environment for construction to identify significant technological developments and lead the reader to further references on specific aspects." Organised into nineteen sections, three devoted to basic materials of construction (timber, steel and concrete) and fourteen relating to specific aspects of construction, it drew some 22 engineers and architects into the research and writing. In the same spirit, the final chapter on 'Defence Science and Technology' offers short, factual sections on optical munitions, aircraft, radar, tropic proofing, the sophisticated Malkara and Ikara, and other postwar weaponry and naval and aeronautical developments, but does not attempt to relate the innovations or the fluctuating fortunes of the Defence Science and Technology Organisation to social, economic or policy change.

Essentially *Technology in Australia* is a work of technical reference, in which the people these technologies served, their changing social and economic environment, and the relevant historical writings that depict them, have been ignored. The Academicians have shown some hubris. When early plans for an Australian bicentennial technological history surfaced, proposals were put forward for an interpretative history that used historians alongside the technological experts. The Academy's Council chose otherwise. After much effort, several deaths, and high publication costs, we have a bicentennial volume more suited to the historical environment of the 1960s than to analytical interest in Colonial and 20th century endeavours and their relevance for technology policy in 1988. Clearly, an interpretative history of technology transfer, technology creation, the technology of a small country and its distinctive social, spatial, economic, inventive,and restrictive characteristics in Australia, remains on the drawing board.

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Research Foresight: Priority-Setting in Science *by Ben R. Martin and John Irvine* (Pinter Publishers, London, 1989) pp.ix + 366, ISBN 0 86187 510 9

With the rise to critical importance of research and development (R&D) and intellectual capital in the economic cycle and international competitiveness, there has been a dramatic increase in the level of the competition to develop, capture and apply these intellectual products. Many of the changes that have been occurring in the structure and management of the research system can be explained in terms of response to these increasing levels of competition.

Thus, if research is critcal to economic performance and the level of competition to develop and capture exploitable knowledge is high, it becomes important to attempt to identify the areas and types of knowledge which are most likely to lead to substantial economic returns. This has led to substantial investment in attempts to identify research areas of potentially high pay-off, through forecasting and foresight activities.

Because of the high level of competition for appropriate research results, the potentially high returns to be obtained from their application, and the high resource cost of producing exploitable research results ahead of the competition,

there is a need to concentrate the resources skill, infrastructure and money in areas with a high estimated return. This has led to the development of priority-setting.

The intense competitivenss requires that the research process be managed in way that maximises its efficiency and productivity. This has led to the emergence of new structured methods of research and management, based on more explicit *a priori* goal and milestone-setting, careful monitoring of progress towards the designated milestones, and a regular review of the continuing appropriateness of the goals.

There is also a need to review, after projects and programs have been completed, how effective they have been in achieving their goals and what lessons can be learnt to achieve more effective management of future projects. This has led to the development of explicit techniques for formal research evaluation and of performance indicators which can be used to assess regularly research performance.

The effective production of potentially valuable research results is, of course, not sufficient to produce economic returns. This process is seen as being so critical in the research-production cycle that a range of new mechanisms and management techniques have been developed to ensure effective linkage and rapid transfer between the two stages. There is continuing experimentation in the development of new and more effective linkages of knowledge production and knowledge exploitation within firms, between firms and across the public/private sector boundary.

Finally, the value of exploitable research is such that it has become even more important to seek to capture all the benefits of investment in research. This has led to defensive measures, such as increased intellectual secrecy, restrictions on publication, and more extensive intellectual property protection.

The most extensive analysis of the development, the characteristics, the achievements and the limitations of forecasting and foresight in science has been conducted by Ben Martin and John Irvine from the Science Policy Research Unit at Sussex University. In two books, *Foresight in Science: Picking the Winners* (1984) and *Research Foresight: Priority-Setting in Science* (1989) (also released as *Research Foresight: Creating the Future* by the Netherlands Ministry of Education and Science), they have examined in some detail the development of research foresight and priority-setting in eight countries — USA, France, FRG, Japan, Australia, Canada, Sweden and Norway — the only notable omission being the UK.

Perhaps the most important theme which emerges is the significance of the shift from rationalistic predictive forecasting to the construction of 'foresight' and 'anticipatory rationales'.

> Anticipation or foresight involves an explicit recognition that the choices made today can shape or create the future, and that there is little point in making deterministic predictions in spheres (including science and technology) where social and political processes exercise a major influence. (*Research Foresight,* p.4)

They describe foresight as a process by which one comes to an understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making.

To paraphrase Martin and Irvine (pp.5-6), the special features of foresight are that:

- it is a process rather than a set of techniques;
- it is concerned with creating an improved understanding of possible developments and forces likely to shape them;

- its aim is to outline the range of possible futures arising from alternative sets of assumptions about trends and opportunities;
- it provides a means for clarifying the scope for current action and implications for potential developments;
- it requires a holistic approach;
- the process should be transparent to allow the underlying assumptions, data and analytical frameworks to be scrutinised; and
- any single analysis is limited and hence a set of complementary approaches should be adopted.

