

BOOK EXCERPT 9.2

The Necessary Revolution

How We Got Into This Predicament



Peter Senge

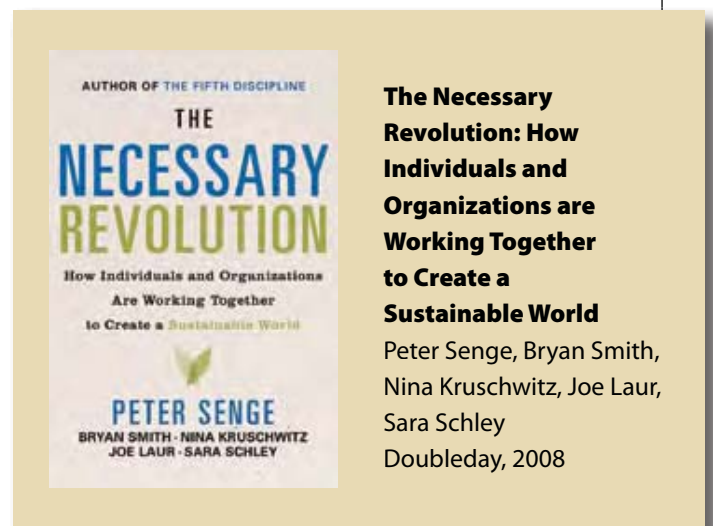
Something important has happened in the last stage of the industrial era that sets it apart from the past: Globalization has brought a level of interdependence between nations and regions that never existed before, along with truly global problems that also have no precedent. The Industrial Age isn't ending because of a decline in opportunities for further expansion. It is ending because individuals, organizations, and governments are realizing that its side effects are unsustainable. But endings are also beginnings. In *The Necessary Revolution*, Peter Senge and his coauthors share the guiding ideas that are essential for creating a more sustainable future: seeing systems, collaborating across boundaries, and moving from problem solving to creating. The book is full of stories and examples of individuals and organizations who are putting these ideas into action, many of whom are associated with SoL. This excerpt explains "how we got here" and lays out the case for urgency in radically shifting the kind of thinking that has made the industrial era so successful, and so disastrous.

The Wages of Success

How did we get to the point where we are running out of the resources (such as oil) that support our way of life, and others (such as clean air and fresh drinking water) that support life itself? And how did entire industries, such as fishing and agriculture, find themselves in trouble as well, as chronic overfishing and the drive for ever-higher crop yields led to widespread depletion of fish stocks and a historic loss of topsoil?

How on earth did we get here? The short answer is because of our success, success beyond anyone's wildest dreams.

In the first stage of the Industrial Revolution (1750 to 1820), the rise of large-scale manufacturing caused labor productivity in England to rise a hundredfold. But the Revolution did not simply change the way we worked; it transformed the way we lived, the way we thought about ourselves, and the way we viewed the world. Nothing like it had ever occurred before.



The Necessary Revolution: How Individuals and Organizations are Working Together to Create a Sustainable World

Peter Senge, Bryan Smith, Nina Kruschwitz, Joe Laur, Sara Schley
Doubleday, 2008

It didn't take long for innovations such as the assembly line to spread to other countries in northern Europe and to the hinterlands of the United States, whose exploding population and vast store of natural resources enabled the former colony to become the next industrial power. Industry was booming and so, too, were

the material standards of living. As the United States' population increased from about 10 million to 63 million between 1820 and 1890, the country's industrial production grew thirtyfold. The resulting fivefold growth in output per person was even greater than the productivity gains on the other side of the Atlantic.

The impacts the Industrial Revolution had on quality of life were undeniable. As industrial expansion continued into the twentieth century, life expectancy in the industrial world roughly doubled, literacy jumped from 20 percent to over 90 percent, and benefits hitherto unimaginable sprang up in the form of products (from private cars to iPods), services (from air travel to eBay), and astounding advances in medicine, communication, education, and entertainment. With this kind of success, it is little wonder that the side effects of the Industrial Age success story went largely ignored.

But the downsides of this great prosperity were steadily accumulating from the very beginning. Some were hard not to notice. In the 1800s, England's level of fossil fuel combustion grew dramatically, and so too did levels of water and air pollution. In the late 1800s, London's infamous "fog," particulate emissions from burning coal, caused a virtual epidemic of respiratory diseases once confined to coal-mining communities. By 1952, air quality in London was so bad that the "great smog" (four days of toxic air trapped over the city) killed more than 4,000 people and galvanized the government to create air pollution regulations.¹

Other side effects went unseen. Invisible CO₂ emissions in the United Kingdom rose from virtually zero to over a million tons per year by the end of the nineteenth century. During America's twentieth-century economic miracle, the amount of fossil fuels burned grew so much that by the end of the century CO₂ emissions totaled almost two billion tons annually, or about seven tons per person.



