

Report on the NATO Advanced Research Workshop: "Knowledge, Technology Transfer and Forecasting", October, 1995

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TA-relevante Bücher und Tagungsberichte

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Fifty scientists from around the world met from October 12 to 14 in Budapest to participate in a "NATO Advanced Research Workshop on Knowledge, Technology Transfer and Forecasting". The meeting was organized by Dr. Annamaria Inzelt, Director of the IKU Innovation Research Centre and Reinhard Coenen, Deputy Director of the Institute for Technology Assessment and Systems Analysis of the Research Centre Karlsruhe, both members of the Executive Committee of the International Association for Technology Assessment and Forecasting Institutions (IATAFI). Participants were primarily from NATO countries and East and Central European Cooperation partner countries, although representatives also attended from China, India and Africa with the support of IATAFI. IATAFI is an international non-governmental organization established to help network scientific institutions involved in technology assessment and forecasting with each others and with those institutions that could benefit from technology assessment. The organization maintains headquarters in Bergen, Norway, where the President Dr. Jan Andersen (formerly of Statoil) and Business Manager Trygve Hindenes (of Statoil) reside.

The workshop was organized in six sessions:

- _ Opening session: Technology Transfer, Assessment and Foresight - Global Challenges
- _ Session I: Diffusion of Laser Technologies
- _ Session II: Knowledge Transfer in Biotechnology
- _ Session III: Technology Flow in the Field of Information Technology
- _ Session IV: Foresight
- _ Closing session.

The theme of the opening workshop session was **Technology Transfer, Assessment and Foresight - Global Challenges**. This topic underlined many of the presentations and discussions throughout the workshop. The global challenge faced by all participants seems to be related to changes in the structure of economies in all countries and its cascading effects on scientific institutions. Three general conditions in the "global economy" underscored much of the discussion at the workshop. These were:

- There is not enough funding (money) to satisfy all scientific desires.

Structural changes in the economy are driving government changes which are affecting the allocation of resources to scientific institutions and universities (institutions and universities are receiving less money and anticipate receiving even less money in the future.)

Existing structures of science and technology development are or will need to be changing (some institutions are threatened with extinction, while others are already extinct).

Because of these conditions, participants discussed knowledge production and knowledge transfer against a background of changing social, political and organizational arrangements. Taking a step back from the actual discussions in the sessions on "Laser Technology" or "Knowledge Transfer in Biotechnology" or "Technology Flow in the Field of Information Technology" it seems institutions represented by the various participants were all in similar situations, whether from the former East Block Countries or the Western Countries. If one takes an "organizational ecology" approach to understanding the scientific situation in these countries, scientific institutions can be compared to species struggling to survive against a changing environment. How these institutions adapt to the changing environmental conditions will determine whether these institutions thrive and grow healthier or whether they wither away and die. While the "relative

deprivation" in institutions of the former East Block Countries may be higher than in Western institutions, the changes in the global economy seem to be affecting all institutions. Inherent in the current debate on science funding is the relationship between scientific production and economic development. In earlier times the relationship was taken on faith to be linear and positive, an assumption being challenged in many countries with high budget deficits. This challenge, in part brought on by the end of the Cold War arms race, has threatened the status quo in the scientific community and created the need for change.

Given the need for adaption of scientific institutions in most countries, it seems one can easily identify areas where scarce resources should not be expended. These would include the following: 1) Defending current scientific structures (institutions and institutional arrangements) and past "models" as appropriate for the future. 2) Working harder under the current structure with the idea that changes in the environment were only temporary aberrations. 3) Maintaining institutional boundaries (instead of consolidating, networking and teaming), and 4) Thinking locally and regionally instead of globally. These approaches will only deplete scarce "energy reserves" of institutions and minimize their chances of successful adaptation.

Like many scientists, those involved in technology assessment and social forecasting may not be as self reflective (institutionally speaking) as we might be. While we can analyze and forecast for others, we often have difficulty analyzing and forecasting the fate of the very scientific institutions of which we are a part. The similarity of the situation for all the participants at the IATAFI workshop highlighted this problem. While technology assessment seeks to help us understand and anticipate potential problems and benefits of changes in technology, as a discipline we have not used our capabilities to develop and promote a healthy environmental niche for the very institutions that do assessment and forecasting (or adapt to new niches). One need only look to the abolishment of the United States Congress' Office of Technology Assessment to recognize our failure to anticipate and adapt institutionally.

