to asses how they seem to matter. It is a prime example of the power of appreciative theorising. The essay begins with a detailed definition of the term 'national innovation system'. The author then takes issue with several influential writers on international competitiveness and innovative performance. The importance of education as a necessary but not sufficient condition for economic growth is highlighted. Policies directly aimed at technological advance are found to be very diverse, making generalisations in this areas impossible. The chapter also focuses on the dispute over high-tech policies and the importance of high-tech industries in general, and discusses the relevance of the national innovation concept in the age of globalisation.

To sum up, the essays in this book testify to Nelson's life-long struggle against the limitations of mainstream theoretical economics and in support of an evolutionary theory of economic growth guided by a large dose of appreciative theorising. However, one does not have to be an evolutionary economist to value appreciative theory. For example, Romer, who is credited with initiating new growth theory in the 1980s, also regards descriptive theory as necessary to help model builders pin down the important causal relationships and feedback mechanisms to guide formal modelling.[4]

It has been a great pleasure to read (or re-read) the essays contained in this book. The wealth of useful information and appreciative theorising contained in them is a welcome contrast to much of the formal literature on the subject of technological change and economic growth. It provides many insights that help put current policy debates about economic growth, the role of universities, science and technology policy and related issues into perspective.

### Notes and References

1. The best known of the latter is the influential book by Richard Nelson and Sidney Winter *An Evolutionary Theory of Economic Change*, The Belknap Press of Harvard University Press, Cambridge, MA, 1982, which combines formal and appreciative theory.
2. Alfred D. Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business*, The Belknap Press of Harvard University Press, Cambridge, MA, 1977; Douglass C. North and John J. Wallis, 'Integrating Institutional Change and Technical Change in Economic History: A Transaction Cost Approach', *Journal of Institutional and Theoretical Economics*, 150, 4, 1994, pp. 609–24.
3. Richard R. Nelson (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford University Press, New York, 1993.
4. Paul Romer, 1993, 'Idea Gaps and Object Gaps in Economic Development', *Journal of Monetary Economics*, 32, 1993, pp. 543–73.

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## Knowledge, Technology Transfer and Foresight

Annamária Inzelt and Reinhard Coenen (Eds)

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This book is a selection of papers presented at the NATO Advanced Research Workshop with the same title held in Budapest, Hungary in October 1995. It is also the eighth volume of NATO's ASI (Advanced Science Institutes) Partnership Series on Science and Technology Policy. One of the aims of the workshop had been to bring together researchers in the field of natural and social sciences from around the world, including

the CIS and Eastern and Central European countries; hence, the variety of problems, approaches and positions represented in the book. The quality and analytical depth of the 16 contributions also differ significantly. The book contains a list of the participants in the NATO's three-day workshop with names and addresses from 20 countries, including China, India and Zambia. With only a few exceptions of technical papers, the targeted audience is that in science and technology policy.

In times of changes in the role of government and significant funding cuts for research and development, both in the West and in the former socialist countries, the focus of the book is on:

- the assessment of existing technologies (namely, the identified key groups of 'emerging pervasive technologies': laser technology, biotechnology and information technology); and
- ways of exploring possible future developments through technology foresight.

In the five page introduction, the editors Inzelt (from the Innovation Research Centre in Budapest) and Coenen (from the Nuclear Research Centre in Karlsruhe) have put the discussions into perspective by outlining the challenges faced by all nations in the global economy and the need for science institutions to adapt and react to them. They have also identified four approaches which could impede the scientific community in the process of transformation, namely:

- keep current institutional models and institutional arrangements as appropriate for the future;
- ignore environmental changes and consider them as only temporary aberrations;
- disregard the importance of building networks and cooperation; and
- emphasise the local and regional instead of thinking globally (this issue should be treated carefully as there is evidence, e.g., showing that local aspects are as, if not more, important than global)[1].

It seems, however, that there has not been a binding topic for the Budapest meeting and consequently, the book is not focussed on making a contribution to any particular aspect or concept in the area of science and technology policy. It reads as a review of the then current developments in relation to the selected key technologies and foresight exercises carried out in the US, UK, Germany and Russia. The choice of laser technology is of particular interest to the reader not only as a pervasive technology (with implications for material processing, health, telecommunications, metrology, computer, office and other technologies) but also because in this area the former socialist countries have a lot of accumulated technical knowledge and expertise with limited experience in commercialisation.

