

Harnessing Corporate Power to Heal the Planet

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Pioneering companies in sectors ranging from wire to plastic films and planned residential communities have already demonstrated that today's environmental challenges hold many profit-enhancing opportunities.

The late twentieth century witnessed two great intellectual shifts: the fall of communism, with the apparent triumph of market economics; and the emergence, in a rapidly growing number of businesses, of the end of the war against the earth, and the emergence of a new form of economics we call natural capitalism.

This term implies that capitalism as practiced is an aberration; not because it is capitalist but because it is defying its own logic. It does not value, but rather liquidates, the most important form of capital: *natural* capital, in other words the natural resources and, more importantly, the ecosystem services upon which all life depends.

Deficient logic of this sort can't be corrected simply by placing a monetary value on natural capital. Many key ecosystem services have no known substitutes at any price. For example, the \$200 million Biosphere II project, despite a great deal of impressive science, was unable to provide breathable air for eight people. Biosphere I, our planet, performs this task daily at no charge for six billion of us.

Ecosystem services give us tens of trillions of dollars' worth of benefits each year, or more than the global economy. But none of this is reflected on anyone's balance sheets.

The best technologies cannot substitute for water and nutrient cycling, atmospheric and ecological stability, pollination and biodiversity, topsoil and biological productivity, and the process of assimilating and detoxifying society's wastes. With the human race increasing by 8,700 people every hour, more people are chasing after fewer resources. The limits to economic growth are coming to be set by scarcities of natural capital.

Sometimes the value of ecosystem services becomes apparent only when they are lost. In China's Yangtze basin in 1998, for example, deforested watersheds fostered flooding that killed 3,700 people, dislocated 223 million, and inundated 60 million acres of cropland. That \$30 billion disaster forced a logging moratorium and a \$12 billion crash program of reforestation.

This is not to say we're running out of such commodities as copper and oil. Even with recent fluctuations, prices for almost all commodities are near record lows and will fall for some time, in part because of improvements in extraction technologies. But in many instances these technologies impose environmental costs that further degrade the ability of living systems to sustain a growing human population.

Before the Industrial Revolution, from which capitalism emerged, it was inconceivable that people could work more productively. Nonetheless, textile mills introduced in the late 1700s enabled one Lancashire spinner to do the work previously done by 200 weavers, and the mills were only one of many technologies that increased the productivity of workers.

Profit-maximizing capitalists economized on their scarcest production factor: skilled people. They substituted seemingly abundant resources and the ability of the planet to absorb their pollution to enable people to do more work.

Given today's patterns of scarcity and abundance, that same business logic dictates using more people and more brains to wring 4, 10, or even 100 times as much benefit from each unit of energy, water, materials, or anything else borrowed from the planet. Success at this will be the basis of competitiveness in the decades to come and will be the hallmark of the next industrial revolution.

The first of four principles of natural capitalism is to increase resource efficiency radically. This not only increases profits, but also solves most of the environmental dilemmas facing the world today. It

greatly slows resource depletion at one end of the economic process and discharge of pollution (resources out of place) at the other end. It creates profits by reducing the costs of both resources and pollution. And it also buys time, forestalling the threatened collapse of natural systems.

That time should then be used to implement the other three principles of natural capitalism. These are: (2) eliminate the concept of waste by redesigning the economy based on models that close the loops of materials flows; (3) shift the focus of the economy from processing materials and making things to creating service and flow; and (4) reverse the destruction of the planet now under way by instituting programs of restoration that invest in natural capital.

By applying the four principles of natural capitalism, businesses can behave as if ecosystem services were properly valued and begin to reverse the loss of such services even as they increase profits.

1. Increase resource productivity.

It is relatively easy to profit by using resources more efficiently because they are used incredibly wastefully now. The stuff that drives the industrial metabolism of the United States currently amounts to, for each American, more than 20 times your body weight every day, or more than a million pounds per year.

Globally, this is a flow of half a trillion tons per year. But only about 1 percent of all the materials mobilized in the economy is ever embodied in a product that endures six months after sale. Cutting such waste represents a vast business opportunity.