Papers presented and discussed at session I on **Diffusion of Laser Technology** covered both strictly technical (Karapatnitski, Rubanov, Szabö) and more general, historical and technology policy issues (Kroö, Spalding, Vondeling). Thus it would be a too ambitious undertaking to try to summarise all the papers. Therefore some conclusions resulting from the discussions are elaborated.

Laser technology represents a new technological regime. It is a strongly science-based technology, on the one hand. Fast technological changes, on the other hand, require continuous education, and thus frequent revisions of curricula, and re-training of scientists, engineers, doctors, etc. Hence laser R&D contributes significantly to higher education, and thus it is beneficial even from a fairly narrow economic efficiency point of view.

Support for laser R&D would result in notable improvements in a wide range of related technologies for the following reasons. First, laser technology has caused a radical change in technological trends. It has opened new research directions (e.g. impacts of high energy light on different materials, measurement of various processes without disturbing them, optical computing) and revitalised traditional technologies (material processing, medical techniques, etc.).

Second, it can be deemed as a 'networking' technology. Since it is a strongly science-based technology, it requires a close co-operation among scientists, R&D and production engineers and often users (doctors, industrialists, etc.). Moreover, most of its applications draw on a wide spectrum of disciplines and technologies (related areas of physics, chemistry, material sciences, on the one hand, and precision engineering, information technologies, alignment, control, measurement and material processing technologies, on the other hand, e.g. in the case of industrial applications).

A further important point for policy consideration is that laser technology, as already indicated in the previous paragraphs, is a pervasive technology, that is, it contributes to wealth creation through improvements in a number of fields (material processing, telecommunications, computer and office technologies, R&D, diagnostics and therapy in the health sector, test and measurement in all industries, etc.).

In the industrialised countries the diffusion of laser technology has been a fairly quick and far-reaching process. Nowadays various types of lasers are crucial in manufacturing - particularly in automotive and electronics industry for heat treatment, cutting, welding, marking for quality assurance, ceramic scribing, etc. - as well as in construction, R&D, information handling and medicine. Laser technology is not only of technical importance - due to its superiority to older technologies and capability to provide formerly unimaginable technical opportunities - but also of economic importance. Besides the direct impact on users' profitability an indirect economic effect should also be mentioned. Expenditures on R&D projects, on accessories, components, and on 'other system elements' have accounted for a considerable part of total laser sales. This suggests that laser technology, strictly defined, has not only 'pulled' a wide range of other innovations, embodied in auxiliary mechanical, optical, electronic, electromechanical devices, but promoted their diffusion as well.

Scientists and engineers in the former communist countries have achieved remarkable laser R&D results. The commercialisation of laser technology, however, was not that successful in these countries. Yet, accumulated skills and knowledge, coupled with appropriate economic incentives and institutions conducive to innovation might provide an excellent basis for successful and mutually beneficial international co-operation both in R&D and manufacturing of laser equipment, and thus leading to economic success.

Economic research could contribute to achieve this end by analysing new modes of knowledge production and flow,

notably academia-industry links, various forms of alliances among companies, the role of users and innovative small and medium-sized enterprises, both in a given country and in the international context. It is also of crucial importance to gain a thorough and deep understanding of the on-going restructuring process both in the R&D sphere and in industries, e.g. the impacts of austerity measures in R&D in higher education, privatisation, foreign direct investment projects, the collapse of the former communist countries, etc.. Further, the transition process also provides a unique opportunity to study emerging institutions, both market and non-market ones, and thus to draw theoretical conclusions for economies and other social sciences as well as practical, i.e. policy, lessons for transition economies and advanced countries.

At session II on **Knowledge Transfer in Biotechnology** six papers were presented highlighting some important aspects of biotechnology and related problems. It was generally agreed that biotechnology is a multidisciplinary, pervasive industry (similar to laser) with very strong science linkage. Speaking about biotechnology, quite naturally attention is focused on genetic engineering or the new generation of biotechnology disregarding the fact that, in a sense, it has been with us from antiquity in such ancient activities as bread making with yeast or brewing. However, the scientific discoveries in the second half of the 20th century opened the way to genetic engineering, posing constant challenges to scientists in different scientific fields. Biotechnology is a technology which could be utilised in a number of industries, e.g. in the chemical and pharmaceutical industries, agriculture, environmental protection, etc.. Due to its special characteristics, biotechnology is an activity which could be carried out in small firms as well.

