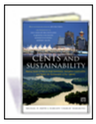
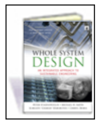
The Natural Edge PROJECT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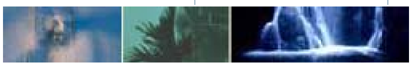

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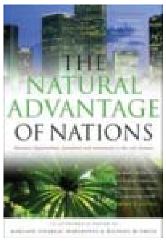
"California is going to be the leader in the fight against global warming, I say the debate is over. We know the science, we see the threat, and the time for action is now."
Governor of California, Arnold Schwarzenegger, June 2005

Links of Interest

- Centre for the Encouragement of Philanthropy in Australia
- Green Innovations Inc.
- World Resources Institute
- Nautilus Institute

The Natural Advantage of Nations (Vol. I): Business Opportunities, Innovation and Governance in the 21st Century



This book is about innovation, solutions, competitiveness and profitability. It is also about building environmental integrity and sustainability now and for future generations. It draws a bold vision for the future and tells us how to get there by building on the lessons of competitive advantage theory and the latest in sustainability, economics, innovation, business and governance theory and practice. The authors incorporate innovative technical, structural and social advances, and explore the role that governance can play in both leading and underpinning business and communities in the shift towards a sustainable future. The result is nothing less than the most authoritative and comprehensive guide to building the new ecologically sustainable economy. (more...)

Chapter 1 (Part 4) - A critical mass of enabling technologies

> *Innovation is the central issue in economic prosperity.*
> Michael Porter, Harvard Business School

> *Innovation is a central driver of economic growth and social development. The evidence for this relationship is compelling and now widely recognised: innovation is a major determinant of the success of firms and of economies. The development ad commercialisation of new products, processes and services are key drivers of economic growth. Innovation depends on research and ready access and receptiveness to new technology and ideas. It propels productivity, spawns new industries and transforms existing industries. Economies which can effectively foster and commercialise innovations will grow faster and will generate more jobs and higher living standards.*
> Investing for Growth, Commonwealth of Australia, 1997[37]

Nations and firms are increasingly aware of the importance of being ahead of the next so called 'wave' of innovation and are asking 'What will give rise to the new areas of innovation?' In order for a wave of innovation to occur, there needs to be a significant array of relatively new and emerging technologies and a recognized genuine need in the market that is leading to a market expansion. As *Natural Capitalism* discussed, the first Industrial Revolution began with the steam engine and new machines to increase the labour productivity of cotton-spinning and the production of steel. This was followed by further industrial shifts with the engineering that evolved out of advances in the understanding of, for instance, electro-magnetism.

This was followed by a focus on mass production of the automobile and electrification of cities, a wave which lasted until the 1940s. The rise of semiconductors and electronics provided just some of the enabling technologies that helped create new business opportunities throughout the 1950s and 1960s. In the case of the Information and Communications Technology (ICT) wave of innovation, it is easy to identify the technologies that were driving the growth of capacity in the industry. Innovations in computer processing power, network bandwidth and data storage have all helped achieve the predictions of Gordon Moore in the 1970s that 'computing power will continue to double every 18 months, while costs hold constant.'[38] This last wave of industrial activity was largely based on semiconductors, fibre optics, networks and software.

Many of the applications in the previous IT wave of innovation were based on the idea of reducing transaction costs.[39] In the book, *Unleashing the Killer App*, Downes and Mui suggest that the market for the many Internet applications was in the reduction of 'transaction costs'.[40] For instance, email is a cheap and fast means of communication, finding information is now much faster and cheaper online, together with Internet booking, purchasing and banking significantly reducing the costs of customer transactions.[41] The ICT revolution is just one in a series of long waves of industrial innovation first noted in the 1940s by Joseph Schumpeter, an Austrian-born economist. In his work, Schumpeter tracked the rise and flow of economies with respect to technology. We submit that there is now a critical mass of enabling eco-innovations making integrated approaches to sustainable development economically viable. As reported in *Small is Profitable*,[42] voted as one of the three best books by *The Economist* magazine for 2002: 'These developments form not simply a list of separate items, but a web of developments that all reinforce each other. Their effect is thus both individually important and collectively profound.'