The basic inputs to foresight with regard to research are: awareness of potential research opportunities, likely trends in socio-economic needs and demands for research, national strengths and weaknesses in R&D, and the domestic capacity to exploit the results of research (p.2).

Foresight processes and techniques are at a fairly early, immature stage of development. The majority of the reports are descriptive, portraying a variety of experiments, each one deeply embedded in the cultural and institutional history of the particular nation. Empiricism dominates in a context where theory apparently has very little to offer.

The generalisations which Martin and Irvine are able to offer, reflecting on this range of disparate experience, are largely of the organising, classificatory type which mark the early development of scientific fields. Thus, a typology of the key features and distinguishing characteristics of research foresight is constructed, with seven different dimensions (p.28). Likewise, the structure of the foresight process is analysed, and a complex flowchart, involving twenty distinct elements, is presented. This is not a criticism of Martin and Irvine's analysis, still less grounds for off-hand rejection of research foresight as invalid, resting on dubious assumptions, or of limited value. Rather it serves to emphasise the early stage of development of the theory and practice of research forersight. Two important implications follow: first, the need to develop and enrich the practice, the assumptions and the theoretical underpinnings of research foresight; second, the need to apply research foresight with considerable caution, not demanding too much too soon from its emerging, but immature structure.

There are considerable grounds, therefore, for caution in the development and application of research foresight. However, the conditions of immaturity can be overcome through the development of effective mechanisms of quality control, and the attraction of interest, and intellect, to the field. There are various signs of emerging institutionalisation, such as specialist conferences, journals and even professional associations emerging, which give promise for the achievement of maturity.

Nevertheless, and allowing for the fallibility and arrogance of immaturity, there are useful insights, and a powerful momentum, arising from various national experiments with, and experience of, research foresight. Thus, from Japan, whose culture and tradition of consensual decision-making has facilitated the strongest development of research foresight, there emerges the importance of developing organisational structures which reconcile the tension of top-down versus bottom-up foresight processes, of integrating the views of interested parties and the results of systematic analysis, and of encouraging the development of an effective division of labour.

The French have recognised, after a long period of learning, the importance of developing an effective infrastructure for 'anticipatory intelligence' and the means to achieve and use it. Foresight and evaluation need to proceed hand in hand, each complementing the other.

Countries with less experience of consensual decision making, such as Australia and Canada, emphasise the development of a foresight culture, relying on systematic approaches to research policy, incremental introduction of foresight strategies, and the importance of an independent broker in achieving acceptance of the results of foresight. In contrast, in a small country like Sweden, with a long tradition of planning, the emphasis is on global monitoring and development and use of early warning indicators. Finally, the pluralist nature of US political and research institutions has not prevented intense efforts to identify research opportunities, but these activities have not been closely integrated with policy-making or budget-setting.

Martin and Irvine (p.335) conclude that *"authority, legitimacy and credibility* are fundamental to success in foresight." But without a culture that supports the political and intellectual assumptions, little success is likely to be achieved. A hostile culture nourishes those self-fulfilling prophecies that nothing can be done about the future. The essence of the combination of foresight with supportive culture and organisational structures is captured in the conclusion.

> a policy of *nurturing the scientific winners* offers a rather better chance of success than one merely emphasising picking the winners. (p.ix).

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Marshall McLuhan: The Medium and the Messenger *by Philip Marchand* (Ticknor & Fields) pp. 320, US$19.95

Although his ideas were never without scorn in many sectors of North America's academic community, Marshall McLuhan is perhaps the most famous communications scholar of the last 30 years. The Canadian professor was a master of the aphorism — the short, pity statement or maxim — the most well known of which are "the medium is the message" and "the global village".

Through his books, lectures and aphorisms, McLuhan sought to show that a key to understanding contemporary society is by analysis of the mass media. The medium is the message as far as modern communications media (especially television) influence our attitudes to social reality almost as much as the messages they carry. And the world is a global village, according to McLuhan, if we understand that modern communications networks and mass media connect and influence human beings in ways unlike at any time in human history.

Philip Marchand's *Marshall McLuhan: The Medium and the Messenger* is a scholarly, well written biography which explores not only the life history of the scholar but also the forces that went into moulding his many influential and controversial ideas. Ignorance of McLuhan's (now difficult-to-find) published work should be no excuse for not reading this book, in fact it is a most worthy introduction for all neophytes of the now expanding area of Social Science which is now respectably called on North American campuses "Media Studies" or "Cognitive Science".

Three major themes thread through Marchand's book.