Especially interesting was the issue pointed out by M. Sharp (SPRU). Her research revealed that the leading European pharmaceutical companies are conducting their research in the USA. As they are using American labs, employing American researchers, there is a risk - according to her - that European scientific capabilities will be eroded. T. Reiss (Germany) disagreed with this view, illustrating the strong and developing biotechnological bases in Germany. She, however, pointed out that biotechnological R&D follows a different pattern in Germany, namely a larger proportion of R&D is spent on environmental protection for example, and relatively smaller proportions on health care than in the USA. P. Mogyrosi (Hungary) suggested in his presentation that somehow Hungary follows a similar pattern in R&D spending to that of Germany. At the same time he called the attention to the very poor financial situation of all Hungarian companies.

In session III on **Technology Flow in the Field of Information Technology** five papers were presented. Sandor Bottka stated the fact that IT is the motor driving modern development. Applied technology has the potential to alter organisational behaviour as well as the structures of power both locally and on a national level.

Compared to its neighbours, Hungary, according to Sandor Bottka is in a fortunate position considering the present extent of IT infrastructure development. However, its effort to produce content to be offered to the networks is in the initial phase. The challenge now is to find partners and launch projects on line with the ideas and objectives of the G-7 Information Infrastructure and EU-Information Society. Technology Assessment could help to indicate which way to go.

Peter Hanak (Hungary) discussed the problem of bringing Central- and Eastern Europe societies up on line with those who are the forerunners in the use of IT. He pointed out a number of main applications and elaborated on how it might be possible to find smarter and faster ways to go. He also pointed out the importance of making a fast and significant step forward to be able to bridge the gap to Western Europe, definitely break out of isolation, thus paving the ground for favourable development. He saw the need for Data-highways as a prerequisite.

Alexander V. Koroshilov (Russia) gave an example of successful transfer of technology from German partners and shared the experiences they had had during the last three years, retraining former military employees by the means of simulation programmes.

Alfonso Molina (United Kingdom) pointed out the importance of the Technology Management and Policy Programme in industries. Correct valuing of IT's contribution to company life and success is a prerequisite for IT diffusion. The capacities of the hardware are increasing dramatically and new production methods for the modern and powerful microprocessors call for new methods to test and ensure their quality if they are to be successfully accepted by the users.

Florin Filip (Romania) gave an overview over what had been achieved so far in building electronic high-ways in his country. He also pointed out important new IT-projects to be implemented in the coming years to facilitate improvements in IT-standardisation, public administration, engineering, computer manufacturing and so on. He also assessed the impact of the participation of Romanian scientists in EU-funded projects.

In Session IV on **Foresight** Sybille Breiner (Germany) and Luke Georghiou (UK) presented papers on foresight activities in their countries, Joseph Coates gave a paper on his Multiclient Study: Project 2025. These activities are described in the focus topic of this issue (see page 5 and 6). The main focus of the papers of Sybille Breiner and Luke Georghiou was methodology of foresight and the process of foresight, whereas Joseph Coates presented results of his own foresight project. Nigel Clarke of the European Patent Office's branch in Vienna demonstrated how patent information can be used for forecasting.

Other papers in this session, by Galina Butowskaya (Belorussia), Galina Sugieva (Russia) and Dimitrios Deniozos (Greece) dealt with the R&D planning and structure in their countries.

Alexander Sheindlin (Russia) discussed in his paper the transitional problems of Russia's energy industry and Baruch Raz (Israel) in his paper "Science and Technology at the Crossroads" the challenges for science and technology in the future.

The discussion on foresight was fairly controversial, the usefulness of foresight for R&D planning and its reliability were discussed, especially along with the pros and cons of Delphi type forecasts. Throughout the session an recurring discussion point was priority setting in Research and Development. Different positions were exchanged. Some argued for a broad non-delicated support of science whereas others took the position that priorities should predominantly be set according to societal and economic needs. The question who should set priorities was also discussed.

In the **closing session** Vary Coates presented a paper on OTA's death and the future perspectives for TA in the United States (see her contributions in this issue)

The proceedings of the workshop will be published in spring 1996 by Kluwers Publishers.

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