Making sense, making money

An enlightened approach to using energy and materials.

Natural Capitalism: The Next Industrial Revolution
by Paul Hawken, Amory B. Lovins and L. Hunter Lovins
Earthscan: 1999. 396 pp. £18.99

Norman Myers

"Oil will become uncompetitive even at low prices before it becomes unavailable even at high prices." So says Amory Lovins, one of the authors of a visionary book that is truly appropriate for the new millennium with its focus on ultra-efficiency of energy and materials. Lovins and his two co-authors postulate that we need to adopt a radical new approach to the way we live with the Earth. The Industrial Revolution enabled us to mobilize natural resources without restraint. Now that natural resources — not just traditional materials and energy sources, but water, topsoil, forests and the climate itself — are being degraded and depleted, we must move towards a capitalism that safeguards the natural resource base that ultimately underpins all economic activities. As the book says: "Nature bats last and owns the stadium."

Conventional capitalism is remarkably inefficient. In the United States, materials used by industry's metabolism every day amount to more than 20 times the total weight of the American population. Yet only one per cent of these materials ends up in products that are still in use six months after being sold, the rest being junked. It would be better to have industrial parks where each manufacturer feeds upon the wastes of others until emissions are finally reduced to zero. This 'industrial ecology' eliminates not only waste, but the concept of waste itself — as is practised by nature with its closed-loop ecosystems.

There are success stories along these lines in Sweden, Denmark, Colombia, Namibia, Kenya and Fiji. The Ebara Corporation in Japan and DuPont in the United States are formally committed to zero waste, and the Asahi Beer Company in Tokyo already recycles 98.5 per cent of its raw materials. Bristol-Myers Squibb claims that the economic benefits of pollution prevention exceed the costs fourfold.

Much the same applies to energy efficiency. The US Energy Star Program enables televisions and videos to achieve a 75 to 95 per cent reduction in the energy used in stand-by mode, which currently costs Americans more than $1 billion a year.

To achieve sustainable economies, we need to reduce our materials and energy intensity (the amount used per unit product) by 50 per cent worldwide. Given that developing countries will be reluctant, let alone unable, to do this for some time, developed nations should aim to cut theirs by 90 per cent. Through numerous examples, the book shows how this can be done while enhancing our quality of life. It also shows why natural capitalism will often generate super profits.

A 90 per cent reduction should not be as difficult to achieve as it might appear. When we learned to substitute coal, machines and technologies for human muscle, we expanded worker productivity 200-fold within half a century. In similar though less significant style, German manufacturers now find they can dispense with 98 per cent of 'secondary' packaging around toothpaste tubes, ice-cream cartons and the like.

The strategy of a 90 per cent reduction in materials is known as 'factor 10'. It is entering the vocabulary of government officials, economic planners, scientists and business leaders around the world. The governments of Austria, the Netherlands and Norway have already committed themselves to pursuing 75 per cent, or factor 4, efficiencies, which means that, by using existing technologies, we could enjoy twice as much well-being while using half as many materials and causing half as much waste.

The same strategy has been endorsed by the European Union as the new paradigm for sustainable economies. Better still, Austria, Sweden and the OECD (the Organization for Economic Co-operation and Development) have urged the adoption of factor 10, as has the World Business Council for Sustainable

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Man's abuse of the planet's biological resources is vividly illustrated by this image, one of 143 pictures featured in the BG Wildlife Photographer of the Year Exhibition at the Natural History Museum, London.

Winner of the category entitled 'The World in Our Hands', this powerful image depicts a slaughtered family of lowland gorillas in Cameroon. The photographer, Karl Ammann, explains that the gorillas were cornered, chased up trees by trained dogs and then shot down. By persuading the hunters to arrange their spoils at the foot of a tree he was able to record the senseless killing. The hunters would probably receive just £30 for the adults. And the babies? Local children would be given them to play with and eat.

The exhibition runs in London until 27 February 2000, with travelling exhibitions touring Britain until February 2001 and an international tour visiting countries including Australia, Germany and the United States. It features a selection of the best photographs in 15 categories, ranging from 'The Underwater World' to 'Urban and Garden Wildlife'. The overall winner, 'Leopard with Rising Moon' by Jamie Thom, shows a leopard resting at dusk, gazing lazily into the camera. *Alison Mitchell*

Development. Leading corporations such as Dow Europe and Mitsubishi Electric see it as a powerful approach for gaining competitive advantage.

Illustrative of the radical new approach is the so-called hypercar conceived by Amory Lovins. Because it would be largely made of advanced polymer composites, especially carbon fibre, it would use one-third less aluminium, three-fifths less rubber, four-fifths less platinum and nine-tenths less steel, and so would weigh only one-third as much, as the cars of today. Thanks to these and other design efficiencies, notably a hybrid-electric drive, it would achieve 140 to 250 miles per imperial gallon, it would be 95 per cent less polluting, and it would be almost entirely recyclable. Hypercars could eventually save as much oil as OPEC (the Organization of Oil Producing Countries) now sells. They would be not so much cars with microchips as computers on wheels.