Despite growing awareness of the importance of a healthy environment and successes in pollution reduction, even a cursory summary shows that things have mostly gone from bad to worse worldwide. Let's look at the problems by category.

Industrial Waste

- The U.S. economy consumes over 100 billion tons of raw materials per year; more than 90 percent of this, by weight, ends up as waste from extraction and production processes. That works out to about 1 ton of waste per person per day.²
- Solid and liquid industrial wastes (such as plastics and petrochemical wastes) disperse through groundwater, and airborne pollutants (such as acids) can travel hundreds or thousands of miles

before they end up in rainfall, soil, and water. These pollutants affect health both directly (they've played a role in the significant increase in asthma since 1960) and indirectly (by decreasing food and water quality).³

- The "Asian Brown Cloud," a dense blanket of airborne, mostly industrial particulates, has been blamed for 500,000 deaths from respiratory illness per year in India alone.⁴
- Seventy percent of the developing world's untreated industrial waste is dumped into rivers, lakes, oceans, or soil.⁵

Consumer and Commercial Waste and Toxicity

- Approximately 8 billion tons per year of carbon in the form of carbon dioxide are emitted globally through the burning of fossil fuels for transportation, heat, and electricity worldwide. This is approximately 5 billion tons more than the biosphere can absorb.⁶
- Around the world, more than 90 percent of computers, TVs, video and audio recorders, PDAs, and other consumer and commercial electronics end up in landfills. About 20 to 30 million cars are taken off the road every year around the world; in the United States, about three-quarters by weight are recovered as scrap metal, but in the developing world, most old cars end up as waste in landfills.⁷
- Packaging waste has grown 400 percent in the past twenty years, mostly cardboard and diverse plastic containers and wrappings. While a few types of plastic containers are recycled at higher rates (such as water and soft drink bottles in developed countries), the vast majority of plastics worldwide – more than 90 percent – end up as solid waste. In the United States, for example, 93 percent of plastics end up in landfills.⁸
- Toxins embedded in everyday products also pose significant health risks even before they are discarded to landfills. For example, immunologists have shown that a great many diseases (such as many cancers) have become far more prevalent to-

day due to toxins in our bodies that come not only from food ingredients but also from chemicals in products, dyes used in cloth, and plastic compounds in children's toys, computer screens, and household appliances.⁹

Non-regenerative (Non-renewable) Resources

- In a study commissioned by the U.S. government, the U.S. petroleum industry recently reported that world oil and gas supplies will be unable to keep up with rising global demand over the next twenty-five years, which could lead to continually rising prices (oil rose from \$25 per barrel to \$100 per barrel between 2000 and the end of 2007), shortages, and social instability in both producer and consumer economies.¹⁰
- The United States consumes about 20 million barrels of oil a day (about 25 percent of global consumption); China consumes about 6 million; Japan, 5 million. About 80 percent of the oil consumed in the United States is imported.¹¹
- Other mineral resources in significant decline include zinc, copper, and iridium, all critical for technological innovations we've come to depend on, such as computers and cell phones.
- Coal is relatively abundant (known stocks are expected to last 50 to 100 years at current extraction rates) but problematic: It is the single biggest source of air pollution in the United States (and includes substantial amounts of highly toxic elements such as mercury), and CO2 emitted per unit of energy (BTU) is roughly double that of natural gas. Coal generates 54 percent of the United States' electricity, 80 percent of Australia's, and 80 percent of China's growing electricity use.¹²

Regenerative (Renewable) Resources

- Freshwater quality. More than one-fifth of the world's people do not have reliable access to clean drinking water, and many are chronically dehydrated. Many natural water supplies – rivers, lakes,

groundwater – have become increasingly degraded. Roughly two-thirds of the water we use goes to agriculture, and runoff from pesticides and fertilizers is the single biggest polluter.¹³

- Topsoil. Overproduction has caused severe or extreme soil degradation of over 1 billion hectares (or over two and a half billion acres) in the past fifty years – more than the size of India and China combined.¹⁴
- Fisheries. Over 70 percent of the world's fisheries are chronically overfished. Many species are so depleted that if drastic actions are not taken soon, their populations will likely be unable to recover. This will affect more than just consumers; the fishing industry itself will suffer, and as coastal economies are ruined, the unemployed will migrate, becoming part of the growing millions of unwelcome migrants worldwide.¹⁵
- Forests. More than a third of the world's forests have disappeared in the past fifty years. Their loss, especially in the tropics, affects the lives of many communities and species and reduces the rate at which CO₂, the main greenhouse gas driving climate change, is absorbed from the atmosphere.¹⁶

Our diminishing resources and growing waste underlie a host of related economic stresses and reflect environmental and social imbalances that all but ensure that, without significant change, these problems will worsen.

