

Natural Capitalism: Creating the Next Industrial Revolution Study Guide

Natural Capitalism: Creating the Next Industrial Revolution by Paul Hawken

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Plot Summary

"Natural Capitalism" is a cooperative effort of Paul Hawken, Amory Lovins and L. Hunter Lovins to outline the principals of natural capitalism, an ethos by which the resources of the natural world are as highly valued as financial resources have been in previous human history. A summary of the state of industry and its cost to the natural world is outlined in the first chapter, with a call to the United States to lead the next industrial revolution and restore our economy, educational systems and environment. Hypercars and cities organized around the principal of community and pedestrian accessibility are the first strategy outlined, as they explain the cost to the environment, our industries and our lives in time and tragedy that would be saved by rethinking our cars and the design of our neighborhoods.

Discussing the wider topic of industry, the authors discuss waste as the most immediate albatross business must throw off. To model industry after nature would mean that systems are completely closed, reusing everything they take from nature or from the destruction of something old. To use as little material for the most good would mean that waste is eliminated before goods ever leave the factory. There is also a tremendous amount of waste the authors point out as unnecessary in buildings, as architects are taught that compromise is a matter of course, but if plumbers, electricians, architects and the like are allowed to work in cooperation with each other, their work can become complementary and waste can be eliminated.

They also describe how the simplicity of the systems that use less energy, and the ability to eliminate waste from production will tunnel through the cost barrier, until better design costs less both over time and in production. A perfect example is carbon fiber cars, in which the steel frame and heavy drive train are rendered unnecessary because of the incredible lightness and strength of the car's body. A similar cost elimination is demonstrated in the chapter on Muda, or waste, and a service and flow economy. This is a system in which people subscribe to a service to provide what a purchased appliance would otherwise provide. Service and flow leaves ownership of the appliances with the company, as well as the responsibility to make it as efficient as possible and reuse whatever they can as a means for them to keep their costs down. This makes innovation and efficiency the very best way of doing business.

The authors explain that there is nothing humans can manufacture that will provide for life on our planet like the life that is already here, and no amount of synthesis that can replace it once it is lost. For that reason, the very best way to protect business and livelihood is to protect the environment as the source for everything that makes life good. We can go a long way down that path by learning from the waste-free processes by which nature produces its resources, and following its example. "Nature's Filaments" describes several examples. "Food for Life" follows a similar track describing how delicate our food supply is, and how destructive it is for corporations to sequester and manipulate whole species of plants. To allow nature to function as unaltered as possible is the only way we will be sure it is able to survive, and it is true in the botanical as well as the aqueous world.



The climate is another of the systems that must be protected from those altering influences that we have already observed as having a detrimental effect on the planet, like carbon dioxide. Everything from fossil fuel burning to responsible forestry, farming and livestock practices can affect that balance, and it is increasingly more urgent all the time that we recapture and stop releasing greenhouse gasses. Government has a responsibility in this area to subsidize what is beneficial to the environment and penalize what is not, so that the cost to the environment of certain practices is factored in to the price of doing them.

The final two chapters are dedicated to examples of how these principals look in practice, the most detailed example of which is the city of Curitiba in Brazil. In the final chapter, the authors describe the culture in which we have been having this conversation, the different ways of thinking about it, and how to harmonize all of them, so that everyone can see the virtue of making these changes.



The Next Industrial Revolution

The Next Industrial Revolution Summary and Analysis

Following a preface describing the influence of such works as "Factor Four" and "The Ecology of Commerce" on the writing of this book, it begins with a chapter laying out the four strategies of the green revolution. It sets the scene of future possibilities by describing a world of clean industry, universally high standards of living, and an economy in which welfare gives way to family-wage jobs, all attainable following economic and technological trends already in place.

Modern industry depletes natural resources out of proportion to their production, leading to the inevitable loss of the natural capital that makes industry and life possible. The strategy the group proposes will require four kinds of capital: human capital (intelligence, creativity, labor); financial capital (investment); manufactured capital (factories, infrastructure); and the natural capital of living ecosystems and resources. Industry has never been forced to factor in its cost to the ecosystem, nor to concern itself with its waste. The authors explain, however, why simply assigning monetary value to the natural resources will not solve this problem, and do not attempt, then, to give these resources value, only to propose that we cannot go on behaving as if they are valueless.

Examining conventional capitalism, the writers explain that when the highest good in business is the financial bottom line, industry serves capitalism only and becomes the train that runs over the environmental and human good. It has become necessary for humanity to reexamine its whole value system, and apply the economic principal of scarcity to our thinking about natural capital if we are to survive. Specifically, humanity must learn to give equal value to all forms of capital, using financial capital to preserve and protect human and natural capital alike.

In that new paradigm, in "Capitalism as if Living Systems Mattered," the authors list new fundamental assumptions to guide sustainable industry: valuing closed systems (no waste); seeing natural capital as a commodity to be replenished and expanded; and ensuring that industry retains human quality of life as a goal. The chapter closes with in-depth explanations of the four central strategies of natural capitalism in which all forms of capital are equally valued raising the standard of living in every part of the world. They are "Radical Resource Productivity," in which resources are so productively used that every country benefits from the efficiency of every other country, as people live in interconnected dependence on and service to the natural world; "Biomimicry," in which materials are designed based on the standards set by the natural world without any synthetic, toxic or wasteful chemistry, heat or machinery; "Service and Flow" in which people subscribe to a service for the tasks of their appliances, while the items themselves remain in the ownership of their manufacturers, ending planned obsolescence, producing less waste, and giving companies incentive to recycle. The

result will be the mutual goal among all belief systems and nations of protecting and preserving the resources on which we all depend.



Reinventing the Wheels: Hypercars and Neighborhoods

Reinventing the Wheels: Hypercars and Neighborhoods Summary and Analysis

The chapter opens with a description of the ills of a traditional automobile society: waste in production, toxic emissions, the land given to concrete roads, and the number of deaths that result from their use. In 1990, the Rocky Mountain Institute made their hypercar design public domain, and still, the U.S. automotive industry continues to operate as if still in the Iron Age. Cars are still made of steel, requiring a very heavy frame to support their weight, and heavy engines to move them.

The solution is proposed in three parts: to make cars ultra-light, to build them more aerodynamically, and to give them hybrid-electric motors, so that a fraction of the gas used by a regular car is used to charge a battery that runs an electric motor. Ninety percent of the electricity generated turns the wheels, they use no energy at all when the cars are not moving, and they are exponentially less expensive to build. The industry is tending in the direction of hypercars because of rising costs and consumer demand for a more efficient choice in vehicles, and when they do, they will meet all four of the criteria for natural capitalism.

