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Books

Unesco surveys the globalization of science and technology

Jacques Richardson

Unesco Science Report 2005 **edited by Susan Schneegans**
Unesco Publishing, Paris, 2005, ix + 274 pages, €44.00, ISBN 92-3-1039967-9 (French edition later in 2006)

Readers may not at first recognize the latest transformation of the former quarterly journal *Impact of Science on Society*, published in Paris (1950–1993) by the United Nations Educational, Scientific and Cultural Organization (Unesco). After three book-length editions of an intervening biennial, *World Science Report* (last published in 1998), the newest version has just made its appearance in the UN's science-agency output. The volume looks a winner among the UN system's many specialized publications.

What this book sets out to do, and what it accomplishes most pleasingly, is to catalogue — by region or country — how science teaching and research and development are organized, how and with what they are done, and with what semblance of priority where this can be established. Independent specialists from different world areas are the authors of authoritative contributions, with texts, statistics and supporting graphics collated intelligently into a single, coherent and highly useful study. Unesco has produced, in effect, an almanac of world science — the whole introduced by a 24-page Introduction researched and written by theoretical physicist Peter Tindemans of Global Strategies and Partnerships, a consultancy in the Netherlands.

As one would expect, the Report rightly makes much of the economic factor known as the gross expenditure on R&D (GERD), a percentage of gross domestic product (GDP) that has slowly slipped in value in Europe and North America during much of the past decade, but risen significantly in Asia (27.9% in 1997, overall, to 31.5% in 2002) — a net rise "driven largely by China's dynamism". Yet the report notes, astonishingly, that Japan's share of the world's GERD fell between 1997 and 2002, from 15.2% to 12.8%. The lesson is: keep your science-policy eyes on Asia.

South Asia (which here includes Iran and Mongolia) is covered in a professional overview by V V Krishna and Usha Krishna. They relate that, while 26.6% of the science and engineering students in higher education today are women, the female population in R&D organizations averages only 18.6%. India is moving ahead fast in all respects, however, having had for some years a promisingly high rate of researchers and technologists (women included) emerging from the universities and specialized institutions. While all of this region's countries remain economically dependent on agriculture, the authors foresee "rapid transformation" coming in this respect, in part with the aid of the World Bank and other lenders, during the years 2006 to 2015.

The chapters on Europe, North America and Japan speak easily for themselves. The last, written by social economist Okubo Yoshiko and science-policy expert Kobayashi Shinichi, points out that since the 1990s Nippon has "undergone a paradigm shift from 'science, technology and society' to 'science and technology for society'". As to the Arab world, chronically lagging behind in terms of most scientific advance, zoologist and former Jordanian prime minister Adnan Badran comments that for this zone to "thrive, it must become part of the global knowledge and information society … knowledge-driven and interdependent".

Objectivity, persistence and detail needed

Until the fall of the Berlin Wall, Soviet and satellite science carried on much in the former tradition of

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the Russian 'schools' of science, whereby a mentor of scientific standing fostered paternally his most promising 'candidates of science' (PhD students). Russian contributor Victor Sadovnichy insists that creating "a system enabling development of new knowledge … supported by an inflow of professional personnel" needs to find better ways to "use and implement the results of research into new technology". Although Russia and some of the former Soviet satellites have an excellent corps of prepared students to draw on, co-author Boris Kozlov cautions that "when calculations are made of the ratio of the number of patent applications made abroad to the number of domestic applications … the figure for the Russian Federation is substantially lower than those of the leading countries" in the world's innovation process.

As for Latin America, two women researchers deal exhaustively with the problems there of teaching and using science and technology to advantage. Ana Maria Cetto and Hebe Vessuri, respectively physicist and sociologist of science, sketch the heavy reliance of their countries on outside material contributions to scientific progress. "One of the constraints that cooperation systematically faces", they underline, "is finance, particularly with regard to the possibility of making independent decisions on programme definition".

Things are improving, none the less: nations such as Argentina, Brazil, Chile and Mexico are clearly moving ahead in numerous disciplines and applications. The status of research in the Caricom countries (the Caribbean islands) are treated separately, however, by chemist Ishenkumba Kahwa and mathematician Harold Ramkissoom. Funding in this region remains problematical too, and scientists and communicators are therefore making a special effort in the popularization of scientific and technical progress.

This leaves Africa, beset as it is by persistent problems resulting from poverty, low literacy rates, climate, drastic food-crop failures and epidemics. The region is described objectively (yet most sympathetically) by Mohamed Hassan of the Third World Academy of Sciences, Jacques Gaillard, Roland Waast and Daniel Schaffer. They explain the national strategies being pursued in most African countries:

> sustained investment in education at all levels; long-term government commitment to … scientific enterprise; reasonable and reliable funding; the ability to access the most current scientific literature through electronic communications and ample opportunities to interact with the international scientific community ….

Yet still needed is more "encouragement to compete at the highest levels of excellence …" They might have added that also needed is the political will to allocate to national budgets higher priority for the education of girls and for continuing education in technical disciplines.

In this report, Unesco seems to have overcome in appreciable measure the difficult challenge of collecting reliable statistics, the numerical data adorning the book's many pie charts and tables. This is attributable in large part to the organization's very capable Institute of Statistics, based in Montreal. Your reviewer can only conclude from such an all-perceiving omnibus study — both its numbers and its text — that, rather than science shaping the world, it is the evolving events of the political, economic, social and cultural spheres that increasingly guide and form scientific–technological change in developing as well as in industrialized countries.