If the last wave of innovation, ICT, was driven by market needs such as reducing transaction costs, we believe that there is significant evidence that the next waves of innovation will be driven by the twin needs simultaneously to improve productivity whilst lightening our environmental load on the planet.

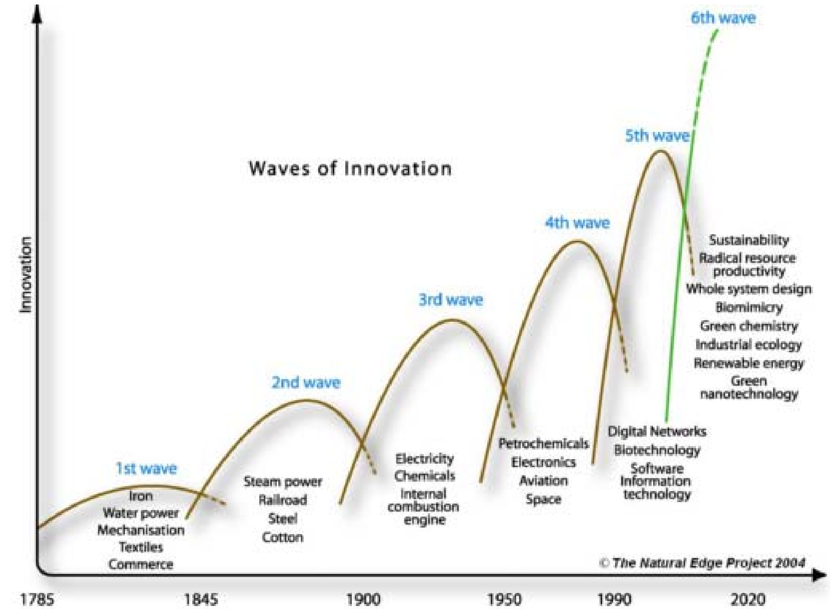


Figure 1.1 *Waves of innovation of the first and the next industrial revolution*

Consider a few interesting points:

- Some of businesses' most significant costs are capital and inputs, such as construction costs, raw materials, energy, water and transportation. It is in businesses' interests to minimize these costs, and hence the amount of raw materials and other inputs they need to create their product or provide their service. Business produces either useful products and services or unsaleable waste. How does it assist a business to have plant equipment and labour tied up in generating waste?

- It is in individual business's interests to find markets for this 'waste' and/or design industrial processes so that waste is minimized and that which is produced can be used or sold elsewhere.

- Womack and Jones found that it takes a year to transform the raw materials into a typical cola can. During this time, these resources travel half way around the world. *Lean Thinking* analysis shows that recycling cola cans would create numerous win–win benefits and dramatically reduce costs through the supply chain.[43]

But the fundamental reason why the pure scale of the challenge of sustainability will drive innovation is best illustrated through the five years of work of the Netherlands Government's Sustainable Technology Development project. The study found that, given projected increases in global population and the trends of the spread of western consumerism, humanity needs to reduce its negative environmental load by at least 90 per cent[44] or there will, over time, be a significant decline of ecosystem resilience.

> *In setting a time-horizon of 50 years – two generations into the future – it was found that ten- to twenty-fold eco-efficiency improvements will be needed to achieve meaningful reductions in environmental stress. It was also found that the benefits of incremental technological development could not provide such improvements.*
> Leo Jensen, Chairman, Dutch Inter-ministerial, Sustainable Technology Development Program 2000[45]

This view may seem extreme, but it comes from a detailed understanding of trends in resource usage globally and how, despite the apparent success of eco-efficiencies, energy and material flows are still increasing globally. This is the dilemma marring the apparent success of eco-efficiency and de-materialization in that consumption outpaces the system-wide gains in production, total resource use grows and so does the GDP. In Japan, total energy consumption has continued to rise, despite significant efforts in eco-efficiencies. This trend is found in many OECD nations and industry sectors.