Carbon-fiber composite bodies on cars are light and strong on their own, so would not require heavy frames, and as a result make the heaviest parts of the motor unnecessary, further shedding weight. The safety of carbon fiber cars is a result of their lighter weight, and of its bio-mimicking strength. Since forming it into car frames would require so many fewer manufacturing elements, the higher cost-per-pound compared with steel is quickly evened out by its simplicity, making it cost-effective both on the manufacturing end, and to the driver over time in efficiency and safety.

As for the batteries, they could be fueled either with biofuel already available from existing agricultural waste, or using reversed electrolysis, by which hydrogen is combined with oxygen to make electricity and water. Since the batteries and engines are mechanically simple, their increased production will drive down the cost of their slightly more expensive materials, and increased production could be made possible by putting the fuel cells in buildings where the electricity grid is overloaded and in need of more power coming in. Then, even the cars could become power plants as their batteries feed the grid whenever they are parked. There follows a discussion of the safety of hydrogen as a fuel compared to gas, demonstrated by the fact that even in the Hindenburg fire, not a single passenger was hurt by the flames. Finally, the chapter spends a good deal of time discussing the possibilities of a service and flow model of car leasing, sharing and pooling, so that fewer cars can be on the road, and of the layout of a community that would make cars less necessary, so that cars may become accessories and services rather than an organizing principal.



Waste Not

Waste Not Summary and Analysis

The problem of depleting our natural resources without accounting for the loss allows American society to live in denial of its own undoing. Unlike the natural world, the world of production is not regulated by natural feedback that makes overproduction and waste impossible, but by bosses and industry demands that insist on maintaining the status quo and keeping profit margins high. The authors use the detailed description of the makings of a can of soda to demonstrate the enormity of the waste that is accepted as a matter of course for industries worldwide.

If things continue growing at the pace they were moving in 1999 when this book was written, the number of acres of land necessary for each individual on earth to maintain an American standard of living would require twelve earths by the year 2030. In the section called "How Much Waste is There?", the authors use the example of Fresh Kills in Staten Island, NY to demonstrate the tonnage of waste cities produce every day, and breaks down by weight and type the average waste of every individual in the United States, demonstrating the urgency of our decreasing our waste if we are going to have the opportunity before the land is filled to turn it into the life-supporting ecosystem it has been.

In "Wasting People," the authors discuss the rising numbers of unemployed workers around the world, while industry remains inefficient. While unemployment rates can look like unemployment is falling, the number of workers who are underemployed, unable to pay for basic necessities, much less insurance and higher education, are not represented in the number. Industry can continue to cut workers with wasteful automation to raise its profit margins, but as the authors point out, only when natural resources abounded did it make sense to use more natural capital and fewer people. However, with resources dwindling and people abounding, that philosophy is no longer practical, as cities decay and crime soars. Instead of the remaining work force working smarter and more efficiently, they are working significantly harder with nothing like a reflective increase in their wages.

"Lost Wealth" talks about the costs of our inefficiency on things for which the spender gets no value, like traffic jams' spent fuel, wear and tear on a car, lost wages and increased accidents. Since we did not adopt the same energy efficiency standards as other advanced countries in 1974, our entire energy system is more expensive than it needs to be. Our insurance system has so driven up medical costs that old diseases we should have eliminated by now still exist because of cost-cutting insufficiencies in treatment and prevention among our poor. The chapter closes with the warning that current industry, if left as it is, will result in "the deterioration of the natural environment; the ongoing dissolution of civil societies into lawlessness, despair, and apathy; and the lack of public will needed to address human suffering and social welfare," all three of which are the direct results of the wastes this chapter describes. Already the social

indicators are observable in American health and cities. The growth demonstrated in the GDP only measures money spent, whether or not it was on the creation of well-being or standard of living. Expensive waste is counted as growth just like actual useful products. So also is crime, disease, landfills, shelters and the other indices of a culture in decline. So if America is going to progress out of its current decline, it must learn to keep an accurate balance sheet.



Making the World

Making the World Summary and Analysis

This chapter on manufacturing, and explains that innovations in improving efficiency come much faster than industry's ability or willingness to adopt them, but their possibilities are as endless as imagination. Factories reuse heat for manufacturing with simple changes like sealing leaks, improving insulation and using "pinch technology" to precisely apply and recapture heat; likewise microchip makers in China and Singapore have been able to save millions of dollars by improving efficiency at a cost of less than one million dollars. Energy, resources and money, as well as pollution and waste can be saved, even eliminated, if industry is willing to make improvements in six categories: design, new technologies, controls, corporate culture, new processes and saving materials.

Scientist Edwin Land called invention simply a "cessation of stupidity," and the authors suggest that simply using existing technologies to their potential can go a long way to becoming efficient. Simple adjustments in geometry can let natural physics improve efficiency, and moving processes closer together can save time, labor and heat. The authors also suggest that sometimes technologies from different industries can combine for a synergistic new use. Out of necessity and experience, industry is naturally innovating more efficient machines all the time. As a result, even old assumptions like Carnot's Law that posits that a factory cannot possibly be more than forty percent efficient are cast aside.

They point out the example set by new graduates from Georgia Tech who went to work for a Georgian power plant, and found a way to save the company millions of dollars a year with adjustments they designed using a simple computer. The key is for controls to measure what is happening at the present moment, instead of what happened a minute or more ago, so the adjustments can be made without wasteful delays. Ideally, controls could be measuring efficiency continuously and making adjustments, so that the processes are made more efficient all the time. Multiple eyes watching at different stages is also more effective than a single brain supervising, as observable in nature. An ecosystem is made up of interdependent parts operating in constant awareness of and reaction to each other, adjusting to changes as they happen, as described in Kevin Kelly's book, "Out of Control."

The authors apply the same concept at work in an evolving ecosystem to the way corporations need to think about their processes. Instead of a linear process moving from requiring to designing and building, repeated the same way over and over again, the process should learn and adjust every time, so that the pattern becomes require, design, measure, analyze and improve. Without such constant measures as a priority, massive wastes can go undiscovered indefinitely, often because of flaws from as far back as the plant where pieces of a factory machine were made.



We use heat-and-energy intensive and often highly toxic processes to make things that nature makes with different chemistry in processes that waste no chemistry, heat or energy. Learning from their processes, design concepts and efficiencies allows humanity to benefit from the evolutionary lessons nature has already learned. Capturing waste and reducing it into reusable elements can turn industry into a closed loop, mutually symbiotic, synergistic system just like the natural world. Manufacturers are taking queues from nature in the form of "desktop manufacturing," in which, instead of factories, "flexible, computer-instructed 'assemblers' will put individual atoms together at a molecular scale to produce exactly the things we want with almost zero waste and almost no energy expended" in much the same way that soil and sunlight become trees and milk becomes babies, and the nanotechnologies to make it possible are evolving quickly.