The first three chapters are dedicated to the selected key technologies with three papers on knowledge transfer in biotechnology, four on the diffusion of laser technology and four on information technology. The majority of papers emphasise the importance of international cooperation and joint research projects financed by the European Union. As there is no other coherent theme running in the book, I will try to briefly outline some of the findings from the various contributions which I found deserving attention and thought provoking.

*Biotechnology*

Sharp's article on the large European multinationals in the field of chemical and pharmaceutical industry offers analysis and empirical evidence of the increased develop-

ment of close links with the US biotechnology science base. Companies, such as Hoechst, Ciba Geigy and Hoffman La Roche, have both direct subsidiary laboratories physically located in the US and indirect linkages via small dedicated biotechnology companies. Although the European companies seem to benefit from the foreign science developments through knowledge transfer, the net gain in terms of job creation (and especially high value added jobs) appears to be for the United States. The findings of this paper are of a particular interest to countries, including Australia, which have a strong scientific and technological base to offer to multinationals. The crucial importance of research and development links for biotech innovations is analysed by Reiss in the case of German small and medium-sized enterprises. He justly describes the biotechnology field as one with very strong science linkages, multidisciplinarity and high innovation dynamics where cooperation between industry and research institutions is an intense necessity.

The paper by McKelvey draws an interesting parallel between biotechnology and software development on the basis that technology transfer involves mainly knowledge and techniques and less objects and machines. Similarly, the two industries have been dominated at the commercialisation end by American firms. McKelvey argues that technology transfer is not a simple flow of information and redefines it as an active process of knowledge creation which requires intellectual property protection. The article also discusses issues about the collective nature of innovation and the structures of legal institutions which reward individual endeavours.

*Laser Technology*

The article by Rubanov reviews the laser related projects carried out in the Academy of Sciences' institutions in Belarus. Its purely technical nature can hardly justify its presence in the book. Spalding who is a physicist by profession, tackles some issues, such as who benefits from technology transfer and means for technology transfer, which have long been discussed in the relevant literature. Some of the information on laser projects funded by the European Union presented by him, however, might be of interest. The paper on diffusion of medical lasers in the Netherlands tests the S-shaped curve model and is based on a very impressive comprehensive 100% coverage of Dutch hospitals. The authors' findings are that diffusion usually starts in university hospitals, followed some years down the track by general hospitals, and that the most common medical usage is in ophthalmology.

Although containing some technical data, Kroo's paper on laser technology in Hungary is perhaps the most interesting in this section. He talks about the origins of the technology from fundamental studies in optics when physicists were looking for problems to be solved with this powerful tool. Shooting holes in razor blades which had been one of the laser applications for the Hungarian physicists in the 1960s is no longer on the agenda. Kroo discusses current and potential uses and technology transfer projects, including international projects and programmes sponsored by the EU.

*Information Technology*

The development of computer networks (and the Internet in particular) in the countries of Central and Eastern Europe in the first half of the 1990s is analysed in the article by Hanák. He outlines the problems these countries face to keep pace with the West and describes the telework projects funded by the EU, namely ESATT (European Science and Technology Transfer Network), INDIS (Information Dissemination) and WISE (World Wide Information System for Support of R&D Efforts). It is interesting to note

that Hanák has not included medicine and health as important applications for information technology and computer networks which probably reflects the developmental status of these technologies in that part of the world. The paper by Filip looks at IT issues in Romania and talks about building a 'culture of IT utilisation'. The information technology and telecommunications sector is one of the few research and education priorities supported by the Romanian Government after the collapse of the socialist system. The country has an explicit IT development strategy with some of its positive outcomes being the Information Technology Transfer Centres and the National Computer Networks for Research and Development and Higher Education. The National GIS (Geographic Information Systems) Project started in Hungary in 1992 is another example of positive developments in the former Eastern Block countries in what Bottka describes as a current 'chaotic environment'. His analysis shows the GIS market offering a lot of opportunities to IT companies and for cooperation.

The article by Molina is a very interesting case-study of the semiconductor company Inmos whose main product, the transputer (transistor plus computer), is supposed to be the flagship of the British microprocessor industry. This analytical paper looks at intra-organisational diffusion of information technology and provides the explanation that what is necessary for success is the dynamic interaction between technical and social factors. His concept of 'socio-technical alignment of technology' and the study of cyclical products (two generations of transputers) deserve attention.