Nowhere are the opportunities for savings easier to see than in energy. The United States has already cut its annual energy bills by \$150 billion relative to what they would have been if savings had not been implemented since the first oil shock in 1973. However, we still waste \$300 billion worth of energy each year in an economy whose total energy bill is more than \$500 billion (\$516 billion in 1995). Just the energy thrown away by U.S. power stations as waste heat, for example, equals the total energy used by Japan.

Fortunately, we already have ample examples of companies that have shown how to improve energy efficiency (i.e., reduce waste) and increase profits.

Southwire Corporation--an energy-intensive maker of cable, rod, and wire--halved its energy per pound of product in six years. The savings roughly equaled the company's profits during that period, and company officials estimated that the energy-efficiency effort probably secured 4,000 jobs at 10 plants in 6 states that were jeopardized by competitive market forces. The company then went on to save even more energy, achieving two-year paybacks despite all the earlier energy-efficiency improvements.

Dow's Louisiana division (now Dow Louisiana Operations) implemented over 900 worker-suggested energy-saving projects during the period 1981 to 1993, with average annual returns on investment of over 200 percent. Both returns and savings rose in later years, even after the accumulated annual savings from the projects had passed \$100 million, because the engineers were learning faster than they were using up the cheapest opportunities.

State-of-the-shelf technologies can make old buildings three- to fourfold more energy-efficient and new buildings nearer 10-fold--and cheaper to build. Examples include large and small buildings in climates ranging from well below freezing to sweltering, both types of which can be kept comfortable with no heating or cooling systems. Industries can achieve profitable savings in motor systems, process designs, and materials productivity. Rocky Mountain Institute's Hypercar design synthesis for automobiles and other road vehicles will produce huge energy and materials savings--and spell the end of the car, oil, steel, aluminum, coal, and electricity industries as we know them [see "The Car of the Future?" *The World & I*, August 1996, p. 148].

How can such savings be captured? An international company recently redesigned a standard industrial pumping loop slated for installation in its new Shanghai factory. The original, supposedly optimized, design needed 95 horsepower for pumping. Dutch engineer Jan Schilham made two embarrassingly simple design changes that cut that 95 hp to only 7 hp--a 92 percent reduction. The redesigned system cost less to build and worked better in all respects.

First, Schilham chose big pipes and small pumps rather than small pipes and big pumps. The friction in a pipe falls inversely as nearly the fifth power of its diameter. In considering how big to make the pipes, normal engineering practice balances the capital cost of the pipe against the ongoing energy costs of pumping fluid through the pipe.

But this textbook optimization ignores the capital cost of the pumping equipment--the pump, motor, variable-speed electronic control, and electrical supply--that must be big enough to fight the pipe friction.

Ignoring the potential equipment saving, and optimizing one component (the pipe) in isolation, "pessimizes" the system. Optimizing the *whole system* instead, and counting savings in total capital cost as well as in energy cost, makes it clear that, within a critical range, as pipe size increases the capital cost falls more rapidly for equipment than it rises for the much fatter pipe. The whole system therefore costs less but works better.

Schilham's second innovation was to lay out the pipes first, then the equipment. The normal sequence is the opposite: install the equipment in traditional positions (far apart, at the wrong height, facing the wrong way, with other stuff in between), then tell the pipe fitter to hook it all up. The resulting long, crooked pipes have about three to six times as much friction as short, straight pipes. Using short, straight pipes to minimize friction cuts both capital and operating costs. In this case, it also saved 70 kilowatts of heat loss, because straight pipes are easier to insulate.

This matters because pumping is a major user of electricity worldwide. Optimizing a whole pumping system, at the level of a whole building or a whole factory, can typically yield energy savings of 3- to 10-fold and cost less to operate. But more importantly, the thought process of whole systems thinking applies to almost every technical system that uses resources.

Consider real estate development. Typical tract home developments drain storm water in expensive underground sewers. Village Homes, an early solar housing development in Davis, California, instead installed natural drainage swales. This saved \$800 per house and provided more green space. The company then used the saved money to pay for edible landscaping that provided shade, nutrition, beauty, community focus, and crop revenues that paid the homeowners' assessments and paid for a community center. The people-centered site planning (narrower, tree-lined streets, with the housing fronting on the green-ways) saved more land and more money. It also cooled off the microclimate, yielding better comfort at lower cost, and it created safe and child-friendly neighborhoods that cut crime 90 percent compared with neighboring subdivisions. Real estate brokers once described the project as weird. It is now the most desirable real estate in town, with market values \$11 per square foot over average.

