

Book reviews

R.K. Jain and H.C. Triandis: Management of Research and Development: Managing the Unmanageable (2nd edition), Wiley, New York, 1997, 316 pp. (£39.95)

According to the authors this book is aimed at those involved with managing research in both private and public sectors. The focus on practising manager is reinforced by the stated assumption that even if readers have previously been exposed to the ‘behavioral sciences’ whatever they learned will have ‘long since have been forgotten’ (xvi). As well as practitioners, the book should be of interest to those responsible for courses related to R&D management. This does not mean that the focus is narrow as the authors deal with topics ranging from individual motivation and strategic planning to science policy. Given such a broad scope it is inevitable that many issues are dealt with in a rather cursory manner. I also found that the referencing was less rigorous than would normally be the case in a book written for an academic audience. For example, in the early chapters there is constant reference to the value of organic structures vis a vis mechanistic forms of organisation—but the work of Burns and Stalker (1961) is not mentioned.

Following a useful introduction to the topic of R&D management the next five chapters concentrate on the individual by examining job design, attitude change and motivation. Each chapter concludes with ‘questions for class discussion’ and a guide to further reading. The way in which the authors view the world is illustrated by the following statement: “The kinds of people who are most likely

to succeed in an R&D organisation are those who are analytical, curious, independent, intellectual, and introverted and who enjoy scientific and mathematical activities” (p. 22).

This stereotypical view of scientists is then reflected in suggestions for job design. Autonomy, variety, task identity and feedback are linked to ‘satisfaction’ but there is no attempt to establish whether or not these factors contribute to R&D output. Presumably, those responsible for managing R&D will primarily be concerned with efficiency and effectiveness rather than the level of individual job satisfaction. Furthermore, it is stated that ‘publishing is vital’ (p. 70) to scientists and that they have ‘a tremendous need for autonomy’ (p. 71). However, there is no attempt to justify such claims which are based on a traditional view that R&D scientists operate as autonomous professionals. An example of the lack of rigour is provided by the authors’ assertion that ‘commonsense suggests satisfaction results in high productivity’ (p. 103). In chapter 6, a model of motivation is introduced in which ‘the probability of an act’ is dependent on habits and behavioural intentions. The origins of the model are extremely vague but it is claimed that there are ‘numerous studies which support this formulation’ (p. 104) although neither of the two examples mentioned are related to R&D employees.

Chapters 7 to 10 focus on managerial issues such as dealing with diversity, leadership styles, managing conflict and performance appraisal. Diversity is certainly a topic which should be taken more seriously by those concerned with the management of R&D. As the authors point out, we now live in a world in

which multi-cultural societies and global communications are part of our everyday lives. At the micro level, heterogeneous groups are considered to be more creative and less predisposed towards group-think than homogeneous groups. Conflict is another topic which has received very little attention in the R&D literature. Issues related to the group-level conflict between R&D and those in marketing, accounts and strategic management are discussed from a socio-psychological perspective. Although the importance is weakened by an assumption that such issues can be settled by means of a 'conflict resolution grid'. Chapter 8 utilises Fidler's model to help managers identify their 'leadership style' but again there is little evidence to indicate this approach is particularly relevant to R&D. Performance appraisal is dealt with in a fairly cursory manner as illustrated by the assumption that it is a function of 'ability $\times$ motivation' [$P = f(A \times M)$]. I also felt that it would have been logical for this chapter to have immediately followed the sections on job design and motivation.

The final four chapters deal with such issues as technology transfer, organizational change, university research and strategic planning. The links between technology transfer and research in universities are acknowledged by the authors particularly with regard to the role of science parks. However, I felt that separating these topics with a chapter on change management was an unnecessary distraction. At the same time, I commend the authors for stressing the importance of managing change in R&D organisations and of linking technology management to strategic planning. A study by Roberts (1995) is quoted which suggests that the CTO (chief technology officer) is a member of the main board in 95% Japanese companies compared to only 20% in the US: 'this figure presents the strongest damnation of US senior executive practice and prioritization' (Roberts quoted on p. 255).