Replacing disposable things with recyclable and durable things is complemented by the idea of beginning manufacturing in "near-net-shape." This is the concept in which every bit of the raw material that enters the factory leaves the factory as product, so that none is wasted. That concept is furthered with the idea of simplifying designs so that fewer and smaller parts are needed. Buckminster Fuller taught that the most efficient way to design is with a wisp of material, so that all of the material is function and none is excess; as J. Baldwin describes it, the object becomes pure principle. Repair, reuse, upgrading, re-manufacturing, and recycling are also concepts that must drive innovation as industry evolves. The authors cite the example of "extended product responsibility" set by Germany and spreading across Europe and Japan, in which cars, electronics and other durable goods are designed to be easily disassembled and recycled and laws are passed to make recycling compulsory, leading to tremendous reductions in waste.



Building Blocks

Building Blocks Summary and Analysis

Three examples of integrating green technology, efficient function and uplifting aesthetics in building open the fifth chapter. Builders in these examples set out to create organic buildings that integrate art with function, use local materials, and renewable energy in buildings so efficiently built that their demand for energy is less by far than conventional buildings. They all have in common a new approach to building and community design that prioritizes humanity and nature, so that local communities and ecosystems are stimulated by instead of sacrificed to the new buildings. The goal of this new kind of design is not only to help nature to recover, but to make neighborhoods safer and driving less necessary.

A cooperatively designed, renewably fueled building is at once less expensive to build and more attractive to buyers than conventional construction, as it improves worker productivity by improving air and water quality. Conventions are also being reexamined, down to constant indoor temperature, as in Japan where they stimulate productivity and creativity by continuously varying both temperature and scent in work spaces. This speaks to the theme of worker satisfaction and performance that the authors demonstrate with five examples where daylighting and improved air quality increased productivity and sales and reduced operating costs and absenteeism.

The authors describe ways to incentivize the changes that would bring the most benefit, like paying contractors for the energy costs they save in a building instead of for the price of building it; a system of split incentives between landlords and tenants, so both have an interest in using efficient systems; educating brokers and realtors to the presence and benefit of these systems, so their marketability increases, and feebates, a system in which people who use more energy pay a fee, and people who use less receive a rebate paid for by the fees, so there is further incentive for everyone to save however they can.

They also describe the synergistic improvements that come from making a workplace environmentally friendly: lighting and quality air improve productivity; superwindows insulate to reduce HVAC costs; solar panels turn buildings into power stations that feed the grid; and speculative building allows for under-floor wiring and ventilation so outlets, vents, and plumbing can be easily changed to make a room function according to its changing purposes. Finally, computer-operated ventilation and de-humidification systems optimize natural air flow and require no new energy at all, but reuse captured heat.

Next they discuss retrofitting buildings for new purposes, and using the building materials from dismantled buildings to build something new. They also discuss improvements to home design that make heating and cooling exponentially more efficient. "Appliances" talks about how time and innovation have already made

appliances worlds more efficient, multi-use and safer. Finally, "Redesigning Community" discusses the advantages of sharing appliances within a neighborhood. Roads can narrow as gathering places are close enough to walk to, community can be built, neighborhoods can fill with trees and stay cooler, support gardens with drainage swales and green roofs, and the health of the community and the earth can be the guiding principals as our cities evolve.



Tunneling Through the Cost Barrier

Tunneling Through the Cost Barrier Summary and Analysis

The chapter opens with a discussion of the value of good training for engineers like Eng Lock Lee, who are in the mindset of rethinking everything to make it as efficient as possible, and the tremendous difference that can be made when they are educated in that way, and that can affect whole industries' philosophies. The premise in "Tunneling Through the Cost Barrier" is that, while the law of diminishing returns says there comes a point at which making a heating unit, for example, more efficient becomes more expensive than its savings will ever pay for, by shifting the way we think and investing in insulation instead, the cost barrier is circumvented by way of requiring a much, much smaller heater as a result. Engineers must let go of the assumption that one system's efficiency must necessarily be compromised to allow for the operation of another. Integration of design is essential, and whole-system engineering allows each system to work in concert with every other system in a building. Insulation is the authors' first example, and the second is a factory at which an engineer pointed out that much smaller pipes make it necessary to use much smaller pumps, so where before, they had been using wide pipes to reduce friction, the savings from using smaller pumps far outweighs whatever inefficiency might have come from the smaller, also less expensive pipe.

Continuing on the theme of energy efficiency, the authors point out that the best progress is made by moving backwards toward the power plant, just as making a car lighter saves the factory from having to make a powerful drive train. As they point out, "saving one unit of energy farthest downstream (such as reducing flow or friction in pipes) avoids enough compounding losses from the power plant to end use to save about ten units of fuel, cost, and pollution back at the power plant." Reducing the call for power from our appliances, as well as eliminating the wastes that happen between the plant at the power's destination, will make it necessary for the plant itself to make less and less energy, thereby also using less and less fuel, and producing less and less pollution.



Muda, Service and Flow

Muda, Service and Flow Summary and Analysis

The chapter opens with an explanation of the role of Taiichi Ohno, the father of the Toyota Production System and proponent of the idea of industry without muda, or waste. His proposition is that "any human activity that absorbs resources but creates no value" is muda, and should be eliminated in industry and in life. Lean thinking, the antidote of muda, has four elements. They are the continuous flow of value by which quality continuously improves, production defined by the customer instead of by the producer, production only at the pull of the customer instead of batch and queue where capital is locked up in excess inventory, and production in search of perfection so that resources are used to their best efficiency. In the section on simplification and scale, the authors discuss moving production elements closer together, for example, so each element can be better and better adjusted to the final product, so no part of a product is compromised to fit another, and no part of production is wasted. Production can then bend to the needs of the consumer instead of the needs of industry.

Lean thinking in action is an explanation of how simplification of factories, moving elements closer together and allowing for continuous adjustment of design for efficiency uses the same capital and human resources to increase productivity two-to-four-fold while overproduction, flaws and accidents decrease four-to-ten-fold. The motto of this type of thinking in industry is, "don't study it, just do it, keep trying. If you've fixed it, fix it again."

Next follows a long section dedicated to the third principal of natural capitalism: service and flow. Among the examples the authors give is that of Carrier's offering coolth services instead of selling air-conditioning units, so that they take under their responsibility the insulation and efficiency of a building, making it necessary for them to use smaller and smaller HVAC units to accomplish the same level of comfort. The advantage is that the customer subscribes to a service, so the income continues to flow in, and the more efficient they can make a building, the less they have to spend to cool it. The advantage to the customer is that the responsibility of upkeep of the machine always falls to the supplier of the service, and the cost of energy will continue falling for the customer the better the provider is at its job. In several categories, suppliers of services can provide continuous, customized, decreasing-cost solutions, and both the customer and the provider profit from increased efficiency.