The same approach can diminish the risk of climate change. DuPont is proposing to reduce its greenhouse gas emissions 65 percent from 1990 levels by 2010. In addition, by 2010 DuPont aims to derive a tenth of its energy and a quarter of its raw materials from renewables. It is making these changes in the name of increasing shareholder value. In a similar vein, ST Microelectronics, a manufacturer of microchips, has set a goal of zero new emissions while it implements a 20-fold production increase.

Many executives are realizing that protecting the climate is not costly but profitable, because saving fuel costs less than buying fuel. Using energy in a way that saves money is therefore an important way to strengthen the bottom line and the whole economy, while also resolving the climate problem.

This is why the European Union has already adopted at least a fourfold ("Factor Four") gain in resource productivity as the new basis for sustainable development policy and practice. Some countries, like the Netherlands and Austria, have declared this a national goal. Environment ministers from the OECD (Organization for Economic Cooperation and Development), the government of Sweden, and distinguished industrial and academic leaders in Europe, Japan, and elsewhere have gone even further, adopting "Factor Ten" improvements as their goal. The World Business Council for Sustainable Development and the UN Environment Programme have called for "Factor Twenty." There is growing evidence that such ambitious goals are feasible and achievable in the marketplace. They may, in fact, offer even greater profits.

2. Eliminate the concept of waste.

Resource efficiency is natural capitalism's cornerstone, but only its beginning.

Natural capitalism would eliminate the entire concept of waste by adopting biological patterns, processes, and often materials. This implies eliminating any industrial output that represents a disposal cost rather than a salable product.

Architect Bill McDonough tells the story of being asked by the Steelcase subsidiary DesignTex to design a "green" textile for upholstering office chairs. The fabric it was to replace used such toxic chemicals to treat and dye the cloth that the Swiss government had declared its edge trimmings a hazardous waste. McDonough's team eventually found a chemical firm that would let them explore its textile chemistry in detail.

They screened more than 8,000 chemicals, rejecting any that were toxic, built up in food chains, or caused cancer, mutations, birth defects, or endocrine disruption. The 38 that passed could make all colors. The cloth would look better, feel better in the hand, and last longer, because the natural fibers wouldn't be

damaged by harsh chemicals. Fewer and cheaper feedstocks, as well as no health and safety concerns, meant that production cost less. The new fabric was beautiful and won design awards.

The Swiss environmental inspectors who tested the new plant thought their equipment was malfunctioning when the effluent water proved cleaner than the Swiss drinking water input: the cloth itself was acting as a filter. More important, the redesign of the process "took the filters out of the pipes and put them where they belong, in the designers' heads."

Professor Hanns Fischer noticed that the University of Zurich's basic chemistry lab course was turning pure, simple reagents into mainly hazardous wastes, incurring costs at both ends. The students were also learning once-through, linear thinking. So in some of the lessons, the students turned the toxic wastes back into pure, simple reagents. Students volunteered vacation time to repurify the wastes, because it was so much fun. Demand for wastes soon outstripped supply. Waste production declined 99 percent, costs fell by about \$20,000 a year, and the students learned the closed-loop thinking that must ultimately save the chemical industry.

This is an archetype for the emerging world where environmental regulation will be an anachronism. In that biological world, the design lessons of nature will improve business--as well as health, housing, mobility, community, and national security. Such a world emerges from the cybernetics of not inflicting on others any emission to which you wouldn't expose yourself: How clean a car would you buy if its exhaust pipe, instead of being aimed at pedestrians, fed directly into the passenger compartment? How clean would a city or factory make the water it discharges if its intake pipes were downstream of its outlets? We all live downwind, downstream.

3. Create service and flow.

A further key element of natural capitalism is to shift the structure of the economy from focusing on the production and sale of things to focusing on providing the customer a continuous flow of service and value.

This change in the business model provides incentives for a continuous improvement in the elimination of waste, because it structures the relationships so that *the provider and customer both make money by finding more efficient solutions that benefit both*. That contrasts sharply with the conventional sale or leasing of physical goods in which the vendor wants to provide more things more often--increasing waste--and at a higher price, while the customer has the opposite interests.