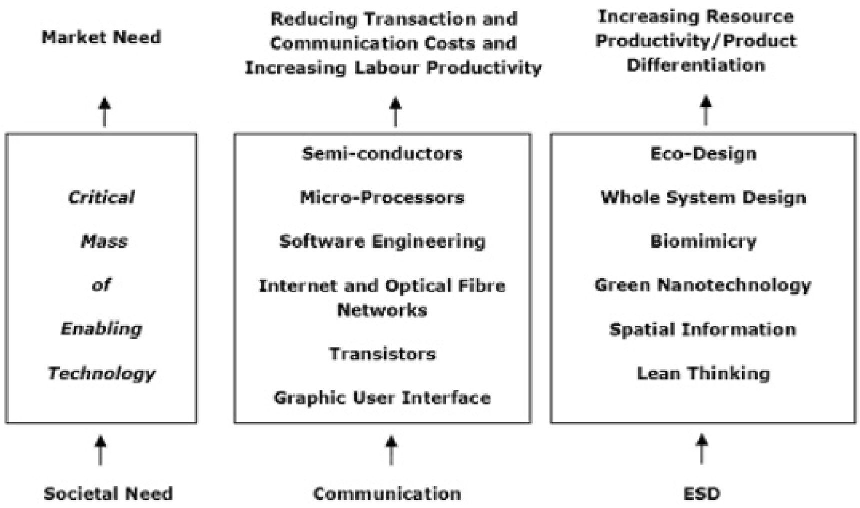


Figure 1.2 *Critical mass of innovations meeting real market needs creates new waves of innovation*

We now possess both the technological innovations and design know-how to tackle many environmental problems cost effectively and in some areas very profitably. Specifically, this involves everything from green buildings, hybrid cars, wind power, resource processing, transport systems, a wide array of recycling and other enabling technologies that will be covered in Section 4. However this is just the start, still more innovations are emerging from the fields of materials science, green chemistry, green nanotechnology and from simply having the humility to learn from nature. One of the best books on this is by Janine Benyus called *Biomimicry*.[46] Her book asks how does nature do business? How does nature work? Nature manufactures an amazing array of products and yet it does it very differently than our present industrial system. Nature manufactures with low energy flows, near body conditions, no persistent toxics. Everything that is an output of a process is food for some other process. The loops are closed. If you look at our manufacturing it's very different.

Benyus uses the example of an abalone. It manufactures in seawater at ambient temperature immediately next to the creature's body an inner lining, stronger than our best ceramic. How does it do it? It turns out you can find out. Scientists at Sandia Laboratory in New Mexico in the States realized that the abalone was inducing calcium ions from surrounding seawater to fit exactly into its ionic blueprint. They found that if they take silicon wafers and electrically charge them and dip them into alternating baths of calcium carbonate and polymer they can to create a similar material as it self-assembles at the molecular level. The same way nature does it. So you can make scratchless eyeglasses and breakless windshields and even a nose cone for space shuttles. Researchers and business people can learn from nature to create better products. Nature has evolved over billions of years. Hence, there is much we can learn from the way nature designs things.

For instance, the rotor technology – fan blades, mixers, propellers – developed by PAX Scientific, Inc, of San Rafael, California is modelled on streamlined shapes found in nature. Using these shapes, the company's biomimetic inventions demonstrate remarkable improvements in energy efficiency and productivity with significant reductions in noise. One example is the PAX mixer. The company was approached by an engineering firm to help improve problems of stratification and stagnation in municipal water storage tanks. Water held in these tanks, which can contain more than 1 million gallons, stratifies according to weather conditions, with each depth maintaining a different temperature. This stratification allows bacteria to grow more rapidly in the upper, hotter layers of the tank. Additionally, the tank's single inlet/outlet pipe does not support effective mixing, creating pockets of stagnation throughout the water. Perth born Jay Harman, PAX's CEO, found a solution in the shape of swirling seaweeds from which he developed a mixer/impeller. The PAX team then installed this mixer inside a 1 million gallon reservoir/holding tank. Twenty hours later, the entire reservoir had been completely and effectively mixed by the impeller, which used only 24 watts (should read 124 watts) of power to achieve this effect.