In the section called "A New Lease on Life," the authors describe the ecosystem-wide benefit to a service-and-flow economy. It reduces waste as manufacturers recycle their finished products and make them ever more efficient, it raises the quality of life for everyone in the system, and eliminates the periodic booms and busts in industry since there is no static inventory to lock up capital in down economies.



Capital Gains

Capital Gains Summary and Analysis

This chapter is dedicated to the inequity of value placed on natural capital and the things that destroy it. The Biosphere studies identified what financial cost would be involved in trying to equate the life-sustaining abilities of an ecosystem in a closed system, and the costs for only 8 people were more than \$200 million. Similarly, studies into artificially producing the environmental conditions necessary for life globally that we are destroying with industry are astronomical, and still the conditions would be inadequate. Instead, there must be a recognition in business that natural capital is invaluable, and that protecting and restoring it must trump traditional ideas if we are to survive.

Subsidies are the way the government has encouraged economic growth in one direction instead of another in the past, and so must logically be used again. Bringing about the changes that would be necessary however, will require a universal shift in thinking, and a complete reworking of our tax system. Instead of taxing employment, and thereby discouraging human labor, we must reward it. Instead of subsidizing wasteful and destructive agriculture and agricultural practices like pesticide use and the use of nitrogen fertilizers, we must tax it out of existence. Perverse subsidies encourage an economy to lean in the direction of destruction by artificially cheapening the destructive thing and making its alternative therefore too expensive. Instead, we must tax destruction, waste and pollution. Then, we could even use the income generated to invest in the future protection and regeneration of the protected natural capital.

The chapter closes with a letter written by the CEO of Interface, Inc., Ray Anderson, in which he communicates his vision for the sustainability and resource responsibility of the company to his employees. He states his intention to use only recycled materials for their floor, thereby cleaning up and re-purposing waste and ceasing the company's pull on the environment, and to fuel their factories entirely with the sun, so it leaves no waste behind. Four years after he wrote the letter, Interface's revenues had doubled, as had its employment, and profits had tripled.



Nature's Filaments

Nature's Filaments Summary and Analysis

The chapter opens with a description of the industrial revolutions that made growing, harvesting and using cotton and wood for our clothes, papers and homes exponentially easier. Then, petrochemical industry came along with synthetic fibers that, while they relieved the burden on growing and harvesting natural fibers, they produce a great deal of pollution and use nonrenewable resources. Paper as an industry is also incredibly inefficient and expensive to our natural resources, and has produced an incredible amount of landfill waste before recycling became the norm. The other alternative is to replace paper storage and interchange of information with electronic storage and communication, so that in the same way that reducing energy use at the consumer end reduces the amount of energy a power plant has to produce by huge amounts, reducing the pull on paper on the consumer end reduces the amount of paper the industry has to create, whether from natural or recycled sources. Compounding arithmetic, begun with individual reductions, affects the overall savings at the production end quite dramatically.

The next alternatives the chapter describes are meant to replace our dependence on wood, particularly from old-growth forests. Wood fiber and other such engineered wood products can be made from used wood into much stronger, lighter and more uniform pieces, allowing for strong and light structures that can be easily built, since the pieces are already shaped for their purpose, and easily disassembled and recycled. Similarly, in houses, reductions of 70-74 percent can be made to the amount of wood in walls of houses, while the wood used is stronger and more stable over time without the creaking and moaning of natural wood. Recycling wood has already become a major industry, as have wood reclaiming projects that go toward soil improvement, and decopiers that allow ink to be removed from paper so it can be used up to ten times. Worldwide sentiment has begun to rally around the idea that wood fiber harvesting is a poor trade-off for the value of the indigenous forests they destroy.



Food for Life

Food for Life Summary and Analysis

A revolution similar to the one that happened in the textile industry happened in agriculture as the responsibility of feeding the exploding population began to be absorbed by large corporations, and increasingly larger swaths of land are dedicated to increasingly smaller varieties of crops. The "Green Revolution" in the middle of the 20th century was focused on high-yield seeds, biocides, irrigation and nitrogen fertilizers, and the results have been dramatic and increasing imbalances in nitrogen levels and other such chemical changes to the soil, as well as the loss altogether of topsoil as the complex mix of living bacteria, bugs and worms that depend on a biologically diverse mix of plants in an area die away. While energy efficiencies have increased with the advances in engineering, the condition of the soil and the available diversity of seeds has decreased with frightening speed as corporations have bought up and narrowed the focus of all of the seeds that once gave the Americas their botanical variety.

Innovation is always moving in farming, however, and energy-saving efficiencies like the wind-drying silo have saved crops and energy costs without using any energy at all, and solar driers have revolutionized fruit and vegetable drying. Lighting chicken coops have made the chickens healthier and happier, heating the coops less and allowing for fans to cool the air and increase productivity. Hoop structures for pigs have allowed the pigs both the freedom to wander around and the environment-saving freedom to deposit their droppings back into the soil. Innovations like these could make big differences in other livestock, as well. If animals are allowed to interact with their environment more like they do in the wild, they and their environment alike are more healthy. Simple changes like flooding fields instead of burning them and making them into soil-rebuilding bird habitats when they are not in crops are possible. The chapter concludes with reinforcement of the idea that healthy soil directly results in healthy climate, as the CO₂ goes to the microbes that live in the soil and allow that soil to be more productive with plants, and that the most effective way of making our soils as healthy as they can be is by emulating nature's patterns as they were before we changed them. Governments will have to change the things they subsidize, so the most destructive practices are the most expensive to continue, and the ones that restore our ecosystems become the most profitable. Organic farming capitalizes on the very principals that make a natural ecosystem thrive to make its own productions as productive as they can be, and is catching on to become a widespread biointensive science, requiring much less land to much greater productivity. These practices also make a deliberate science of restoring and strengthening the soil and its native inhabitants, restoring the Americas to the fertile richness that drew us to their shores.

Aqueous Solutions

Aqueous Solutions Summary and Analysis

The premise of the chapter on water is that we live on the water planet, and to let water flow in its natural patterns as closely as possible allows it to fulfill its role as a habitat for and contributor to life. Our systems for using water have been designed around the assumption that it is an infinite resource, and so our cleanest drinking water can be used for things like toilets, showers and car-washing as freely as we use it for survival. It has not taken us long, however, to see that we could not go on using it at the rate we had been, particularly in agriculture. Irrigation has become hugely more efficient in agriculture, as have alternatives like drip-irrigation that delivers water just to the root of the plants that need it instead of leading to run-off.