The first imbalance concerns nature's capacities to continue regenerating resources and providing the "eco-services" upon which human life depends – clean water, breathable air, fertile soil, pollination, and a stable climate. In economic terms, most of these services either have no substitute or are prohibitively expensive to generate by alternative means.¹⁷ Today, according to the UN's Millennium Ecosystem Assessment report, one-third of the major ecosystems that provide these essential services worldwide – from forests to grasslands and wetlands – are in "significant



decline," and another one-third are "in danger." Since 1900, more than half of the world's wetlands have been lost. Today, 50 percent of the world's five hundred major rivers are heavily polluted or drying up in their lower reaches. The acidification of oceans (primarily due to the absorption of CO₂ from fossil fuels) has, in the past twenty years, caused the loss of 20 percent of the world's coral reefs, while 20 percent more have been seriously degraded. Many of these reefs protect coastal areas from flooding and serve as critical breeding areas for marine life.¹⁸

As the Millennium Ecosystem Assessment report also discusses, declining ecosystems and increasing pollution tend to correlate with the erosion of our sense of spiritual and non-material well-being, in developing and developed countries alike. Growing social stresses are all too often taken as the norm today. In the developed world, we are plagued by anxiety, overwork, stress, mistrust, fear, and anger. America isn't the only advanced country "bowling alone," to

borrow Robert Putnam's famous phrase for the breakdown of social community; similar signs of social stresses have been increasing in other nations, such as the tensions in Europe over growing African and Islamic immigrations.

In developing countries, environmental and social stresses often have a harder economic edge. According to the World Bank, from 1980 to 2000 the bottom quartile of the world's people found that their share of global income fell from 2.5 percent to 1.2 percent.¹⁹ Today, about 50 million people globally migrate each year to cities, usually driven by the collapse of traditional economies and environmental degradation of land and fisheries (as noted previously). This migration rate is far greater than can be absorbed by urban economies, and as a consequence approximately 500 million chronically underemployed people currently live in squatter camps or slums.²⁰

Inevitably, these underlying imbalances – deteriorating ecosystems and fraying social harmony – reinforce one another. The poor invariably bear a disproportionate share of the consequences of industrial waste and compromised ecosystems. This is one reason the extremes in inequity persist and are largely getting worse worldwide. Second, people living under growing stress, whether physical, psychological, or economic, have great difficulty acting as stewards for the future.

An inventory such as this can go on forever, becoming more exhausting as it becomes more exhaustive. The point, however, is not to be comprehensive but rather to be systemic: to see the deeper patterns behind all these problems, which at first glance might seem unrelated.

What these examples demonstrate is that the industrial system that has brought us so many benefits is now generating countless dangerous side effects that are swamping its ability to continue advancing standards of living. One of two outcomes is possible: Either we keep on with business as usual, leaving the accumu-

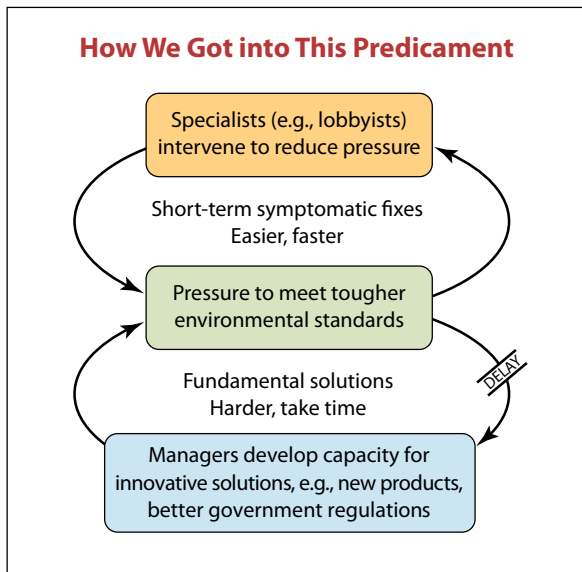
lating side effects to continue growing until they overwhelm us, or we step back far enough to rethink where we are headed. Notice we said the first thing that needs to be done is to take a step back.

Not surprisingly, when we – individuals, companies, non-profits, governments – first acknowledge problems such as the ones we're discussing, our instinct is to do the opposite, to apply exactly the same kind of thinking that created these challenges in the first place. We focus on the symptoms in front of us – the river is dirty, we emit too much CO₂ – and ignore the underlying forces contributing to them. We devise ways – usually through some combination of stop-gap regulations or find-the-villain blame games – to try to fix the symptoms.

