

# CHAPTER 1

## Introduction: An Overview

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We live in the best of times, times in which science and technology have made incredible advances, the international political system is the most peaceful it has ever been, and democracy steadily advances. But we also live in the worst of times, times in which the U.S. economy and middle class have gone into long-term decline, global warming, if not stopped, could fundamentally alter life, critical ecosystems are being destroyed, and the end of the era of cheap oil has arrived. We seem to possess the means to solve our global, systemic problems; yet we are having a hard time setting a path that will lead us to a sustainable future.

### **BEST OR WORST?**

Computers and new communications technologies seem to be changing our lives almost every day. Scientists are continuously exploring new ways of understanding the world, including the universe, terrestrial ecosystems, and the inner workings of the cell and the human body. Engineers constantly create technological change, including better vehicles, better buildings, and better gadgets. Cutting-edge factories are miracles of productivity and output.

Despite the horrors of 9/11, this may be the most peaceful moment in world history, at least among the planet's most powerful nations. No one seriously thinks that war could break out among the United States, Europe, China, India, or even Russia or other

large countries such as Brazil. Before 1991 and the breakup of the Soviet Union, the threat of nuclear and conventional superpower war hung over our collective heads; the 20th century had been the most violent, including two world wars; the 19th century was one long string of international and colonial wars, and so on, back for thousands of years.

With the important exception of China, most countries in the world are at least nominally democratic, a first in world history. From 1776, when the United States was born as a white-male-property-owning democracy, until now, a world in which India and Russia are democracies, along with Latin America and most of eastern Asia, the peoples of the world have never had such a large voice in the conduct of their own affairs.

And yet, even with all of this technological, international, and national good news, the world stands at the precipice of environmental collapse, and the people of the United States, in particular, risk slipping into a sharply lower standard of living. Even as scientists are able to unravel the complexities of ecosystems, those ecosystems are being wiped out. The engineering marvels of the global energy system are leading to changes in the climate that will melt the glaciers needed for many of the world's rivers, wipe out cities that are close to sea level, and turn lush agricultural areas into deserts. The global transportation infrastructure and much of the world's buildings were constructed on the assumption that oil will continue to be found for a very long time, even though global production has peaked. Although medical advances are made in the United States, millions of people can't even get medical help.

Even though the Cold War no longer exists, the enormous U.S. military still does, soaking up money and engineers, embroiling the United States in unwinnable and unwise wars such as in Iraq and Afghanistan. Human beings seem to have moved from making war on each other to making war on the planet, stripping it of various minerals, leveling huge forests, and turning oceans into wet deserts. Even though there are fewer global wars, there is more global poverty.

Although people can elect their political leaders, they can't elect their economic ones. In the United States, large corporations have just about taken over the federal government; hundreds of chief executive officers (CEOs) have more power than millions of voters. Globally, financial and corporate decisions affect whole communities that have no say over how their economies are affected. In the United

States, millions of people and thousands of communities had no choice but to see their factories closed and their jobs lost.

On the one hand, we have the technological means to solve the myriad problems we face, we have the democratic means to achieve those ends, and the international situation is conducive to a peaceful, cooperative resolution of these crises. On the other hand, we face a daunting set of interconnected problems that are global in nature, that provide wealth and power to those already wealthy and powerful, and that require the development of a new global consciousness.

## A SYSTEMS PERSPECTIVE

This book is written with the assumption that we live in a world full of tough problems, but that it is possible to build a better global civilization. To handle the complexity of these times, *Manufacturing Green Prosperity* will offer a new framework for understanding the political, economic, and ecological systems that are at the heart of what we call civilization. In particular, an entirely new kind of economics will be presented with the following characteristics: an economics in which production, and manufacturing in particular, is acknowledged to be at the center of economic life; one that presents a realistic picture of the need for the government to design and finance much of the structure of the broader economic system; and one that incorporates an understanding that, for an economy to operate in the very long run, it must be a good steward of the environment on which it depends.

Once we have a usable framework in hand, we can more easily understand the interactions of the various parts of our society and ecosystems. We can more clearly perceive the direction that the system as a whole is headed, and then we can better understand what kinds of solutions are needed. We will need to change some of the fundamental structures of our global systems, not just fix things around the edges. When changes are big, we need a road map of where we are and where we are going.