The book does represent a serious attempt to introduce practising managers to a wide range of problems associated with managing R&D. However, this diversity means that many issues are dealt with at a superficial level: change management and strategic planning are both discussed in approximately eleven pages. Secondly, there is no recognition of the way in which outsourcing is revolutionising R&D

management. For example, Whittington (1990) identified a trend towards the 'fragmentation' of R&D in the UK as extramural R&D grew in importance throughout the 1980s. My own research indicates that the outsourcing trend has continued and extramural R&D rose from 5.5% of intramural spend in 1989 to almost 16% in 1994 (Jones, 1997). Such a change is highly significant for R&D because the traditional problems associated with professional employees, referred to in the title of this book, are resolved by marketisation. A final caveat is that the authors do not present any primary data nor do they offer insights from their own experience of managing R&D. In fact, there is far too much reliance on the classic work of Pelz and Andrews (1966) to support their many assertions about the problems of 'managing the unmanageable'.

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References

- Jones, O. (1997). From Post-it Notes to Post-Modernism: Organisations, Innovation and Virtual R&D. *Aston Business School Research Paper*, RP9733.
- Pelz, D.C., Andrews, F.M. (1966). *Scientists in Organizations: Productive Climates for R&D*. New York, Wiley.
- Roberts, E.B. (1995). Benchmarking for the Strategic Management of Technology. *Research-Technology Management*, 38: 1, pp. 44-56.
- Whittington, R. (1990). The Fragmentation of Industrial Research and Development, In: A. Pollert (Ed), *Farewell to Flexibility*, Oxford, Blackwell.

PII S0048-7333(98)00069-9

Review of: The Human Side of Managing Technological Innovation Ralph Katz (ed.)

It is very hard to do justice in a short review to the wealth of management knowledge, information, ideas, tools, frameworks and methods presented in

this lengthy book (618 pages). I will stick to a brief review of the aims of the book, the contents and possible criticisms (particularly omissions).

The book's overall aim is to reconcile the dual challenge facing innovating firms in today's turbulent markets: (a) the need to achieve operational efficiency, including profit, cost and sales targets in current markets with (b) the need to innovate effectively for the future, to develop the next generation of technologies, products and services. The main focus of the book is on how to deal with the human side of the problem. How to motivate, manage and understand the individual technical professionals, groups and crossfunctional teams essential to effective innovation within the firm. As such, the book deliberately does not deal with corporate strategies for innovation, but focuses on the world of human issues within the firm.

The book is a panoramic collection of 51 papers dealing with different aspects of innovation in the firm. Section 1 examines performance management, motivation, work environments, individual creativity, and overall R&D and engineering vitality. Section 11 looks at the formation and management of high performance teams through the use of case studies (including DEC's Alpha design team), how to avoid insularity and rigidities in older teams, and how to deal with managing groups and projects in different types of organisations, including functional, project, and matrix organisational structures.

Section 111 looks empirically and theoretically at the different leadership and managerial roles that technical professionals play during the innovation process. This section addresses various problems encountered as technical professionals move from functional specialist to manager, attempt to manage organisational improvements and champion innovation in different cultures. Section 111 contains the famous 'intrapreneuring' idea in an article by its originator, Gifford Pinchot 111 (Chapter 26).

Section IV examines how organisational structure and culture can influence the behaviour of technical people, emphasising the differences between science and technology, research and development and how 'technical gatekeepers' can help communicate across technical cultures. Section IV also includes the well known case of 3Ms Post-it Notes (Chapter 33) and the 'Skunkworks tale' by Tom Peters (Chapter 31).

Section V looks at how organisational processes and practices affect innovation, dealing with decision making in routine vs. non-routine activities, fast vs. slow decision takers, the use of accounting systems to *assist* innovation [for a change], human resource diversity, reward and promotion. Section V also examines the issue of how best (and how best not) to try and reduce product development cycles.

Finally, Section VI examines how innovation links to other processes and functions within the firm, including three articles on the R&D-market interface. Section VI also presents three different perspectives on innovation, including the role (positive and negative) of users in the innovation process (by Eric Von Hippel, Chapter 49), possible conflicts between product and process innovation over the course of the product life cycle, and a summary paper on what the field thinks it knows about managing invention and innovation by Edward Roberts.