Landscaping has learned to use plants that do not require huge amounts of water in the driest seasons, and those that are native to the area, so they require only the water the area already supplies. Low-volume toilets and waterless composting toilets have saved incredible amounts of water, and have led to innovations in ways of making human waste fertilizer, further enriching the soil. Low-flow shower heads and sinks have learned to combine water and air to make as much pressure and wetting ability, saving both water and the cost of heating it. Similarly, front-load washing machines and ultrasonic washers and dishwashers have also led to better-performance in both of those tasks, in addition to reducing their pull on water. Pulling less water from aquifers also decreases the likelihood of pulling toxins from fertilizing on the surface into the water supply.

Following a section on the benefits of collecting rainwater, since it is both pure and locally collectible, the chapter also spends a great deal of time talking about how effectively biological treatment of gray (soapy) and black (human waste) water can restore the purity and usefulness of water, saving tremendous energy costs and toxicity. Dr. John Todd of Living Machines invented the system of treating water with a combination of filtering plants, algae, bacteria and enzymes that eliminate toxins from water, using the heavy metals and contaminants as food for these living systems. The key is educating future generations about the benefits of implementing efficiencies and systems like these, so that future innovation is based on the lessons of these discoveries.

Climate

Climate Summary and Analysis

The chapter opens with an explanation of carbon dioxide's affect of holding in the heat of the sun, making human life possible, but changing weather patterns and rapidly increasing the average temperature all over the world, setting heat records every year since 1983. Weather patterns change as the melting ice caps disturb ocean currents and reflect less heat than the ice, faster evaporation changes rain patterns, and rising ocean levels threaten coastal cities. Ice ages coming in mere decades can result from the disruption in ocean currents, and these are changes that could come before we are able to perfect the computer models that predict them, since so many systems interact with each other to effect these changes. But, fortunately for the climate, resource productivity is also good for business, making it cost less to eliminate the threats to the environment than to ignore them.

The international academic community has agreed for years that energy from renewable sources is much more profitable than getting it from dirty ones, and despite the best efforts at disinformation to the contrary from the Global Climate Coalition, energy companies and countries worldwide are shifting to sun, natural gas, biomass and soil-conserving farm practices that stop the release of CO₂ at great savings. Even France, who has been a bastion of faith in nuclear power, is seeing its nuclear power outpaced 2 to 1 by innovations in efficiency. Even with governmental policies in the US hostile to efficiency, renewable energy and energy efficiency has made great strides in the past twenty years. While the cost of energy has had a direct effect on how efficiently Americans have used it since 1970, it is not the only factor, as cities have undertaken educational campaigns to tell their citizens how to live with less energy, and smarter living has resulted in tremendous energy savings.

The chapter concludes with a discussion of how the United States could help its major industries transition to the fearful time of energy efficiency when its profits could fall due to decreased demand. It can incentivize job creation in new equipment and technologies creation, as well as implementation of more responsible farming and forestry practices, and focus on rewarding the economic use of fuel. The authors also speak optimistically about the Kyoto Protocol encouraging business to see reduction of carbon emissions as improving business' bottom line, citing times when the market has driven efficiency even without government mandate.



Making Markets Work

Making Markets Work Summary and Analysis

This chapter opens with an explanation of the theory behind a capitalist democracy, and its working just the way it should when all of the conditions are perfect and nothing has been tainted with anything like subsidies or taxes that tilt the market toward one outcome and away from another. In the real world, however, where government tilts markets all the time, innovation introduces new competition all the time, the markets are fraught with monopolies and several other factors mean competition is never fair, some strategy for navigating the system needs to be employed. Firms struggle to allocate money for efficiencies because they are long in the habit of looking at initial cost instead of savings over time, but Energy Service Companies (ESCOs) allow entrepreneurs to be paid for increasing efficiencies, and are catching on. Allowing companies to take the time to examine how efficiencies could save them instead of limiting their creativity with tight time constraints also saves a good deal of waste from repeating inefficiencies left unexamined. Rewarding risk-taking encourages innovation and improvement, as well.

The section on Regulatory Failures discusses the flaw of a system that rewards power company and home-builder profits instead of the efficiency with which they could deliver their commodity. The authors suggest feebates and better regulation so that efficiency is the standard for which everyone is working. "Informational Failures" talks about informing the consumer, since they can only seek out the efficiencies that they know are possible and accessible. "Value Chain Risks" is a section devoted to anecdotal evidence of the success of manufactures incentivizing efficiency in design, and encouraging cities to try pioneering technologies by replacing whatever experimental systems do not work. "False or Absent Price Signals" talks about the fact that until the "polluter pays" concept translates to energy costs, so inefficiency is penalized, we will continue to use it like the future and the environment are worthless assets. They suggest itemizing energy bills, incentivizing lower energy bills rather than higher energy sales, and taxing inefficiency, rewarding clean-up. "Incomplete Markets and Property Rights" discusses the way industries could partner in such a way that their joint transactions could create savings for each other, and arbitrageurs could seize a whole untapped part of the market exploiting the spread between resources and anti-resources, so saved resources become a powerful economic tool. The chapter concludes with a section on creative policy frameworks in which local governments reward less driving, and make public transportation more accessible, and another concluding that fair rules make markets work, so that competition is genuine and equal, and regulations only serve to keep people and industry safe, and to establish genuine feedback loops to industries.



Human Capitalism

Human Capitalism Summary and Analysis

The fourteenth chapter discusses the means by which people could be used in the same strategy as natural capital, by mimicking natural patterns, reinvesting in natural capital, service and flow and resource productivity guiding their actions, and uses the example of a Brazilian city called Curitiba. It is a city being re-purposed to foster community by encouraging pedestrian areas, planting gardens throughout the city, and protecting areas with tax refunds to let them remain wooded on private property, and managing traffic so large roads can give way to smaller ones, and encouraging public transit. The city's revolution began with Jaime Lerner, a mayor nominated for his mild manner, but his skills were in architecture, engineering, city planning and humanism, so he focused on ways of employing the unemployed with environmental jobs, revolutionizing the homeless areas with build-it-yourself kit houses and appointments with architects for every family, and opening up buildings left from dead industries to become educational and creative centers for children and adults alike.

The sections of the chapter focus on individual areas of innovation demonstrated by the Curitiba example, and are meant to be inspiration only, since every city must evolve according to its own identity, geography and population. The sections are "Transportation and Land Use," discussing its public buses' efficiency both in fuel use and organization; "Water, Wastewater and Greenspace," in which they describe the ways a city can observe its natural water and vegetation patterns and design to accommodate and capitalize on them to become as verdant as possible; "Industry and Community" describes how they have cleaned up their industry to such an extent that companies recycle everything they use due to laws requiring that they dispose of waste on their own property; "Children and Health, Garbage and Nutrition" talks about how the city exchanged garbage for food credits to both clean and feed the worst parts of town; "Education, Day Care and Jobs" talks about the attention paid to under-privileged children and gang-members in programs that provide daycare, gardening education and employment of gang-members as gardeners in their neighborhoods; "Stragglers and Arrivals" describes the programs designed to give independence to the elderly and homes to the homeless with education and home-building programs; "Identity and Dignity" talks about the efforts at making business and community information readily available to everyone, thereby increasing community, and "Synthesis" describes the way natural capitalism became synergistic with human capitalism to establish a sustainable and universally rewarding city to be an example to the whole world.