The paper by Sheindlin on energy security of Russia and Europe (the last paper in the book) provides an outline of the issues from the position of the same energy sector. It would have been beneficial for the book to include broader perspectives than just one article. The overview of the Russian fuel and energy complex includes natural gas, oil, coal and nuclear power. Renewable energy sources and technologies do not appear to have any significant importance, contrary to the nuclear power industry which is considered 'a guarantor of energy security in Russia and Europe' (p. 236) and is expected by the year 2010 to generate 30–35% of Russia's electricity and 40–50% for its European part. Even if we leave aside the controversy about technical security and dangers in exploiting nuclear reactors for power generation, there is still the expectation that some consideration should be given to the issues about storage and reprocessing of nuclear waste. This is not, however, the case.

The technology foresight section of the book is the one which I enjoyed the most. It draws experiences from the US, Germany, UK and Russia. It would have been even more interesting to see a comparison between the different approaches, methods and aims adopted by the various countries. It is worth examining Coates' list of the 83 highest probability statements about year 2025 which includes scientific discoveries, research and technological development as well as social, economic, political, environmental and military factors shaping society. It left me asking questions, such as: 'Is Coates really right that a global currency will be in use?' or 'Will economic health really be measured by including considerations about the environment, quality of life and work?'

Breiner's article about the German experience in technology foresight provides a very informative outline of the problems faced by adopting the Japanese Delphi techniques as well as outcomes of the relevance tree approach. Georghiou's paper talks about the British programme which is less technology driven and has emphasis on market, quality of life and appropriable benefits for the UK. Sagieva's contribution describes an evaluation exercise undertaken by the Russian Ministry of Science and Technology Policy to assess the 38 supported programmes based purely on their scientific and technical merit. Five of them were found to provide leading edge positions for Russia, including high-energy physics as well as global environmental changes and climate.

Taken as a whole, the book represents a plurality of approaches and different audiences may find different parts of relevance. Taking into account the price, the publishers and the editors should put more attention on straightening the English and avoiding references to missing tables and figures.

### References

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## Technology, Open Learning and Distance Education

A. W. (Tony) Bates

*London and New York, Routledge, 1995, vii + 266 pp., AU$45.00 (pbk), ISBN 0 415 11682 1 (hbk), ISBN 0 415 12799 8 (pbk)*

Espousing the view that '... technology is neither good nor bad in itself, but the way it is used that matters' (p. 20), Bates directs his book specifically at key decision-makers: in education and training (eg. the Dean of Humanities in a university under pressure from the Division of Continuing Education to fund technology-based courses, or the Vice-Chancellor endeavouring to take on more students for less cost); government officials in Higher Education grappling with the problem of whether to give a university a grant to upgrade its instructional television facility in the face of conflicting evidence about the utility of that technology at that time; and politicians and civil servants looking for ways and means of improving the quality of education in a climate of economic stringency. This book then is for those who, in searching for innovative and more cost-effective ways of providing a quality education and training for their students, have reason to believe that technology-based distance education and open learning might provide the best avenues for meeting those needs.

Underpinning many of the arguments put forward by Bates is the concept of Lifelong Learning and the evolution of a 'Learning Society'. In concert with the themes contained in Raggatt, Edwards and Small [1], Bates not only suggests that technology has changed the way we learn, but that technology-driven media have the potential to provide the kind of flexible, vocationally oriented learning in a diverse range of settings that include the workplace, study groups, and the home. Kirkup and Jones [2], in their chapter on New Technologies for Open Learning link open learning and distance education to the notion of the Learning Society. They point out, however, that distance education as a term is dated and that it is more meaningful to talk about open distance education (ODL) because it puts the emphasis on the learner; a dominant theme in a Learning Society. Bates, however, while acknowledging the separateness of the two terms also draws attention to a commonality: '... the one thing they have in common is an attempt to provide alternative means of high quality education and training for those who either cannot go to conventional, campus-based institutions, or do not want to.' (p. 27). As Bates sees it, in a generic sense it is more accurate to talk about 'open and distance education' rather than simply 'open distance education'.

In relation to the terms 'technology' and 'distance learning', Bates makes it clear that