Focusing on eliminating the symptoms is always tempting. Taking two aspirin to relieve the pain of a headache can be an effective solution that works quite quickly. But if a person gets severe headaches every few days, there are probably deeper, longer-term sources of the problem, such as stress or overwork, that all the aspirin in the world will not help. In fact, the aspirin can even make matters worse by masking the pain, and along with it the signals that there are deeper sources of the problem. Over time, this neglect leads to a worsening of symptoms and the need for still more intense symptomatic fixes, such as more powerful drugs that simply continue the pattern of ignoring the underlying cause of the pain.

In most organizational situations, this pattern, known as "shifting the burden," often includes shifting the locus of responsibility for dealing with difficult problems to various "others" or "experts." Business executives have been doing this for years, hiring consultants to sort out their chronic management problems, safety specialists to reduce the number of accidents, and, today, environmental specialists, such as pollution experts, to scrub emissions from smokestacks.

FIGURE 2.1 **Shifting the Burden to “Expert” Specialists**



The net effect of decades of shifting the burden to experts is that many people today regard issues involving water, waste and toxicity, energy, and community health as “someone else’s problems.” While businesspeople often have strong views about the ineffectiveness of government regulation, many also

simultaneously advocate that it is up to government to tackle such problems. And many, rather than working proactively with government to come up with more innovative fundamental solutions (lower loop in Figure 2.1), have shifted the burden to lobbyists who fight to preserve the status quo (the upper loop).

And, of course, government leaders likewise have their own set of “experts” for addressing symptoms in the form of environmental departments and agencies to whom they shift responsibility. These groups are often isolated from the core functions of government such as economic and foreign policy, taxation, and national security, and as a result their actions have marginal impact.

But the time for shifting responsibility to others, or covering up deep problems with simplistic solutions that only make problems “go away” for a short time, is running out.

In the earlier phases of the Industrial Age, the wealthy simply moved away from factories and their waste by-products. Later, we found ways to dump wastes farther away from population centers (New York City

Tips on Reading Causal Loop Diagrams

Throughout the book, you will find causal loop diagrams such as Figure 2.1, which portray interactions that give rise to patterns of change (or non-change) and forces over time. For example, in the shifting-the-burden pattern, the problem symptom “Pressure to meet tough environmental standards” can be addressed in two ways: a short-term symptomatic fix, such as using lobbyists, or a more fundamental solution, such as new environmentally friendly products or working proactively with government for better regulations. Think of these two loops as competing: If the symptomatic fix wins out, pressure to meet tougher standards diminishes and there is less need for fundamental solutions. But this leads to new forces. If fundamental solutions are neglected, the problem symptom will eventually return: since nothing is being done to actually address the underlying environmental problems, pressures will build up again. If the company still opts for the symptomatic solution when these pressures again need to be addressed (which is likely, given that the fundamental solution is no easier and they now are used to working with the lobbyists), it will lead to still more lobbying. In this way, forces build over time to shift the burden to depending more and more on lobbyists.

exports over 10,000 tons of solid waste per day).²¹ But in today's interconnected world, "away" is going away. As population and industrialization have continued to grow geometrically, waste generated in one region affects others. The earth, after all, is a finite system. Particulate emissions from Beijing affect air quality in Los Angeles, and those from Los Angeles affect asthma rates in New York. Our common atmosphere, oceans, and groundwater systems have always connected us, but the scale of industrial activity has now reached a point where the consequences of local actions are no longer simply local. The space in which short-term, Band-Aid solutions to fundamental challenges will work is contracting as fast as the space for more landfills and toxic waste dumps. The time for rethinking and redesigning is at hand.

Seeing the Whole Picture

For most of us, the endless litany of environmental and societal crises is overwhelming, both emotionally and cognitively. It is no wonder that so many simply "turn off" when confronted with another story of climate-change-related severe weather, water shortages, or toxic waste. The first problem to deal with is simply "How do I take all of this in without frying my circuits?"

"Systems thinking" has long been a cornerstone in our work on organizational learning, but the term often seems more daunting (it can easily sound like an intellectual task reserved for Ph.D.s) than helpful. In fact, systems thinking is not about fighting complexity with more complexity. It simply means stepping back and seeing patterns that are, when seen clearly, intuitive and easy to grasp.

Several years ago, working with the Rocky Mountain Institute, an energy and resource research and consultancy group, we developed a simple "systems picture" to help people make sense of the situation in which we find ourselves today.²² The gist of the picture centers on six basic ideas.