Once Upon a Planet

Once Upon a Planet Summary and Analysis

The final chapter summarizes the rest of the book in light of the conversation being had in today's media. Some camps subscribe whole-heartedly to the observations of science and their suggestion that industry urgently needs change if the planet is to survive, while others do their best to discredit the people making the claims in order that the money-making machines be allowed to continue. The enormous number of media outlets cover the conversation, and with news cycles moving fast, no conclusion is ever reached, and so the conversation stalls with no decisions made. It is left, then, to private industry instead of government to innovate and to hold itself to the highest standards of environmental responsibility. The authors describe what the owners' manual for earth might be like, explaining its unbending laws of physics and natural interaction there to be discovered and adhered to, unbending and here for our protection. Human laws must therefore learn those laws and shape human activity accordingly. Tax structures can reward environmental responsibility, corporations can cooperate and consult with one another to optimize their efficiency, and natural capital costs will have to be factored in to the costs of things to give incentive to their protection.



Characters

Paul Hawken

The author of the book. He recognized in 1994 that industry and government both needed a biological and social framework that would allow transformations in commerce to evolve and become universal. Also the author of "The Ecology of Commerce," "Growing an Economy" and "The Next Economy." Following the publication of "The Ecology of Commerce," Hawken started fleshing out a philosophy that would integrate strategies for business, government and academia, since all of those areas would have to be transformed for the revolution to be successful. Central to his way of thinking was the idea that human productivity had passed its age of being the backbone of industry, and must necessarily be replaced with a radical increase in resource productivity. The result of such a shift would be an increase in family wage jobs, as people would replace machinery in less industrial work, and in what have recently come to be called green-collar jobs. Moreover, as the environment improved, and our knowledge of how to get the most good with the least waste grew, the worldwide standard of living would increase. He cooperates in the writing of this book with the Lovins, because they were reaching the same conclusions in their own work at the Rocky Mountain Institute at the same time Hawken was researching and publishing his essays on the subject.

Amory Lovins and L. Hunter Lovins

Joint authors of the book for publication in Germany called "Factor Four: Doubling Wealth, Halving Resource Use", the Lovins recognized, as well, the unparalleled value of the role business must necessarily play in a green revolution. They had written "Factor Four" with one of Europe's best innovators in environmental policy, Ernst von Weizacker and founder of the Wuppertal Institute. The Lovins do a very similar type of work in research and innovation at the Rocky Mountain Institute, and the group of them collectively completed fifty case studies in which resource productivity had quadrupled, demonstrating that people could live twice as well at half the cost in material and energy with already existing technology. The authors recognize that evolution must necessarily continue past this point, and that it will require world-wide effort across every industry to reduce our waste as a species and repair the damage we have done to the global ecosystem. This book is intended to be a guideline and a set of working and proven examples of the philosophies that will move humanity forward. The Rocky Mountain Institute is also the research facility that perfected the hypercar and released it as public domain, so anyone could build them if they so desired.



Ernst von Weizacker

Founder of the Wuppertal Institute for green innovation in Germany, and co-author of "Factor Four: Doubling Wealth, Halving Resource Use" with Amory and L. Hunter Lovins of the Rocky Mountain Institute.

Walter Stahel

Swiss industry analyst who helped conceive the idea of a service and flow economy.

Michael Braungart

German chemist who helped conceive the idea of a service and flow economy.

Daniel Roos

MIT professor who told the 1998 Paris Auto Show that in the next 20 years, the leaders in the automotive industry would be completely different kinds of companies, like electronic and computer companies, since cars will be mostly battery operated and much lighter.

Ronald Reagan

Gutted the light-vehicle efficiency standards in 1986, continuing our reliance on foreign oil to fuel our heavy vehicles, and making it necessary that we spent, even in the 1990s, \$50 billion a year to protect our oil interests in the Middle East.

Edwin Land

The scientist who called invention a "sudden cessation of stupidity" and "not so much having a new idea as stopping having an old idea."

Kevin Kelly

Author of "Out of Control" and developer of the idea of the world of the born taking the place of the land of the made, so that systems change and adapt continuously to eliminate waste.



Ton Albers

Architect of the ING Building in Amsterdam, Holland, in which designers of every category cooperated to make a fully-integrated, green, efficient and aesthetically pleasing building for the same cost as a conventional building and exponentially less operating cost and impact on nature.

Eng Lock Lee

Singaporean energy expert cited throughout the book for his disdain of conventional wasteful design and his ideas on making buildings green in the future.

Stewart Brand

Author of the 1994 book, "How Buildings Learn" that describes a kind of design in which wiring, pipes and other interior elements can be designed to be easily moved to let the building adapt to its evolving uses.

Taiichi Ohno

Japanese efficiency sensei who masterminded the Toyota innovation in industry and teaches a model of industry without waste, or muda.

Allan Savory

Zimbabwean wildlife biologist who noticed that wild grazers did no harm to the soil whilst the herds driven by the people did, and began mimicking the native grazers' patterns, letting the soil heal and benefit from the churning and fertilizing to support crops before grazing on it again.

Thomas Crapper

Inventor of the water closet.

Jaime Lerner

Mayor of Curitiba, the Brazilian city that adopted the principals of natural and human capitalism to exemplary degrees.



Objects/Places

ING Building in Amsterdam

The example of design integration to which the authors first point to describe how efficiency, aesthetics and functionality can be optimized when all of the designers work together.

Hypercar

The lightweight car designed at Rocky Mountain Institute made of carbon fiber, with a hybrid-electric motor to use a fraction of the standard amount of gas.

Hydrogen Engines

Utilize reverse-electrolysis to make electricity and water out of hydrogen to fuel cars.

Village Homes in Davis, California

The neighborhood designed by Michale and Judy Corbett around principals of natural capitalism whose property values, low crime rates and strong sense of community now make it one of the most desirable neighborhoods in California.

Inn of the Anasazi, Santa Fe, New Mexico

Converted inn designed to be both green and celebratory of the local agriculture, handicrafts and cultures, completely self-sustaining and a highly sought spa location.

Spider Web

A substance stronger than kevlar, and made without toxic chemicals or high heat in nature.

Carbon fiber

The super-strong, super-light material hyper cars use for their bodies.