Regarding weaknesses, all except one of the authors are US or US-based and (consequently?) the book is heavily US-oriented (there is just one paper on Japan, Chapter 8). Questions might be raised as to the applicability of the arguments, assumptions and values to other countries and cultures, say Korea, Austria, Ireland or China. Indeed, in Chapter 27 Scott Scane makes the point that "managers [and analysts] cannot be ethnocentric and always apply American championing styles, as these approaches are likely to be rejected where they are culturally inappropriate" [p. 303]. (Chapter 36 makes the same point, p. 400). I add the words "and analysts" after "managers", noting also that Scane's point goes far beyond the issue of championing styles. The limitations of the US approach in other cultural contexts (especially Europe and Japan) is dealt with convincingly by John Kay in his critique of US management orthodoxy (Kay, 1993).

Another possible criticism is that most of the papers implicitly assume that the firms in question are large (or medium sized) and are either leaders, close to the leading edge or have pretensions in that direction. As such, the book does not deal with the 'rest of the iceberg' but focuses on the tip. Small firms are not dealt with, despite the huge number of small firms which: (a) operate at the leading edge of innovation; (b) work in support of large innovative firms; or (c) fall into the 'rest of the iceberg' cate-

gory. Small firms face very different innovation management problems from large firms. The focus on large US firm issues also precludes consideration of the many 'latecomer' firms in East Asia which operate (some very effectively) from behind the technology frontier, mass producing relatively simple products. These firms also innovate, but in a very different way from the US leaders the book focuses on.

A further omission is the absence of a sense of the importance of the nature of the product. What you make has a great bearing on how you make it, and how best to make it. For example, a firm making one-off high cost complex products (e.g., a flight simulator) for business users faces a very different set of challenges from a firm producing biros, digital watches or cars for mass market consumption.

These omissions do not add up to a major criticism of the book, or the papers contained, but they do suggest the scope of the book to the potential reader. Overall, the book is a useful and important collection of papers and will be of interest to scholars in the US and abroad. The issues dealt with are very important ones and, to my knowledge, this is the only major collection of papers on the 'human side of innovation' yet collected. Most of the papers are of a high quality and some are by leading US scholars in the field. The book is enriched by contributions from industrial leaders (e.g., GE, Chapter 11 and 3M, Chapter 16) as well as consultants (e.g., McKinsey Chapter 15 and Arthur D. Little Chapter 33). Overall, an extremely useful text of interest to practitioners in business, engineering and science as well as advanced undergraduates, MBA students and researchers in the field of science, technology and management.

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May 1998

References

- Kay, John, 1993. *Foundations of Corporate Success: How Business Strategies add Value*, OUP.K.L.R. Pavitt

Jacques Gaillard; V.V. Krishna and Roland Waast (eds.), *Scientific Communities in the Developing World* (New Delhi, Thousand Oaks, London: Sage Publications, 1997), 398 pp.

Traditionally treated in block, the scientific communities in the diverse developing countries of the world have been often looked at and referred to as being one and the same thing. From this point of view, this book is a great advance. In a well-crafted editorial introduction, Gaillard, Krishna and Waast acknowledge from the very beginning the impossibility of 'treating the developing world as a homogeneous entity' (40). Accordingly, they spell out the objective of the book as 'merely to contribute to a better understanding of the conditions under which scientific communities emerged, developed and are often struggling to sustain their activities' in the developing world. Being well aware of the problems inherent in an enterprise of this type, the editors are quite modest in their intent and, realistically, do not promise to draw far-reaching theories or generalizations about the topic.

The strategy devised was to select papers presented in previous workshops and extend invitation to established scholars so as to cover the most significant scientific countries in the South. The volume is divided into three parts, respectively entitled *Scientific Communities in Africa*, *Scientific Communities in Asia* and *Scientific Communities in Latin America*. Each part examines specific countries, presented as chapters—seven countries in Africa, three in Asia and three in Latin America.