If you had to explain our predicament to a ten-year-old, this would be a good way to start:

1. The industrial system – what we make, buy, and use (from cars and TVs to buildings and power plants) – sits within the larger systems of nature.
2. This larger natural world includes living, regenerative resources, such as forests, croplands, and fisheries, and other resources that, from a human time perspective, do not regenerate, such as oil and minerals.
3. The regenerative resources can sustain human activities indefinitely, so long as we do not "harvest" them more rapidly than they replenish themselves.
4. The non-regenerative resources can only be depleted or "extracted." (That is why mining, oil production, and other similar industries are called "extractive industries.") And not surprisingly, since they cannot be replenished, sooner or later – as is happening right now – many start to run out.

Because modern societies are set up to focus on the benefits and output of industry, we tend to either not see or pay less attention to the fifth and sixth features:

5. In the process of extracting and harvesting resources in order to produce and use goods, the industrial system also generates waste – waste from extracting and harvesting resources, and from how we produce, use, and eventually discard goods. This waste damages the ability of nature to replenish resources.
6. The industrial system also sits within a larger social system of communities, families, schools, and culture. Just as overproduction and waste damage natural systems, they also cause anxiety, inequity, and stresses in our societies.

These six ideas are captured in Figures 2.2a through c on page 27, starting with the initial phase of the Industrial Age, driven primarily by expansion of production and employment, and continuing into the last half

FIGURE 2.2A Industrial Age (1750–1950)

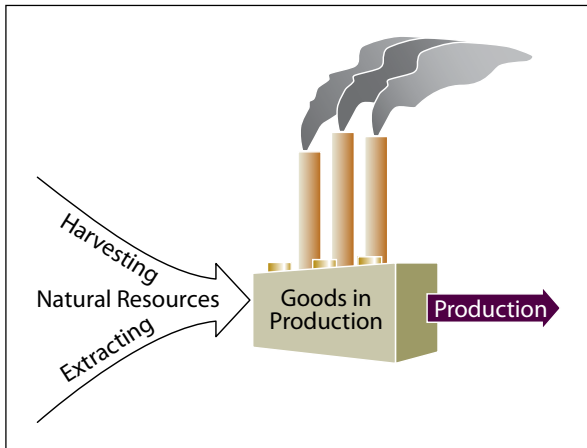


FIGURE 2.2C

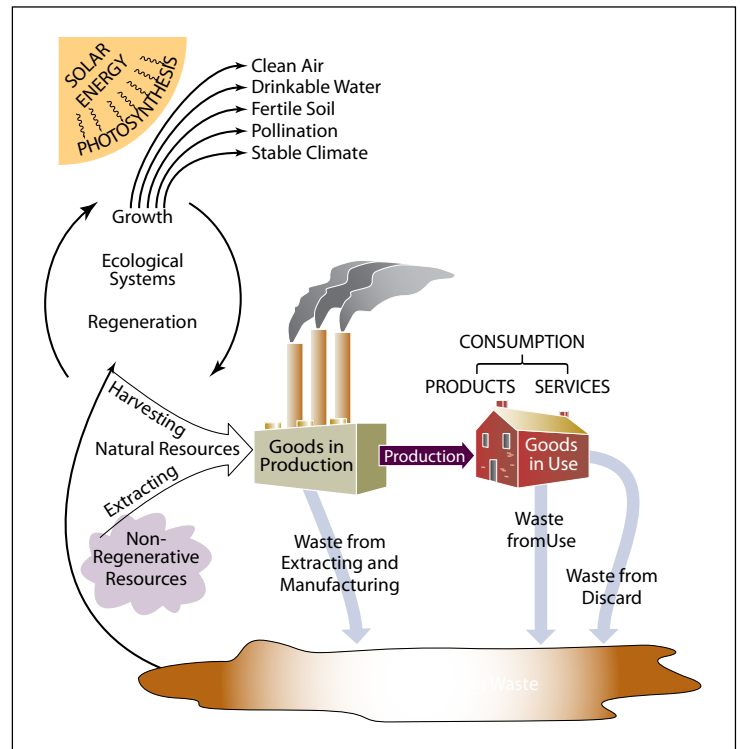
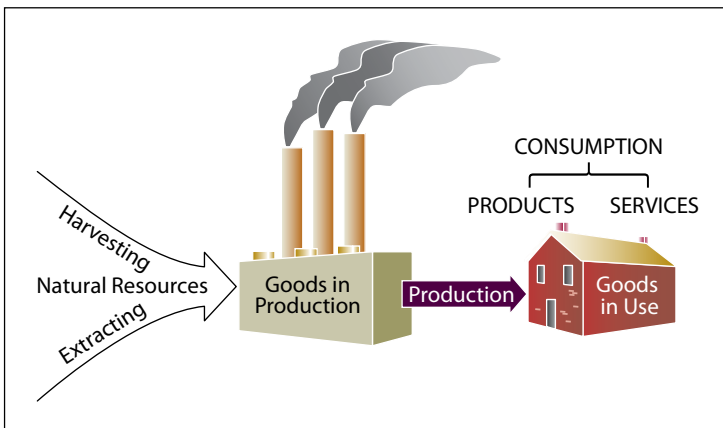