For example, Schindler leases vertical transportation services instead of selling elevators, Electrolux/Sweden leases the performance of professional floor-cleaning and commercial food-service equipment rather than the equipment itself, and Dow and Safety-Kleen lease dissolving services rather than selling solvents. Both customer and provider profit from minimizing the flow of energy and materials.

Carrier, the world's largest manufacturer of air conditioners, is experimenting with leases of comfort instead of sales of air conditioners. Making the equipment more efficient or more durable will give Carrier greater profits and its customer better comfort at lower cost. So too, however, will making the building itself more efficient, so that less cooling yields the same comfort. Carrier is therefore starting to team up with other firms that can improve lighting, glazings, and other building systems. Providing a more systemic solution, creating a relationship that continually aligns interests, is obviously better for customers, shareholders and the earth than selling air conditioners.

A striking example is emerging at Atlanta carpet maker Interface. Most broadloom carpet is replaced every decade because it develops worn spots. An office is shut down, furniture removed, and carpet torn up and sent to landfill. (The millions of tons deposited each year will last up to 20,000 years.) New carpet is laid down, the office restored, operations resumed, and workers get sick from the carpet-glue fumes.

Instead, Interface prefers to lease floor-covering services. People want to walk on and look at carpet, not own it. They can obtain these services at much lower cost if Interface owns the carpet and remains responsible for keeping it clean and fresh. For a monthly fee, Interface will visit regularly and replace the 10--20 percent of the carpet tiles that show 80--90 percent of the wear. This reduces the mass flow of carpet to landfill by about 80 percent and provides better service at lower cost. It also increases net employment, eliminates the disruption (worn tiles are seldom under furniture), and turns a capital expenditure into an operating lease.

Interface's latest technical innovation goes further. Other manufacturers say that they recycle carpet. Actually they downcycle it--reusing it in lower-grade products. In contrast, Interface's new Solenium

product provides floor covering that is almost completely remanufacturable into identical carpet. This will cut their net flow of materials and energy it takes to make them by 97 percent.

It will also provide better service, because the new floor covering, which may be leased or sold, is nontoxic, virtually stainproof, easy to clean with water, four times as durable, one-third less materials-intensive, renewably produced, and otherwise superior in every respect.

Interface's first four years on this systematic quest to turn avoided waste into profit returned doubled revenues, tripled operating profits, and nearly doubled employment. Its latest \$250 million revenue came with no increase in energy or materials inputs, from mining internal waste.

Or consider the Films division of DuPont. Once failing, it now leads its 59-firm market because it makes its films thinner, stronger, and better matched to customers' needs. This enables it to produce higher-value products using fewer materials. It also recycles used film, closing the materials loops, getting it back from customers with a process now coming to be known as "reverse logistics," a new topic of study in business schools. Jack Krol, past chairman of DuPont, has remarked that he sees no end to DuPont's ability to profit in this way.

4. Invest in natural capital.

The fourth principle of natural capitalism is to invest to reverse the worldwide destruction of the ecosystem.

If natural capital is the most important, valuable, and indispensable form of capital, a true capitalist will restore it where degraded and sustain it where healthy--the better to create wealth and sustain life. Once toxicity and waste are designed out of industry, then forestry, farming, and fishing must be redesigned to be restorative to natural ecosystems. This will be especially important as the primary inputs to industry come to be grown, not mined, and living nanotechnologies replace vast industries.

This will place a premium on understanding biological models and on using nature as model and mentor rather than as a nuisance to be evaded. The incentive will derive not just from the goodwill of corporations, but from the scent of real profits and the promise of long-term corporate survival. No doubt some managers (the commercial about the company that is not interested in e-business comes to mind) will lack the willingness to tackle natural capitalism, and their companies will likely fossilize. Meanwhile, more visionary, adventurous managers will lead the wave of companies that embrace the new competitive grounds set by natural capitalism.