It is fair to say that the essays are uniformly of high standard at the same time that they are very different from each other. Such differences may be attributed to a number of factors. First of all, the contributors have drawn from a wide range of disciplinary backgrounds—including history of science, sociology of science, innovation theory and science policy—although they may all be said to pertain to the general field of science and technology studies. This is easy to be seen in a comparison, for example, of the chapter on Venezuela with the one on South Africa. The former, *Science and Production in Venezuela: Two 'Emergencies'*, by Rafael Rengifo, Arnoldo Pirela and Rigas Arvanitis, focuses the analysis on the relations between science and production,

drawing heavily from the literature on the economics of innovation. As for the latter, Jean-Baptiste Meyer's essay, entitled *Science and Technology in South Africa: a New Society in the Making*, provides a useful example of the importance of some recent theoretical work in the sociology of scientific knowledge to the understanding of science on the periphery.

Differences in the contributions can also be due to the diversity of the authors' work experiences and national origins. Thus, the chapter on Argentina, for example, was written by Hebe Vessuri, probably the best known Latin American scholar in the field of science and technology. Her essay is a vivid account of the institutionalization of the scientific profession in Argentina, reaching its highest point in her discussion of the period from 1945 to 1976, with moments of apparent personal reminiscence. Others, like the one on Kenya and Thailand, were authored by Thomas Eisemon and Charles Davis (the one on the Thai scientific community had also the collaboration of Jacques Gaillard), who are both a mix of academics and policy-makers, none of them a national of the country they analyse. Both chapters are elegant, informative and denote considerable expertise of the authors, as well as detailed and rigorous data collection. Far from saying that such different backgrounds produced essays of higher or lower quality, the argument is that work experience and national origin do influence perspectives and insights.

Besides the authors' disciplinary preferences and backgrounds, differences between the various essays probably derive from the existence of previous research and availability of information for each country. Thus, the chapter on Brazil, by Antonio Botelho and Simon Schawartzman, is actually a synthesis of former work mostly of the authors themselves. Little quantitative information is presented and there is no preoccupation in theoretically framing the account which is very much a summarised description of facts described and analysed previously. This is certainly not the case for the African countries contained in this book. For most of them the essays here are the very first approach to the study of their scientific communities, something which stands out from a quick look at their list of references. Given the novelty of the studies on Africa, the editors made the right choice in representing this subcontinent

with a larger amount of countries as compared to Asia and Latin America.

Such diverse essays combine to make the end result something more than the sum of its component parts. Given the opportunity of reading the material together, and not piecemeal as is the case with journal articles, it is possible to appreciate the similarities and differences of the questions confronting the scientific communities in the developing countries. This is certainly a first and necessary step toward producing a body of concepts which may, in the future, guide scholarship on the topic.

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May 9, 1998

PII S0048-7333(98)00070-5

Helga Nowotny and Ulrike Felt, After the Breakthrough, Cambridge University Press, Cambridge, 1997, 210 pp

The discovery in 1986 of a new family of superconductors, the copper oxides, brought an unexpected revival to a rather declining and disappointing scientific area of materials science and started a wave of enthusiasm among scientists.

These so-called high-temperature superconductors were discovered by K.A. Müller and G. Bednorz at IBM Zurich, who received the Nobel prize in 1987. It was considered a great breakthrough which opened the gate to important technological applications in a great variety of fields such as energy, microelectronics, medical instrumentation, etc. A few months after the discovery of the superconducting properties of the 'Zurich oxides', other materials were shown to be superconductors at a higher temperature, which

seemed to confirm that the breakthrough was real. The possibility of having superconductors at room temperature seemed feasible.

Helga Nowotny and Ulrike Felt have reconstructed the history of the discovery and analyse the characteristics of the emergence of a new research field: the role played by the various actors (academic laboratories, national institutes, industry), the launching of national programmes to support the research activities, the role of the international press. The two authors have carried out an inquiry into laboratories (mainly in Germany, Switzerland, Austria and the Netherlands) and science administrations, based on 70 interviews. They have analysed press articles in international journals. This gave them a fairly clear picture of the evolution of the scientific and industrial situation during the months and years following the discovery of high temperature superconductivity.