Figure 1.3 *Mixer/impeller inspired by kelp (Rotor 7-03)*

Harman attributes the mixer's success to the unique design geometries PAX employs. Harman bases all PAX designs on classic geometric ratios found in nature; the resulting shapes cause fluids to flow in a streamlined, centripetal pathway (towards the centre axis). In contrast, most conventional rotors use a centrifugal model, forcing the fluid outward and bouncing it off a boundary wall to force movement in a desired direction. This less direct and less controllable method also causes turbulence. By accelerating the fluid centripetally with very little turbulence, PAX's rotors diminish vibration and reduce heat gain while delivering more directional thrust with virtually no cavitation. (Cavitation is turbulence that causes destructive bubbles to form.) The mixer's performance is representative of similar successes with fan blades and boat propellers. PAX fans, for example, produce up to 75 per cent less noise while using up to 45 per cent less electricity. Amory Lovins, a strong supporter of the PAX technology, remarks that 'Not only are rotors of this shape potentially far more efficient, they are remarkably quiet, and gentle on anything that goes through them like, for example, fish through a hydroelectric turbine. This technology has great potential and many obvious applications. If this invention, or rather, rediscovery of nature's genius, fulfils its promise, it could be one of the greatest technical breakthroughs in energy efficiency in a long time.'

Essentially, science shows very clearly that we, as a species, need to reduce our environmental load on the planet and achieve long-term sustainable development. The past neglect of the importance of resource productivity offers significant opportunities to innovate and gain competitive advantage for those firms and nations that lead. The resource productivity gains, and product differentiation possibilities for firms through sustainable development, will complement and drive the next cycle of innovation. But in the end the greatest challenge of achieving sustainable development is to design industry and the built environment to also be truly regenerative and restorative. This is probably where the greatest amount of research is needed as we have so much to learn from nature.

Table 1.4 *New enabling technologies tunnelling through the cost barrier*[47]

Spatial data	The new wave of IT innovation in Spatial Data analysis and micro-satellites now allows any nation to have extremely cheap access to information about many aspects of their natural resource management, urban design and planning. This even includes the ability to measure precisely underground salinity pathways from satellites. This will be a powerful driver for business and government to embrace sustainability as Spatial Data now allows governments, firms and farmers to make use of as much additional information as they wish in undertaking better sustainability assessment and planning.
Greenhouse technologies	CSIRO innovation in industrial mixing will reduce energy usage by 80%. Australian scientists at CSIRO have developed a revolutionary new mixer for everything from explosives to cosmetics. This new method can mix twice as well as an equivalent commonly used static mixer, consumes five times less energy and has very low shear. (Numerous other case studies like this will be covered in Section 4.)
Novel materials: Bamboo	Bamboo absorbs over 40 times as much CO_2 as plantation forests whilst also bamboo growing to maturity three times as fast. This is faster than any other harvestable timber. Treated appropriately, bamboo can last for over 100 years. The Costa Rican Government is committed to building over 3000 bamboo

homes every year. Bamboo is being used as it excels at coping with and surviving earthquakes and can be built extremely cost effectively. Architects and engineers are showing increasing interest in adopting these modern applications of bamboo as used, for example, in Balinese resorts. Bamboo is also being used in numerous products. (Birkeland 2002)

Cars Another application of whole-system design is the re-design of cars. There is US$10 billion per annum being invested in eco-car research. Hybrid cars are now available in Japan, Europe and the US. Australia's CSIRO has developed one of the best hybrid car designs in the world, which led to over AU$700 million in additional exports of Australian light car components. Demonstration hydrogen fuel-cell cars are already here.

Climate neutral buildings In Melbourne, Australia, the 60L Green Building demonstrates the commercial viability of a building designed to operate with minimized impact on the environment. Built at roughly the same cost as a conventional building, it uses over 65% less energy and over 90% less water than a conventional commercial building. It features many innovations, using the latest in stylish office amenities and is completely made from recycled materials.