Catching up with centuries of deferred but unbooked planetary maintenance might sound expensive. But whole-system solutions create more life, more value, and ultimately more profits. Production is automatically carried out; people need only create hospitable conditions and do no harm. In this exciting sphere of innovation lie such opportunities as these:

- Dr. Allan Savory, cofounder of the Albuquerque-based Center for Holistic Management, has redesigned ranching to mimic the migration of large herds of native grazers that coevolved with grasslands. This can greatly improve the carrying capacity of even degraded rangelands, which turn out to have been not overgrazed but undergrazed, out of ignorance of how brittle ecosystems evolved.

- The California Rice Industry Association partnered with environmental groups to switch from burning rice straw to flooding the rice fields after harvest. They now flood 30 percent of California's rice acreage, from which they can harvest a more profitable mix of wildfowl, high-silica straw, groundwater recharge, and other benefits, with rice as a by-product.

- Dr. John Todd of Ocean Arks International and Living Technologies, based in Burlington, Vermont, builds biological "Living Machines" that turn sewage into clean water--plus valuable flowers, a tourist venue, and other by-products--with no toxicity, no odor, and reduced capital costs. Such "Bioneers" are using living organisms to "bioremediate" toxic pollutants into forms that are harmless or salable or both.

These practices adopt the design experience of nearly four billion years of evolutionary testing in which products that failed were recalled by the Manufacturer. Though many details of such nature-mimicking practices are still evolving, the broad contours of the lessons they teach are already clear [see "The Living Building," *The World & I*, October 1999, p. 160].

Some of the most exciting developments are modeled on nature's low-temperature, low-pressure assembly techniques, whose products rival anything man-made. Janine Benyus' book *Biomimicry* points out that spiders make silk as strong as Kevlar--but much tougher--from digested crickets and flies, without needing boiling sulfuric acid and high-pressure extruders.

The abalone makes an inner shell twice as tough as ceramics, and diatoms make seawater into glass; neither need furnaces. Trees turn air, sunlight, and soil into cellulose, a sugar stiffer and stronger than nylon. We may never be as skillful as spiders, abalone, diatoms, or trees, but such benign natural chemistry may be a better model than industrialism's primitive approach of "heat, beat, and treat."

Beyond profits: What's in it for us?

Natural capitalism implemented in a company creates an extraordinary outpouring of energy, initiative, and enthusiasm at all levels. It removes the contradiction between what people do at work and what they want for their families when they go home. This makes natural-capitalist firms some of the most exciting places in the world to work.

Civilization in the twenty-first century is imperiled by the dissolution of civil societies into lawlessness and despair; weakened life-support systems; and the dwindling public purse needed to address these problems and reduce human suffering. These three threats share a common cause--waste.

The leaders in waste reduction will be in the corporate sector. But there remains a vital role for governments and for civil society. It is important to remember markets' purposes and limitations. Markets make a splendid servant but a bad master and a worse religion. Markets produce value, but only communities and families produce values. A society that substitutes markets for politics, ethics, or faith is dangerously adrift. Commerce can create a durable system of production and consumption by properly applying sound market principles. Yet not all value is monetized; not every priceless thing is priced. Nor is accumulating money the same thing as creating wealth or improving people. Many of the best things in life are not the business of business. And as the Russians are finding under "gangster capitalism," unless democratic institutions establish and maintain a level playing field, only the most ruthless can conduct business.

One of government's most powerful tools is tax policy. Such taxes as FICA and other penalties on employment that grew out of the first industrial revolution encourage companies to use more resources and fewer people. Gradual and fair tax shifting and desubsidization can provide more of what we want--jobs and income--and less of what we don't want: environmental and social damage.

But government's power is limited. Today over half the world's 100 largest economic entities are not countries but companies. Corporations may be the only institution with the resources, agility, organization, and motivation to tackle the toughest problems.

Firms that pursue the four principles of natural capitalism--profiting from advanced resource productivity, closing materials loops and eliminating waste, providing their customers with efficient solutions, and reinvesting in natural capital--will gain a commanding competitive advantage. They'll be behaving as if natural and human capital were properly valued. And as Ed Woollard, former chairman of DuPont, once remarked, companies that don't take these principles seriously won't be a problem, because they won't be around.

Perhaps the only problem with capitalism--a system of wealth creation built on the productive flow and expansion of all forms of capital--is that it is only now beginning to be tried.

On the Internet

Natural Capitalism

www.naturalcapitalism.org (or www.natcap.org)

Rocky Mountain Institute

www.rmi.org

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