One may wonder why such a scientific event was at the origin of an unprecedented wave of excitement and expectation within the scientific community and in the international press whereas the existence of superconductivity had been known since the beginning of the century. There are indeed a couple of factors which, according to the authors, can explain this phenomenon.

Helga Nowotny and Ulrike Felt show that part of the excitement generated by high-temperature superconductivity came from the feeling that this new area reopened the possibility of developing 'non-planned' scientific research as the discovery was largely unexpected, in an area which was supposed to be on the decline. Although K.A. Müller and G. Bednorz were working in an industrial laboratory, they were quite isolated while conducting a systematic research programme against the mainstream of scientific opinion in the field. Their discovery was thus considered by the scientific community as an event which reopened new scientific possibilities and new funding for their activities as if the 'endless frontier' of science had reappeared. The authors describe the strategy of the various actors to mobilise institutions and governments to launch crash programmes so as to get funds to develop the research activities in this new area. The press played an important role in putting the pressure on decision-makers in government and industry so that they reached rapid and favourable decisions. The United States was quick to react,

whereas European Governments were rather slow to be mobilised.

The authors rightly show that a second kind of factor also explains the considerable interest which arose from the breakthrough. Scientific knowledge production has moved since the eighties into a rather new context of applications: there is now almost a continuum between science, technology and the economy which are increasingly interlinked through networks of academic laboratories and industry. Scientific excellence is one of several criteria to decide upon funding research activities in the academic world: there is presently a market for scientific knowledge and basic science is incorporated in the discourse on technology and economic growth. Furthermore, science and technology are considered by governments as assets to achieve industrial competitiveness in world markets. In these conditions our authors rightly point out that the situation was ripe for the merging of basic scientific and technological research agendas in this new area of materials science. The international press echoed forecasts of potential revolutionary technical applications of high temperature superconductors which, in some cases, were just wishful thinking.

Helga Nowotny and Ulrike Felt's book is a very clear story of a scientific discovery and its impact on science policy. It gives an account of the scientists' motivations of the reactions of research institutions and of governmental authorities, of the interplay between the scientific community and the press. One might regret that they did not include France in their inquiry, as the scientific community in that country had been quite active in the field (French chemists 'missed' the breakthrough) but this would not have changed their conclusions. Similarly, as they rightly pointed out that industry was rather 'cool' in supporting the new domain, its strategy and motivation would have deserved a more thorough analysis. Scientists will read with interest this book which gives an accurate picture of scientific activity in an area different from 'Megascience' and which addresses important issues such as the role of the individual creative act in scientific research and the conditions for the exploitation of discoveries. Policy-makers will have a similar interest in reading this book which is a case study of policy-making for science and technology where the role of the actors in anal-

ysed. The clarity of the style is not the least quality of the book, which renders it accessible to all readers interested in science and its applications.

15th April 1998

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PII S0048-7333(98)00071-7

René A. Belderbos, Japanese Electronics Multinationals and Strategic Trade Policies. Clarendon Press, Oxford, 1997, 404 pp., ISBN 0-19-823332-9.

This dissertation consists of three parts: The first part gives an overview on trade policy and the internationalisation of Japanese electronics firms. It is a relatively pragmatic approach to systemise the latest history of Japanese multinational companies in general and their attempts in internationalisation. Generally, mainly four reasons for the direct foreign investments (DFI) of Japanese companies are given: DFI increased (1) in order to avoid import restrictions or anti-dumping, (2) to acquire specific technological skills, software and access to markets, (3) to create regional core networks, and (4) to adapt the organisation and management to the internationalisation strategies. For these developments, many interesting statistics and detailed examples are analysed. In spite of the difficult matter, the chapter titles are well organised. But in the subtitles, a mix of historical approach and definitions together with sometimes too many details confuse the reader to a certain extent, and make it difficult to follow the explanations.

The second part of the book consists of theoretical essays on strategic trade policy and Japanese electronics firms. Belderbos warns his readers in the introduction that for this chapter a certain knowledge of oligopoly theory is necessary. This is true. He reviews the existing theory and analyses the example of the colour television industry on the basis of this theory and develops a model of international rivalry. The chapter is illustrated by stylised facts on the case

of 'Matsushita vs. Zenith' which gives many insights and illustrate the theoretical part. Although the model is explained in detail, a list of *all* abbreviations close to the model (most of them are standard but some readers might want to understand the model and do not have them in mind) would have been helpful.