Other 'techno-breakthroughs' already in view include: diodes that emit light for 20 years without bulbs; ultrasound washing machines that use no water, heat or soap; deprintable and reprintable paper; plastics that are both reusable and compostable; roofs and roads that double up as solar-energy collectors; extra-light materials that are stronger than steel; and quantum semiconductors that store vast amounts of information on chips no bigger than a dot. Fortunately, technological advances are reaching the marketplace faster and faster. In the United States, electricity was taken up by one-quarter of the population in 46 years; the telephone needed 35 years; the microwave oven, 30 years; television, 26 years; radio, 22 years; the personal computer, 16 years; the mobile phone, 13 years; and the World-Wide Web, just 7 years.

We could also derive far greater benefit from biological resources, which so far have been over-exploited and under-utilized. Through what is known in the trade as 'biomimicry', we could draw design inspiration from spiders which, using flies as feedstocks, make silk as strong as Kevlar yet much tougher, and without needing high-temperature extruders. The abalone manufactures an inner shell twice as tough as the best ceramics and diatoms make glass, both processes using sea water and no furnaces.

Over-visionary as some of the book's findings may appear to some eyes, the advance towards natural capitalism is surely as inevitable as it is possible. We live at a time when, by force of environmental circumstance (which is becoming ever more forceful), there is a strong convergence between the idealistic and the realistic. For empirical evidence, check the book's hundreds of "insurmountable opportunities".

We have hitherto sought to exploit the resources of the planet in support of the human cause. Now we need to exploit a human resource — brain power — in support of the planetary cause, and thereby give ourselves an expanded prospect of securing the human cause as well.

Of course, there is a consumerist risk in all this. For example, if the hypercar is so cheap to drive, won't we end up with three or more cars in every garage? And the same with the other 'techno-innovations', leaving us with an overloaded planet once again? To this, Lovins offers another aphorism: "More is better, enough is best." This would be a social revolution indeed — and it would be in accord with the spirit of this inspiring book. ■

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Condensed physics matters

More things in Heaven and Earth: A Celebration of Physics at the Millennium
edited by Benjamin Bederson
American Institute of Physics: 1999. 600 pp. $78, £61

Philip W. Anderson

The cliche about designing things by committee is true. Some appropriate body — perhaps the Council of the American Physical Society (APS) — decided that an issue of *Reviews of Modern Physics* should celebrate the millennium and the society's centennial. Somebody else decided that it would be nice to put the result between hard covers. Marty Blume, editor-in-chief for the APS, and Ben Bederson, editor of *Reviews*, appointed a committee of six very fine physicists, each representing one of the major fields of physics, who did the best they could. In most cases they produced major articles under their own authorship as well as selecting a fine group of colleagues.

So why did I come away dissatisfied? For one thing, the same organizational procedure has been used every ten years or so by the National Academy of Sciences, and issued as a report on the state of physics in the United States (the Brinkman report, the Pake report ...). None of these are best sellers, although they are remarkably useful and in parts well written. What is wrong with them? Aside from fragmentation, there is the inevitable competitiveness which results in each section being written as though we have just reached a pinnacle of understanding. There can be no hint that behind the present synthesis there may lie decades of crisis, misunderstanding and even bitter controversy, which are unlikely to have been resolved just at this moment. There is also little sense of the essential unity of physics, in terms not of subject matter but of much more important but less tangible things such as mathematical structure and epistemology.

The present volume is an improvement in that there are several articles of a straightforwardly historical or autobiographical character, and to me these were by far the best part of the book. Many, but for some reason not all, of these are assembled in an initial section called "Historic Perspectives".

This section contains a number of gems: Hans Bethe on the early history of the quantum theory, Bram Pais on the history of theoretical particle physics, Val Fitch fascinatingly recounting the emulsion period of particle experiment, and Bob Pound's personal story of the early days of NMR, were the most rewarding. In the specialist sections, there was a notable article on the laser by Willis Lamb, Charles Townes *et al.* in much the same anecdotal vein.

The book then proceeds with separate sections on the various fields of physics, much in the tradition of the Pake report. It even follows the inescapable order, affording pride of place to particle physics and sliding down the energy scale (and up, may I say, the scale of relevance) until, concealed in the back of the book, we come to biophysics.

As one has come to expect, the particle physicists make their case with great clarity and intelligence. Particularly lucid and enlightening was Frank Wilczek's survey of field theory.

The astrophysicists perform according to form, opening with a dense technical article by Tyson and Turner which to me sounded particularly vulnerable to the experimentally driven revisions characteristic of cosmology. (I have pinned on my office door the *New Yorker* cartoon whose caption is: "Scientists today confirmed that everything we know about the universe is wrongedy-wrong-wrong.") But the articles on black holes, the microwave background and cosmic rays contain so much vital material that the net result can hardly fail to be exciting. The section ends, however, with not one but two articles devoted to seemingly hopeless searches: for dark matter and gravitational radiation. In a book where so much fascinating physics has been skimped, perhaps these could have been omitted? Or better yet, replaced with a serious discussion of the politics, economics and sociology of such large experimental devices.

I can't cover all the sections in such detail. In a period when nuclear physics is reinventing itself as a mixture of applied quantum chromodynamics and astrophysics, perhaps I can skip over this; and atomic physics seemed to be focused on current, if interesting, news from the research front.

When we come to condensed matter and statistical physics, which I know a bit about, it is not at all clear where the dividing line between them lies: are granules less con-