survey should trigger various follow-up activities within the organisation, for example, workshops on selected items. Thirdly, going through the process of a foresight survey itself is a very valuable undertaking, since great numbers of experts are motivated to think critically about future scenarios favoured or rejected by their peer colleagues. Fourthly, for the company, the benefits of a foresight survey should not only be seen as gains in information and reputation among its clients, but also extended to the internal situation: the strategies for dealing with challenges of the future must become broad company issues which are to be discussed and supported by many employees, thereby contributing to an increase of in-house motivation and identification.

From the social point of view, the direction to be taken in the future may be derived from the increasing demands made on technological development in terms of minimal use of resources, elimination of emissions, recycling economy and sustainable development. These demands require the creation of the new framework conditions, especially those of a non-technical nature, such as legal regulations. Equally important as such ecological problems is the sociopolitical dimension - in particular the unemployment problem. From the point of view of technology policy, we need a form of technological development which encourages wide-ranging

participation by employees in various sectors, and firms of varying size, which leads to an open market with no specific centralised structure.

It is in the nature of long-term foresight that it is burdened with a high degree of uncertainty how the decision-making groups will behave; it is not unusual for wishful thinking, arising from the most diverse motives, to be presented as a probable future event. Taking the long term view, the motivating power of guiding visions is helpful in that it releases social energies and the willingness to undertake concerted action. Long-term lead projects in technology can produce lasting motivation and unite powers which can work towards problem-solving requirements recognisable in the long term, and also produce successes along the way (through desirable multiplier effects).

Lead projects in technology which represent outline solutions to large, global, economic, social and ecological problems, and especially the visionary view of technological development and the challenges now facing us, throw up other, more radical questions of technology policy than those set out here for the time being. It was not the aim of this brief essay to give the questions more concrete form. However, it has been possible to indicate that technology assessment through foresight can itself provide the key to far-reaching changes in future policy. The technology policy of tomorrow must be in place to shape technology policy in the long run.

In Germany, generally, there is a public tendency to be critical about new technology, often without going into any detail. After some foresight studies were published - rich in presenting visions of detailed trends in science and technology - several 'second thought' articles concerning the public understanding of technology by science journalists were published. The message in these articles is basically that dogmatic scepticism against new technology as such should be replaced by public reservations against *certain* technologies. A *technology-specific* public debate on the future of the so-called 'science and technology nation' need to be triggered off. From these observations one is tempted to conclude that the assessment and foresight processes have a lasting and direct impact on society as it affects our notions of future technology. By reflecting future opportunities and impacts of technology, we reflect our procedures to get there.

The second answer

To answer the second part of my basic question: I am not fully convinced that our present society has already made optimal use of forsesight for its own progress. There is great potential if we look forward. I know that some people are very sceptical and see no progress in technology and society. For these, foresight is both costly and irrelevant. Let me list some examples of what has changed in the *past* 25 years since this institute operates. I do not think that in the *next* 25 years we are really not getting anywhere. I conclude by quoting from our anniversary report a list of novelties since then:

'Germany was in the grip of economic recession; in almost all OECD countries the unemployed were standing on the streets. Social Democrat Chancellor Willy Brandt has resigned over the affair of a GDR spy, and the Federal Minister of Economics, Karl Schiller, a professor of economics, felt he could no longer vouch for his Keynesian policy of demand. On some Sundays at that time you could go for a walk along the motorway. Chancellor Schmidt had decreed 'car-free Sundays'. Germany, at that time, did not have: a Federal Ministry for the Environment, a Green Party, relatively well-developed local public transport, separate refuse collection, private TV channels, cable TV, Internet, text programmes, 16 German states, chlorine-free or environmentally friendly paper, industrial robots, genetically engineered tomatoes, CDs, milk bottles, a solidarity tax (to help reunified East Germany). There was no State of Bosnia, no German age-care levy; there were no energy-saving lamps!'

We would probably be irritated by a return to the year 1972; the changes that have occurred since then, albeit imperceptibly, have been too intensive. However, many problems have remained with us and new problems occurred, so that we are sure that the work of ISI, which consists in uttering answers - and reformulating - complicated questions thrown up at the interface of technology, industry and society, will continue with unabated impetus.

Sources:

Dalkey, N., 1969, An Experimental Study of Group Opinion: The Delphi Method, *Futures 1*, pp. 408-420.

Dalkey, N. and Helmer, O., 1963, An Experimental Application of the Delphi Method to the Use of Experts, *Management Sciences* 9, pp. 458-467.

Helmer, O., 1977, Problems in Futures Research - Delphi and Causal Cross-Impact Analysis, *Futures* 9, pp. 17-31.

Hounshell, D.A., 1996, The Medium is the Message, or How Context Matters: The RAND Corporation Builds on Economics of Innovation, 1946-1962, Typescript, Carnegie Mellon University, Pittsburgh, no year, from the author.

IIT Research Institute, 1968, Technology in Retrospect and Critical Events in Science (TRACES), Washington, D.C., National Science Foundation.

Irvine, J. and Martin, B.R., 1984, *Foresight in Science*, Francis Pinter, London.

Isenson, R.S., 1967, Technological forecasting lessons from Project HINDSIGHT, Paper presented the Technology and Management Conference, Harvard University, 22 May.

Kaplan, A., Skogstadt, A.L. and Girshick, M.A., 1950, The Prediction of Social and Technological Events, *The Public Opinion Quarterly* XIV, pp. 93-110.

Meadows, D.H., Meadows, D.L., Randers J. and Behrens III, W.W., 1972, *The Limits to Growth*, Universe Book, New York.

Martino, J.P., 1983, *Technological Forecasting for Decision Making*, North Holland, New York, 2nd edition.

Parke, H.W. and Wormell, D.E.W., 1956, *The Delphic Oracle*, Basil Blackwell, Oxford.