Mining wastes or mining resources Ausmelt is a new smelting process for base metals that increases the capacity of metal producers to recycle repeatedly the planet's finite mineral resources. The technology has since been further developed to reprocess toxic wastes, such as the cyanide and fluorine-contaminated pot-lining from aluminium smelters. The Sirosmelt/Ausmelt/Isasmelt technologies have become the system of choice as smelting companies slowly modernize.

> *We do believe that the efficiency revolution is to a large extent profitable for a country. It (will) provide competitive advantage to those countries pioneering it. And for the other countries it would be dangerous to miss the boat. We also (demonstrated) that some elements of the efficiency revolution are profitable now at the company level. But we emphasised that the state can do much to expand dramatically the range of profitability for both producers and consumers.*
> Ernst von Weizsäcker, Amory Lovins and Hunter Lovins, *Factor Four*[48]

Next Part

The development of this book and its online companion was made possible through access to research, peer review and funding from over 20 organisations, companies and government departments, together with the mentoring from over 75 experts and leaders in the field. TNEP is very grateful for this support and proud to welcome you to the Online Companion for *The Natural Advantage of Nations*.

Foundation Partners in the research, development and review of the book.

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37. Commonwealth of Australia (1997) Investing for Growth: The Howard Government's Plan for Australian Industry, Commonwealth of Australia, p28. (Back)

38. Gordon Moore first expressed Moore 's Law over 30 years ago. Moore, the founder of Intel, noticed that his engineers had an amazing capability to double the processing power of the chips they were designing at a regular rate. He used this insight to come up with his bold prediction. This prediction has held true for the last

30. years. (Back)

39. Transaction costs are the costs of undertaking transactions between purchaser and seller, supplier and distributor. (Back)

40. Downes, L. and Mui, C. (1998) Unleashing the Killer App: Digital Strategies for Market Dominance, Harvard Business School Press, Boston. (Back)

41. The first economist to study transaction costs in business was Ronald Coase. In his 1937 article 'The Nature of the Firm' Coase suggested that it was the costs of transactions which dictated the size and core business of a firm. For example, a sheet of paper may only cost a fraction of a cent, but if you were to purchase it one sheet at a time the cost of your time would far outweigh the cost of the piece of paper. By purchasing the paper in bulk, you reduce the transaction cost of obtaining the piece of paper to an acceptable level. Coase took this idea one step further. He made the case that firms actually formed in order to reduce transaction costs. For example, in order to purchase reams of paper individually the transaction costs would still be high; firms would pool everything from marketing to the stationery cabinet (where reams of paper would reside). These transaction costs would even determine when firms would decrease in size; eventually the stationery cabinet (or department) would become too costly to maintain, and would become a prime candidate for 'outsourcing'; reducing these transaction costs still further. Coase eventually won the Nobel Prize for Economics for this research. (Back)

42. Lovins, A., Datta, K., Feiler, T., Rábago, K., Swisher, J., Lehmann, A. and Wicker, K. (2002) Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size, Rocky Mountain Institute Publications, Colorado. (Back)

43. Womack, J. and Jones, D. (1996) Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Touchstone & Design, New York, Ch 2. (Back)

44. This has been given names such as 'reducing our negative impact on the environment' by a Factor of 4 (a 75 per cent reduction in resource intensity) or a Factor of 10 (a 90 per cent reduction in resource intensity). In short we need to 'do more, with less for longer'. (Back)

45. Weaver, P., Jansen, J., van Grootveld, G., van Spiegel, E. and Vergragt, P. (2000) Sustainable Technology Development, Greenleaf Publishing, Sheffield, UK. (Back)

46. Benyus, J. (1997) Biomimicry: Innovations Inspired by Nature, William Morrow, New York. (Back)

47. When intelligent engineering and design is brought into play, big resource savings often cost even less up front than small or incremental resource savings. Whole systems engineering allows companies to tunnel through the cost barrier and achieve multiple benefits. Chapter 6 of the book Natural Capitalism: The Next Industrial Revolution has numerous case studies of this. (Back)

48. von Weizsäcker, E., Lovins, A. and Lovins, L. H. (1997) Factor Four: Doubling Wealth, Halving Resource Use, Earthscan, London. (Back)