The empirical essays in the third part also require a deeper understanding of statistical methodology. As the book is a dissertation, all variables, definitions and results are described in detail and with many tables. For the specialist reader, this is necessary. For the quick reader or those who are not experts in statistical analysis, these parts of the chapter are 'superfluous'. In the conclusions of the chapters, the main results from the statistics are worked out very well, so that the inexperienced reader understands the connection between thesis and analysis very well without going through the statistics.

With this book, the connection between internationalisation of Japanese multinational companies, their direct investments in the EC or the US and anti-dumping tariffs is shown for the first time. For a proof of all his hypothesis, not all necessary data are available, but the available ones are already convincing: 'tariff jumping' was a fact in Japanese electronics enterprises, meaning that if anti-dumping tariffs were feared, this was regarded as an incentive for direct investment. Japanese companies are not different from other companies in this respect. The incentive was higher in the EC than in the US because in the US, the tariffs could be avoided by raising export prices. In the EC, the tariff would be fixed for 5 years. The later 'local content rules' increased the costs for investments but the Japanese companies' reactions were to produce more components in-house at EC factories and to build up their own local networks.

Belderbos comes to the conclusion that with the EC measures, there was a clear discrimination against Japanese firms in favour of EC rivals and that the anti-dumping may rather have postponed EC firms' rationalisation and ultimate transfer of production to lower cost locations. The potentially negative welfare consequences are directly apparent. That means also that tariff policy is less effective as a profit shifting instrument. The reader asks himself why among the Japanese firms only the electronics companies are examined so often. Pragmatically, because

they are the most internationalised and data are available about them. But that also raises the question if the conclusions are also true for other companies. And what should the European Union do in future cases, not only concerning Japanese but other countries' companies.

The book can be highly appreciated as an approach to empirically showing the correlation between assumptions that were used like 'clichés'. It also proves that Japanese companies are not different from others—they calculate economically without any conspiracy behind. Although it is very difficult to understand all parts of the book and to follow all different arguments, for the specialist it is a very valuable piece of the puzzle in understanding international trade, tariff policy and investment behaviour.

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PII S0048-7333(98)00068-7

The Dynamics of Technology, Trade and Growth—Edited by J. Fagerberg, B. Verspagen and N. Von Tunzelmann, Edward Elgar, London

This engaging and stimulating group of essays are drawn from the proceedings of a conference, the purpose of which was to address the oldest, and once again fashionable, question in economic studies; namely just why it is that the growth in the wealth of nations so dissimilar? This is a question on a grand scale and the contributions to this volume are all sensible enough to realise that it admits of no easy answer. Moreover, while localized pools of light can be shone by rigorous analysis or by detailed empirical investigation they perhaps do little more than amplify the magnitude of the exploratory task. Thus this book is open and refreshing in the several ways it deals with our (still) substantial coefficient of ignorance.

Let me introduce the essays, not in the order that they appear but in relation to their broad approach.

Abramovitz's essay is a clear summary of his views on the degree to which the USA has maintained its lead in wealth creation and the reasons to be adduced by way of explanation. Foremost among these are the historical specificities of biased technical change, reflecting a resource rich, rapidly growing but homogenous North American market, advanced organizational and managerial methods, and social capabilities as reflected *inter alia* in commitments to education, high propensities to save and public support for investment. All of this is clearly articulated within a framework that distinguishes the potential for productivity advance from the ability to realize that potential. That the measurement of convergence and divergence is something of a 'mare's nest' is made rather too clear in the papers by Wolff and by Beelen and Verspagen. For Wolff, the message is focused on differences in productivity growth and the change in the age of capital assets of various kinds, for Beelen and Verspagen it is upon the difficulty of deciding who converges/diverges in relation to whom and on the significance of more disaggregated treatments of the phenomenon. This last aspect of their work is particularly welcome and allows them to begin to address the relation between trade convergence and productivity convergence. The formidable data difficulties notwithstanding both these papers succeed in making clear just how careful one needs to be in addressing the convergence issue and how conclusions are contingent upon the 'club' of countries in view. That more micro/sectoral analyses of comparative performance are highly appropriate, and in short supply, is exemplified by Freeman's fine discussion of the ICT revolution in relation to Japan and the Asian Tigers. Despite recent macroeconomic and monetary events, the message that their sectoral and national innovation systems are geared to rapid catching up, and less clearly forging ahead, remains as sound as ever. The point of all this is to insist that catching up involves positive choices and that imitation is not neutral osmosis but involves of itself active innovation.