Encouraging do-it-yourself innovation

David Bruggeman

***Democratizing Innovation* by Eric von Hippel**
The MIT Press, Cambridge, MA, April 2005, 204 pages (with index), US$29.95, ISBN 0-262-00274-4

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As I finished this review, Steve Fossett broke the record for the longest continuous aerial flight (Gugliotta, 2006). His aircraft was designed by noted aerospace engineer Burt Rutan. Rutan's companies have made numerous innovations in composite manufacturing. His products help users to modify or innovate their own products. Such user-centered innovation is the focus of Eric von Hippel's book *Democratizing Innovation*.

Hippel is Professor of Management of Innovation at MIT's Sloan School of Management and heads the

Innovation and Entrepreneurship Group. This book explores sociological studies of innovations driven by users, rather than manufacturers, of products and processes. Those familiar with the open-source movement in computer science will recognize many of the phenomena described by Hippel.[1]

Most of the material in this book focuses on providing empirical and theoretical depth to the sociological and economic aspects of user-centered innovation, rather than exploring its policy implications. Hippel seems committed to shifting readers' perceptions from focusing on the manufacturer-centered paradigm to including the user-centered model, noting that what works best for the former does not always hold true for the latter.

The kind of democratization mentioned in the title is less the 'one person, one vote' variety and more an 'everyone can run their own factory' version. User-centered innovation means more than the model builder developing add-on components for model kits bought off the shelf. It includes software developments (Hippel cites Linux and the Apache web server program) where users can revise the underlying code to help improve the product or refine it for their particular needs. Hippel also mentions user-developed refinements of high-performance sporting equipment, such as windsurfing boards and sails (page 1-2). In short, user-centered innovations are designed and/or developed by those who will directly benefit from them.

As Hippel sees it, these innovations bridge gaps in the capacity of manufacturers to respond to individual user needs. This capacity is constrained by economies of scale and/or scope. Manufacturers may also lack the knowledge to respond effectively to specific needs.

User-centered innovations usually originate with lead users: individuals or organizations at the forefront of important market trends who can anticipate relatively large benefits from the innovations. User needs are sufficiently heterogeneous that they will often customize products or services for their own use. Lead users may proceed with customization even if a cost analysis suggests it would be cheaper for the manufacturer to make the requested changes. This is because major non-monetary benefits (usually some kind of knowledge) accompany the innovation.

This counterintuitive behavior extends to sharing information. Hippel discusses innovation communities where sharing information provides more benefits than maintaining secrecy. Open-source software provides one example, scientific instruments another. The most important point to note is that a broad user community provides a greater information base for innovation. Those using a manufacturing process for aerospace products (like Mr Rutan) will have different experiences than those using the process for automotive products. Such cross-pollination of information helped automobile manufacturers incorporate anti-lock brakes into their designs (page 135).

Systematic searching for lead user innovations is one of Hippel's recommendations for manufacturers, who must adjust in order to survive increased user innovation. Manufacturers can also develop toolkits to help users facilitate their own innovations (much like Rutan's companies have provided plans and/or parts for kit airplane builders). Such toolkits must allow users to learn through trial and error; otherwise the knowledge generated will be too small to justify the effort.

A similar adaptation would be to develop and sell complementary goods and services. An example from my own research is the geographic information systems industry, which works from satellite imagery generated from public and/or private sources. The base imagery is open-source, but the add-on products and services generate monetary value.

While Hippel spends most of the book defining and explaining user-centered innovation, he devotes chapter 12 of *Democratizing Innovation* to connecting research in this area to other academic fields. User innovation communities share enough characteristics with information communities — groups organized around some kind of information commons — to be considered a subset of those communities. Hippel's analysis is a useful reference point for work in the socio-economics of technology and knowledge, as well as the social construction of technology (SCOT). Hippel argues that lead users factor into Michael Porter's conception of competitive advantage[2] but finds Porter too focused on manufacturers, a criticism he levies against most innovation scholarship.

Chapter 8, "Adapting policy to user innovation", may be of most interest to readers of this journal, though, like chapter 12, it is a minor thread of the book. Innovation policy, like the majority of innovation literature, is focused on the manufacturer. Existing policies either do not address user-centered innovation or do not encourage it. Hippel discusses intellectual property law, and its occasional chilling effect on innovation communities dependent on the free sharing of information. He also addresses policies that constrain the ability to distribute information and modify products. A major challenge in adjusting these policies would be the difficulty of measuring and reporting user-centered innovation, something not generally attempted currently.

Like the innovations of manufacturers, the efforts of users to improve the products and services they purchase contribute to overall social welfare. However, in the same way that Burt Rutan developed new ways of doing business, current practice, study and policy must adapt to an era of increased user innovation. Eric von Hippel's book *Democratizing Innovation* seeks to adjust conventional wisdom; and urges researchers and policymakers to understand and encourage user-centered innovation. A short book, it provides a good introduction to the field, and suggests many opportunities for further research.

Notes

1. Consistent with the open-source movement, this book is available online through a Creative Commons license (this license allows for non-commercial reproduction as long as the original author is credited). For more information, see <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=10805&xid=13&xcid=7690>.
2. For more on Porter's concept of competitive advantage as it applies to this review, consult his books *Competitive Advantage: Creating and Sustaining Superior Performance* (The Free Press, 1985/1998) and *The Competitive Advantage of Nations* (The Free Press, 1990/1998).

Reference

Gugliotta, Guy 2006. Fossett sets flight distance record. *The Washington Post*, 12 February, A18.