FIGURE 2.2B Industrial Age (1950–Present)



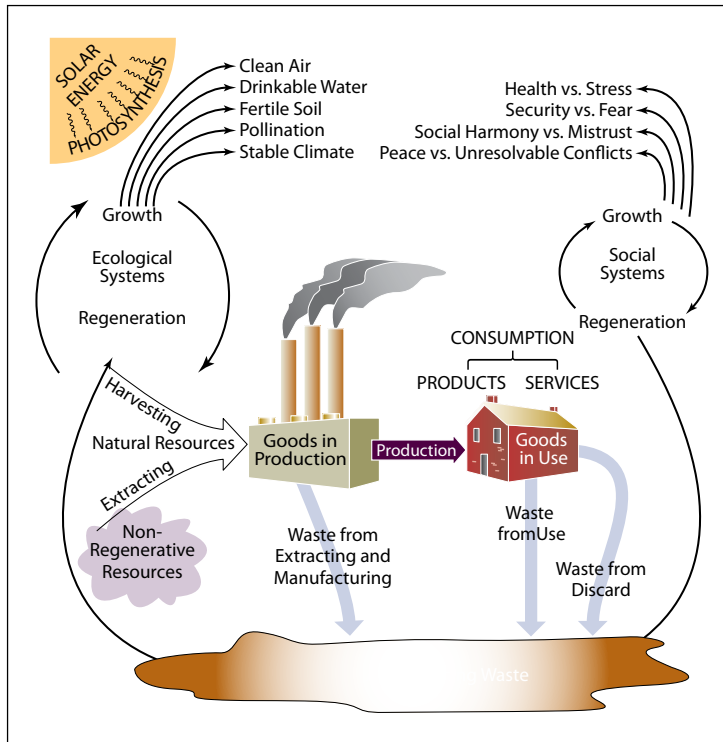
century, driven increasingly by growing consumption. This includes consumption of both tangible consumer goods (such as cellular phones and iPods) and services (such as air travel and music downloads), both of which are produced by companies based on their capital equipment and facilities.

But seeing the whole picture is difficult (see figure on page 28). Until very recently, most politicians, businesspeople, and media have focused on only the

“system within a system” – the industrial economy and how to keep it expanding. Concern for the health of the larger social and ecological systems within which the industrial system sits has been confined largely to the “back page,” even though public concern for these larger systems has been growing for more than a generation. Only in the last couple of years have we seen more front-page articles about the economy, business, and technology that mention the declining health of the ecosystems that enable the global economic system to function.

That relatively few paid much attention to these larger problems is perfectly understandable. Ignoring unintended side effects is hardly limited to this environment. Indeed, it is one of the most common underlying pat-

FIGURE 2.2D



terms that we have experienced when helping companies understand systems thinking. For example, managers are often rewarded generously for cutting costs and improving short-term profits, but the side effects of their maneuvers, such as demoralized workers or angry customers, often end up costing the company more in the long run.

Put differently, we have gotten into our predicament today because of a way of thinking that focuses on parts and neglects the whole. We have become masterful at focusing on immediate goals – such as short-term profits – and neglecting the larger systems of which quarterly profits are but one small part. But this is changing because the larger reality can no longer be ignored.

The Case for Urgency: The 80-20 Challenge

Although the problems of the Industrial Age have been evident for decades, there is now one important difference, an increasingly inescapable mandate urging us to wake up and start operating differently: global climate change.

Though but one of many side effects of global industrial growth, climate change has two unique aspects: The current and prospective costs are enormous for both rich and poor, and it provides simple, numerical indicators of just how far out of balance we are – and how rapid and strong the adjustments must be if we are to avert disaster.

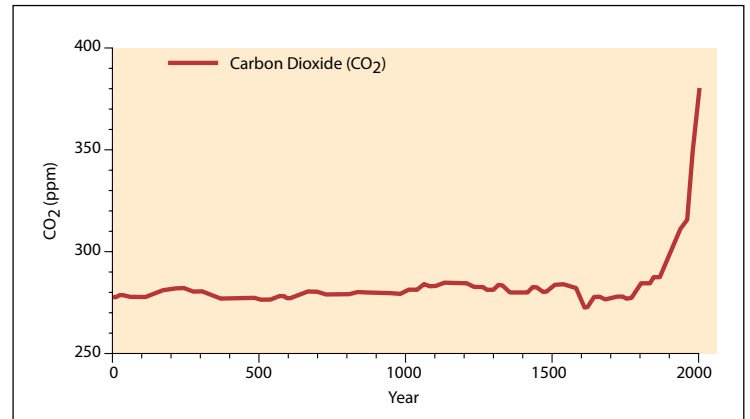
Although science rarely provides absolute certainty, a consensus has emerged among scientists, and among a small but growing cadre of influential leaders, that the changes needed to avert extreme and possibly uncontrollable climate change will be greater and must happen far more quickly than we imagined even a few years ago. In this sense, climate change is a particular sort of gift, a time clock telling us how fast the Industrial Age is ending.