The theoretical contributions to this volume are equally compelling. Vega-Redondo's graph theoretic essay is a particularly appealing way of modelling open-ended stochastic processes in which time genuinely flows in one direction only. The finding that the length of a diffusion lag determines the likeli-

hood of convergence or cumulative divergence is perhaps intuitive but no less compelling for that. The point is simply that different dynamic properties result in different historical paths without any reference whatsoever to some underlying notion of equilibrium. This is precisely what evolutionary processes depend upon and it remains only to see if the apparatus can be generalized to more complicated models in an aesthetically appealing fashion. Using a quite different approach Cinoli presents an integrated model of trade, growth and technical change bringing together the chain of comparative advantage, Kaldorian technical progress functions, demand patterns and instituted dynamic wage setting processes. Of course, many outcomes are possible but that is precisely the point, do not expect any simply relationship between growth and international specialization. This is a proper treatment of endogenous growth in which production functions give way to technical progress functions and cumulative learning, Adam Smith would have seen the point immediately. The final paper, by Reinert, an activity specific viewpoint on catching-up, was, for this reviewer at least, the most engaging of all. It is a paper firmly in the Smith–List tradition, full of insights and references to past literature, the identification of which once again establishes foundations for new work within non equilibrium approaches. This is not mercantilism in any narrow sense but rather the explicit awareness that comparative advantages are not natural but are created by human agency. Only the preposterous idea that all nations draw upon a common pool of knowledge and capability at all times can explain why Reinert's question of the 'choice of economic activity' has not received the attention it deserves.

This is an all too brief conspectus of a rich set of essays, what is to be made of the package overall? I think the first conclusion is that they confirm the inherent wisdom of a broadly evolutionary perspective in relation to growth. Convergence and divergence are inherently matters of variety in performance and changes in the differences between countries, they are naturally evolutionary phenomena. However, even a nodding acquaintance with Schumpeter warns us that they are not best handled from a macroeconomic perspective. Macroeconomic aggrega-

tion simply averages away the consequences of change, such measures, even leaving issues of quality measurement aside, do not capture the richness of micro and structural change which is the leitmotif of development in capitalism. Thus we are likely to understand more if we focus at the sectoral level and engage in comparative work on what is happening within sectors. Moreover, one needs to comprehend the exact rules of aggregation which shape the emergence of macro phenomena, those same rules which simultaneously smooth away the evidence for evolutionary processes. Finally, this volume makes a strong case for treating growth as an instituted economic process, to use K. Polanyi's neat phrase. Firms and other organisations do not act in isolation they are embedded within wider matrices of formal and informal institutions which are essential to the understanding of sectoral change, and these institutions themselves evolve and develop over time. This, of course, is the point behind the innovation systems perspective. If, for example, we are to understand the emergence of novelty, the pattern of selection, the interdependence between service innovation and artefact innovation then the interpretation and overlapping of market and non-market institutions becomes the key conceptual and empirical issue. This, I think, is the import of the introductory essay by the editors. It is a good vantage point from which to develop our understanding of the old questions but not by economic analysis alone.

In this regard, perhaps we have missed an opportunity of significance. To develop a more comprehensive understanding of growth we need to understand more the intertwining of the economic and the social in relation to decline, not expansion. No doubt the study of the great economic extinctions of the 20th century in Western Europe, coal, cotton, ship-building will have much to tell us about how these same economies have experienced growth with transformation.

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1 June 1998

PII S0048-7333(98)00073-0