Toyota

The car manufacturer that first transformed the creativity model by allowing innovation to be continuous and fed by every member of the production line.

Carrier

The air-conditioning company who has started to sell coolth services instead of air-conditioners, allowing them to help make buildings more efficient and require less energy to cool.

Dow Chemical

Another company beginning to be service-and-flow by selling dissolution services instead of chemicals, making the responsibility for recapturing them their own, eliminating pollution.



Themes

Nature as Capital

The fundamental idea underlying the entire book is the idea that nature—its complete ecosystems and the mineral and chemical resources that make it up—is earth's and therefore humanity's most valuable resource. As such, it should be the guiding value that steers the structuring of our world economies. In manufacturing, it should be the last place we look for resources, and the first place we look for inspiration. Recycling and re-purposing elements we have already taken out of nature, we can allow the natural world to heal itself and return to the life-giving and climate-regulating mechanism it must be if life is to continue. Observing nature's ability to make very strong and versatile materials as well as highly effective pharmaceuticals without the use of toxic chemistry or high-energy, high-heat manufacturing should be our greatest resource as we move into a less destructive age of manufacturing. In community development, we should recognize nature as the source of our food and well-being, and organize our communities in such a way that we eat very close to the source of our food, grow our food and livestock in ways that reinforce healthy ecosystems and leave as much of the native plant life, water routes and soils in place as possible as we live among them. In government and business, the authors describe a system in which ecological responsibility is rewarded by tax systems and subsidies, and wastefulness and pollution is penalized out of existence.

Elimination of Waste

Throughout the book, the authors describe both the way modern industry developed into the wasteful collection of businesses it has, and the mentalities that have allowed wastefulness to remain a part of business as usual. In the beginning of the Industrial Revolution, natural resources were plentiful and people to work manufacturing jobs were less so, so exploiting natural capital and saving human labor was the logical way for industry to grow. As it developed, industries complemented each other, allowing processes to be done where they are cheapest, and their materials shipped inexpensively around to the next stop in the process. Their examples of the production of cans of soda, and of windshields for cars are excellent demonstrations of the inefficiency of materials use, fuel for transport and quality of final product for the cost to the environment. The authors point to simple changes industry can make, like service and flow instead of single sales of appliances to eliminate planned obsolescence and the problem of disposing of old appliances; moving processes closer together to eliminate energy and fuel wastes, and continuously revising designs and processes so that repetitive wastes are eliminated, and processes and products are continuously becoming more efficient. Another significant area in which the authors suggest significant waste reduction is in the design of homes and buildings; if all of the elements of buildings were built in cooperation with each other, borrowing each others'



efficiencies, the old architect's maxim that compromise in building is a matter-of-course necessity can be eliminated from our mentalities.

Communities as Living Places Instead of Centers of Commerce

In several of the examples the authors give of instances in which natural capitalism's principals have worked well, and the end result of the changes have been communities and working environments in which people's standards of living, working conditions and sense of community cohesion have been dramatically improved, proving the point that when a community is organized around principals of healthy sustainability and reduced waste, every living thing it affects is served. In the example of the ING Building in Holland, cooperative building that integrated function with aesthetics, water, daylight and plant life resulted in a building that was not only a pleasure to work in, but became a favorite gathering place for formal events, it was such a thing of beauty. In the example of the Village Homes community in Davis, California, principals of building that centered around community gardens, captured rainwater for irrigation, smaller streets to discourage driving, shared green space and renewable energy to reduce cost and pollution resulted in a neighborhood whose houses are so highly sought that they do not stay on the market, but change hands between friends on waiting lists to get in. The example of Curitiba also demonstrates, perhaps best of all, the resulting revolution that happens among community members when their lifestyles are allowed to center around gardening, parks, green space, environmental employment and community life that provides every financial strata of a community with education and natural beauty.

Style

Perspective

The authors are all experts in their fields and dedicated to the goal of business and cultural sustainability. They are both passionate proponents of the ideas of a completely green culture and pragmatists about the necessities of business and global society. Since they have been students and innovators in the field of green innovation, they are very well-informed about the evolutions it has gone through, and in what places it has been particularly well-implemented. They are very well aware of the studies that have taught scientists about the changes in the health and availability of natural resources, and what is being and can still be done to bring them back to health. In addition to a good deal of practical and technical expertise, they are humanists as well as environmentalists, continuously reminding their readers of the importance of strong community cohesion, universal employment and housing, education and involvement in the reviving of communities' natural beauty. The authors are also very aware of the synergy possible between countries, and the importance of every nation of the world participating in the revolution, so that every nation can benefit from a restored global ecosystem, climate and culture of elevated health and standards of living.

Tone

There are multiple tones throughout the book, each passionate, and each necessary for conveying their theses. The authors are at once sympathetic for the motivations of industry-past to use the natural world for everything it had to offer, since resources were plentiful and disgusted that, even well after we have recognized the destruction the continued indiscriminate use of natural resources have caused, industry has continued its patterns. Their disgust carries on from that point to the observation that industry has only sought to become more profitable, not more efficient, or with an eye toward maintaining high levels of employment. However, constant throughout the book is the complementary tone of informed optimism about and passionate advocacy of the possibilities. They point out with solid examples the successful transitions that have been made all over the world from the old way of destruction for progress to closed-loop, ecologically responsible, high-employment ways of doing business. Their being so informed shields their optimism from the possibility of being fanciful or foolhardy, and they site hundreds of resources throughout the book and in the bibliography at the back of the book for finding out more and further examining places in which the principals they propose have already been implemented. Their frustration serves to draw attention to the time that has passed since these discoveries have been made, and the huge distance industry has yet to traverse, while their informed optimism assures the reader of how cost-effective simple changes can be, and how quickly substantial progress can be made.

Structure

The book is organized like a text book, with an introductory chapter introducing the principals all of the following chapters will reinforce. Then, each chapter is dedicated to a different aspect of industry or culture, and within each one discusses both the dangers of leaving the system as it is and both the means and the benefits of making the changes they suggest. The chapters build easily on one another, establishing concepts and introducing anecdotal support in earlier chapters that are built on and complemented in chapters that follow. Throughout, there are reference numbers to refer the reader to the exhaustive list of resource studies, corporate publications, scientific studies and scholarly essays to flesh out the examples they site. While the writing is cooperative, it remains seamless, making no distinction between the voice of each contributor. The result is a cohesive, unified publication in which all of the emphasis is on the information and establishing a worldview in the reader, built from simple ideas and fleshed out with real-world examples.



Quotes

"After two centuries of rises in labor productivity, the liquidation of natural resources at their extraction cost rather than their replacement value, and the exploitation of living systems as if they were free, infinite, and in perpetual renewal, it is people who have become an abundant resource, while nature is becoming disturbingly scarce," Chapter 1, p. 8.