As for the costs of climate change, they already are considerable, and will be far greater if we do not address the issue quickly and systematically. In 2007, Oxfam International, one of the world's largest and most respected civil society organizations (often called non-governmental organizations or NGOs), published the first study on climate change "compensation" costs for the poor – what it would take to compensate for the suffering from disease, failed crops, and dislocation arising from climate change. This report placed the costs at \$50 billion globally and noted that they will rise precipitously in the coming years. In preparing the report, Oxfam's larger goal is to establish a method to make these escalating costs visible. The costs to the insurance industry already can be seen: Insurance premiums are rising dramatically – up to 40 percent in Florida, 20 percent in

coastal Massachusetts, and 400 percent for some offshore oil rigs – reflecting the risks of climate instability. These rates make self-insurance (dropping coverage and taking your chances) more economical for many businesses and homeowners in high-risk areas such as southern Florida. The influential Stern Report, commissioned by the UK government in 2006 and led by a former World Bank chief economist, concluded that if dramatic changes are not made soon, the costs to the world of climate change in the next decade could equal or exceed the costs of World War II.²³

Unlike so many other global social and environmental problems, in one sense climate change is simple – because its primary dimensions are measurable. Scientists now have extensive evidence of how rapidly CO₂ and other greenhouse gases are accumulating in the atmosphere, and how that compares with historical levels.

FIGURE 2.3



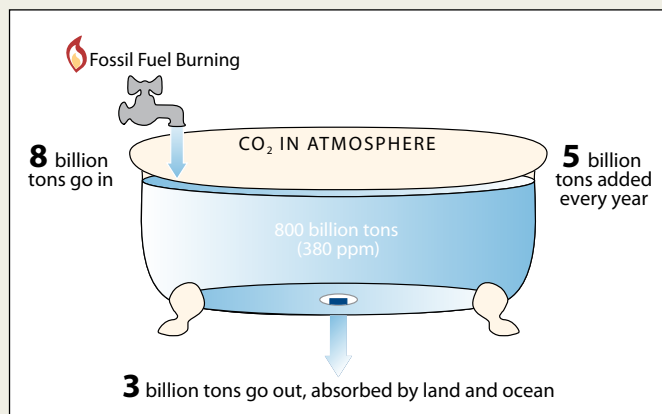
CO₂ concentrations in the atmosphere have been rising throughout the industrial era, with the current level more than 30 percent higher than in 1850.²⁴ This level is continuing to increase rapidly because the

The CO₂ Bathtub

The difference between inflows and outflows of CO₂ in the atmosphere works just like a bathtub: The CO₂ level rises as long as more flows in than flows out. This simple fact has confused many people, including many in important leadership positions, who believe that curtailing emissions growth alone would solve the climate change problem.²⁶

So long as the inflow of CO₂ emissions exceeds the outflow of CO₂ removed from the atmosphere, at some point the bathtub will “overflow.” This means that unless we reduce emissions to equal CO₂ removed from the atmosphere – in other words, a 60 percent to 80 percent reduction of worldwide emissions – we will likely enter an era of irreversible climate change.

FIGURE 2.4



The atmosphere as a bathtub, with annual inputs and outputs of CO₂. The level in the tub is rising by about 5 billion tons per year (2.1 billion tons of carbon equivalent = 1 part per million (ppm) CO₂).

(An interactive simulation of the CO₂ bathtub is available at http://www.sustainer.org/tools_resources.)

amount of CO₂ emitted from combusting fossil fuels in our power plants, buildings, cars, trucks, airplanes, and factories each year – about 8 billion tons of carbon equivalent per year worldwide – is more than double what can be removed from the atmosphere and absorbed by natural biomass (trees, plants, and plankton) and dissolved in oceans.²⁵

No one can say with certainty how much CO₂ in the atmosphere is too much, but a few basic facts are starting to coalesce into a strong consensus.

First, current levels of CO₂ are almost one-third higher than at any other time in the past 650,000 years.²⁷ This includes much of human history, a period of time in which, despite periodic ice ages, the overall climate was conducive to human life.

Second, concentrations of CO₂ in oceans and biomass are far above historic levels, causing problems such as ocean acidification and raising questions about how much more these natural CO₂ sinks can absorb. If they start to absorb less, more CO₂ will concentrate faster in the atmosphere, driving global warming faster.

Third, there is a long time lag before the full effects of CO₂ are felt on temperature and climate; scientific estimates put this at thirty to fifty years. This means that the full effects of current atmospheric CO₂ levels will not be felt until 2050 or even later.

And finally, at some point, rising CO₂ and greenhouse gas levels trigger “runaway” effects in which climate change causes further climate change, such as melting arctic permafrost releasing methane (another greenhouse gas) into the atmosphere, leading to still more warming.²⁸ Once these “tipping point” feedbacks take off, our ability to influence the future may decline significantly.

So how much CO₂ is too much? Some scientists feel that present levels of CO₂ (about 380 ppm) are already too high. Others believe the risks of triggering irreversible and uncontrollable effects will increase substantially if CO₂ levels continue rising as they have for another one to two decades (reaching levels exceeding 425 ppm or so). By contrast, continued business-as-usual growth in CO₂ emissions would lead to mid-century CO₂ levels about twice as high (approximately 550 ppm) as the historic maximum for the last 650,000 years, and far more dangerous – levels that few with any sense of stewardship for future generations, let alone present ones, should tolerate.²⁹

In some sense, the “How high is too high?” debate is academic because simply stabilizing CO₂ levels will require extraordinary and dramatic reductions in emissions worldwide – a crucial point to which the people of the world have just begun to awaken. A little more than a decade ago, a number of nations came together to shape the Kyoto Protocol, the first intergovernmental agreement to confront climate change (which the United States never signed). The accord focused on curbing emissions growth. But as we now know, stopping the rise of CO₂ levels in the atmosphere, the primary source of climate change, will actually require significant emissions reductions. Accomplishing this will require a sea change in the kinds of energy we use, cars we drive, buildings we live and work in, cities we design, and ways both people and goods move around the world, as well as other changes no one can even imagine.

Advances in climate science will continue to be crucial for understanding the specifics of how rising average temperatures are likely to affect rainfall and drought patterns, storm activity and intensity, the spread of disease, and significant increases in sea levels. But science can take us only so far. Sooner or later, it becomes a matter of making choices, not simply waiting for more predictions.³⁰

Already, people and institutions around the world are starting to formulate bold “stretch goals” – aspirational targets that can galvanize the imagination, creativity, and courage truly called for.³¹ Though the details of these goals differ, their central message is the same: To stabilize CO₂ in the atmosphere at levels that minimize the threat of catastrophic consequences will require a 60 percent to 80 percent reduction in emissions within the next two decades!³² We call this the 80-20 Challenge, the bell tolling the end of the Industrial Age.

While focusing on CO₂ levels helps us to understand the urgency we face, it is equally important to remind ourselves that climate change is not an isolated problem. Rather, it is part and parcel of all the other problems that are signaling the end of the Industrial Age: accumulating waste by-products that derive from the take-make-waste industrial system; diminishing resources (some of which are driving CO₂ levels further upward: about 6 billion tons of CO₂ per year are

released from deforestation – including the burning and decaying of wood – alone); deteriorating ecosystems; the intensification of social stresses (such as the United States’ foreign policies, driven by dependency on Middle East oil). Climate change is but one thread in a larger cloth; we cannot simply remove the thread, but must reweave the cloth.

Because the side effects of globalization are inter-related, meeting the 80-20 Challenge of reducing emissions 80 percent in twenty years will require changes in all the major global industrial systems: food and water, energy and transportation, and the global production and distribution of goods. Little in our modern way of living will be unaffected.

In other words, the change will not happen without a radical shift in the thinking that has made the industrial era so successful – and so disastrous. ■

ENDNOTES

- 1 David Urbinato, “London’s Historic ‘Pea-Soupers,’” EPA Journal, Summer 1994, www.epa.gov/history/topics/perspect/london.htm.
- 2 Paul Hawken, Amory Lovins, and E. Hunter Lovins, *Natural Capitalism* (Boston: Little, Brown, 1999), 8. The waste equals 1.5 tons per day if you assume the average American weighs 150 pounds, and twenty times a person’s weight per day.
- 3 Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: General Synthesis* (Washington, DC: Island Press, 2005), www.millenniumassessment.org/en/Synthesis.aspx.
- 4 UNEP, “The Asian Brown Cloud,” Executive Summary, 2002, www.scientificjournals.com/sj/espr/Pdf/ald/5339.
- 5 Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: General Synthesis*.
- 6 See carbon bathtub diagram, page 29, Scientists debate how much of the CO₂ emitted from burning fossil fuels can be absorbed in “carbon sinks” such as plants and algae and dissolved into the oceans. Peter N. Spotts, “Nature’s Carbon ‘Sink’ Smaller than Expected,” *Christian Science Monitor*, May 3, 2007.
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