"Ralph Waldo Emerson once wrote, 'Nothing in nature is exhausted in its first use. When a thing has served an end to the uttermost, it is wholly new for an ulterior service,'" Chapter 1, p. 16.

"Because of the gas's unique burning properties, no one was directly killed by the hydrogen fire in the 1937 Hindenburg disaster. Some died in a diesel-oil fire or by jumping out of the airship, but all sixty-two passengers who rode the flaming dirigible back to earth, as the clear hydrogen flames swirled upward above them, escaped unharmed," Chapter 2, p. 35.

"If even a portion of these expenditures could be shifted to more productive uses, money would be available to balance the budget, raise superbly educated children, restore degraded environments, and help the less fortunate. If that seems an overly optimistic projection, consider that, had we adopted in 1974 the efficient energy practices of some other advanced industrial countries, and applied the savings to the national debt, we would not today have a national debt," Chapter 3, p. 58.

"Under the current system of national accounting, a country could exhaust its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared.... The result can be illusory gains in income and permanent losses in wealth," Chapter 3, p. 61.

"Few believed that Weiss, a Hamburg oil re-refinery, could eliminate its unlicensed discharge into the harbor until Greenpeace activists got impatient, plugged up the pipe, and announced that the plant had two hours to figure out how to clean up before its tanks started overflowing. The plant shut down for a half-year, completely redesigned its refining process, and hasn't discharged effluent since," Chapter 4, p. 65.

"An obvious remedy for this mess is for a developer to stipulate a positive incentive for achieving efficiency. Pilot projects launched by Rocky Mountain Institute in 1996-97 are now testing how efficient buildings can become if their designers are rewarded for what they save, not what they spend. Through simple supplementary contracts, designers would keep a portion of several years' measured energy savings as a bonus fee," Chapter 5, p. 92.

"Green buildings do not poison the air with fumes, nor the soul with artificiality. Instead, they create delight when entered, serenity and health when occupied, and regret when



departed. They grow organically in and from their place, integrating people within the rest of the natural world; do no harm to their occupants or to the earth; foster more diverse and abundant life than they borrow; take less than they give back. Achieving all this hand in hand with functionality and profitability requires a level of design integration that is not merely a technical task but an aesthetic and spiritual challenge," Chapter 5, p. 110.

"...As Christopher Alexander teaches in his famous design text, *A Pattern Language*: 'When you build a thing, you cannot merely build that thing in isolation, but must also repair the world around it, and within it, so that the large world at that one place becomes more coherent, and more whole; and the thing which you make takes its place in the web of nature, as you make it,' Chapter 6, p. 124.

"...the loss of living systems is accelerating worldwide, despite huge capital spending on environmental cleanup by industrial nations and responsible corporations. The gap in understanding would be comical were it not potentially tragic. It's as if you are intent on cleaning your house, which is situated on a floodplain whose river is rising. Cleaning house is an admirable activity, but it's not an appropriate response to the immediate problem," Chapter 8, p. 157.

"True, tax systems are by their very nature interventionist, but unless we abolish government, the question for society is how to intervene. A tax shift attempts to match price to cost. The present system is dissociative. People know the price of everything but the true cost of nothing. Price is what the person pays. Cost is what society pays, here, now, elsewhere, and into the future," Chapter 8, p. 166.

"At the heart of this... entire book is the thesis that 90 to 95 percent reductions in material and energy are possible in developed nations without diminishing the quantity or the quality of the services that people want," Chapter 9, p. 176.

"Their innovations go beyond conventional organic practices to create diverse forms of agriculture that are based, as geneticist Dr. We Jackson of the Land Institute of Salina, Kansas, says 'on nature's wisdom, not on people's cleverness'; that follow ecologist Aldo Leopold's dictum of tending 'to preserve the integrity, stability and and beauty of the biotic community,' Chapter 10, p. 198.

"Letting water flow wherever it belongs on the Water Planet is a key part of natural capitalism. For as Carol Franklin of the landscape architecture firm Andropogon puts it, water is not, as most civil engineers assume, mere gallons of H₂O to be taken away as quickly as possible in large concrete pipes. Water is habitat. Water is life," Chapter 11, p. 233.

"The Economist says of nuclear power plants that 'not one, anywhere in the world, makes commercial sense'.... Worldwide, 90-odd nuclear plants have already retired after serving fewer than seventeen years. Even in France, the world's acknowledged leader in nuclear technology, nuclear expansion has been outpaced two to one by



unheralded, unnoticed, unsupported, but more cost-effective energy efficiency," Chapter 12, p. 249.

"[Curitiba] has done so not by instituting a few economic megaprojects but by implementing hundreds of multipurpose, cheap, fast, simple, homegrown, people-centered initiatives harnessing market mechanisms, common sense and local skills. It has flourished by treating all its citizens—most of all its children—not as its burden, but as its most precious resource, the creators of its future," Chapter 14, p. 288.

"...Earth's operating guidelines are inherent, not imposed. They cannot be imposed, only recognized. Author Bill McKibben put it succinctly in a speech to corporate executives: 'The laws of Congress and the laws of physics have grown increasingly divergent, and the laws of physics are not likely to yield,'" Chapter 15, p. 314.

"The lesson of this book with regard to forecasting is clear: No matter what future one believes in, building the principles of natural capitalism into our planning will make the foundations of society firmer. In scenarios in which the environment begins to change rapidly (or in which its services are clearly declining), resource productivity can buy time, buffering society against sudden changes. As futurist Peter Schwartz counsels, the best option for an uncertain future is the one that leaves the most options open," Chapter 15, p. 317.



Topics for Discussion

What do you see as the most substantial hurdles to the kind of whole-system evolution the authors describe? Do you see any reasons to hope for their elimination in the near future?

What industries or systems do you observe in your daily life that could benefit from a shift to the priorities of natural capitalism?

Which parts of the example of Curitiba would you like to see implemented in your community? Are they changes you can instigate?

The example of Curitiba also demonstrated the ability a government has to effect dramatic changes in the environmental responsibility of its citizens, both in the Garbage for Food exchange, and in its requirement that manufacturers dispose of their own waste on site to inspire efficiency and recycling. What other changes can local governments make to its standards and systems to bring about similar changes?

Has reading "Natural Capitalism" inspired you to make any particular change in your own behavior, aspirations or worldview? Explain.

What do you see as the qualities of America in particular that have made it slower to adopt green energy and sustainable building practices than other countries?

Since this book was written in 1999, what encouragement do you take from current headlines? Would you add anything if you were re-releasing the book today?

The chapter on Human Capitalism talked about job creation as a result of a transformed economy, and a few examples were given in the stories about Curitiba about gang members employed as gardeners. What industries not mentioned in the book do you think would benefit from a New Deal style mass employment of people?