In this book, I will use the concept of a *system* to mentally organize the complexity of national and global systems. The term has been used for many things over the years,<sup>1</sup> so I will be very specific about my definition of the term. Generally, a system contains both the elements that compose it and a *structure*, that is, a description of how the pieces fit together. For instance, a drawing is composed of

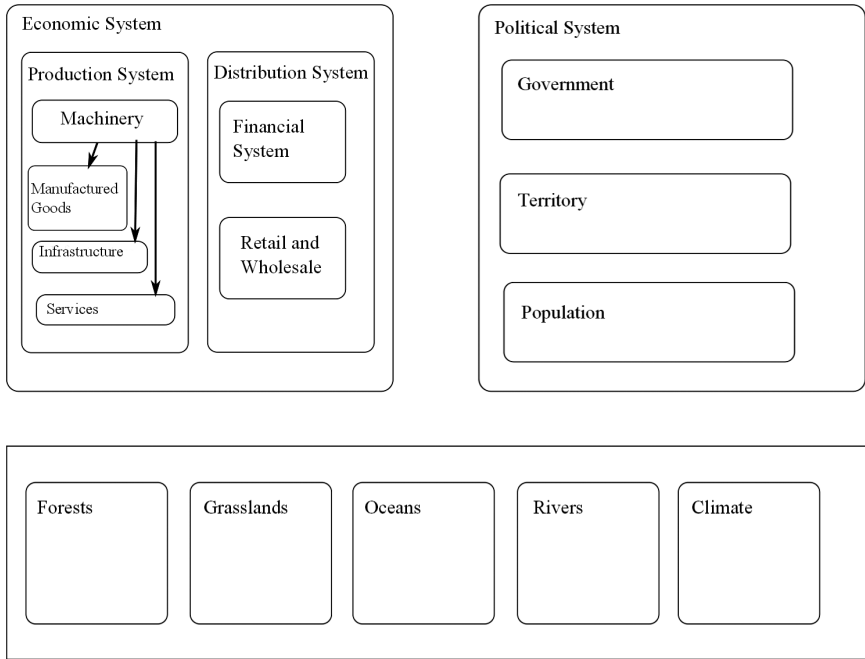
lines and dots that are positioned according to a particular structure; one kind of structure of lines might lead to a drawing of a face. With the same elements, a different structure might lead to a drawing of a window.

How do you know what elements make up a system and how they are structured? You create different models and see which one is better at explaining the complex system under consideration. In the domain of economics, the conventional, neoclassical model is the one that is most used, and it has many important problems. It cannot differentiate among different sectors of the economy, such as manufacturing and finance; there is no concept of a “function” in neoclassical economics, that is, every firm is assumed to exist as a separate, nearly identical entity in a competitive market.

What if we thought of the economy as an ecosystem, like a forest, made up of essential pieces or niches, all of which are dependent on each other? We can model a society as being composed of several systems: first, an economic system, which in turn would include a production system—machinery, which then produces manufactured goods, agriculture, construction, most services, and the physical infrastructure, including transportation, energy, and urban systems—and a distribution/exchange system—finance, retail/wholesale, marketing; second, a political system composed of the government, citizenry, and the territory of the country; and third, the various ecosystems, such as forests, oceans, water, air, grasslands, and climate. Each element of a system is itself another system. Throughout this book I will go into greater and greater detail about some of these systems, particularly the production system, and also show how these various systems form the structure of a wider system (see Figure 1.1).

Most importantly, all of these systems are interconnected. Changes in one system lead to changes in others, often reverberating back to the originator of the change. For instance, because of innovations in manufacturing, at the beginning of the 20th century the potential for automobile manufacturing increased rapidly, and because of advances in petroleum exploration, mining, and processing, enough gasoline was supplied to fill the gas tanks of all of the new automobiles. The transportation system was profoundly changed by the automobile, and oil therefore became an important part of the energy system. Eventually, cities were depleted by new suburbs. Pollution from oil affects both health and the climate, and as oil becomes more and more scarce, the entire oil-drenched parts of our

**Figure 1.1** A political ecological economy as a system



civilization will face decline and a restructuring. The automobile's very success will lead to its decline.

Because of the structure of the agricultural system, it has also risen and will soon decline. Over the millennia, societies have eroded and in various ways destroyed their soil, thereby making the production of food very difficult, if not impossible. Currently, the U.S. government subsidizes corn production, which is intensively produced, depleting soil and water, leading to the overuse of artificial fertilizers that pollute water and oceans, leading to algal blooms that kill large stretches of the ocean. Meanwhile, agriculture has become dependent on the aforementioned peaking oil, both for planting and harvesting the food as well as for transporting it the long distances it must now travel to the spread-out suburbs. The subsidized corn is used for feed for unhealthy livestock "factory" farms, which turn natural fertilizer (cow poop) into a terrible pollution problem. This form of agriculture is also responsible for about one-sixth of global greenhouse emissions. Industrial agriculture is destroying the ecological processes on which it depends.

Changing any one part of the society, involves changing myriad different parts as well. It's like a spider's web—pull on one part and the other parts move.

## **A SPIDER'S WEB OF PROBLEMS AND SOLUTIONS**

Since the parts of the society are all interconnected, the solutions to their problems are interconnected. It will be difficult to solve one set of problems without solving another set at the same time. Solving one set of problems means restructuring one system, which is a critical part of other systems' functioning.

For instance, the economy of the United States is not creating enough jobs, and the middle class looks to be in long-run trouble. What to do? According to the argument I will make in this book, the basis of any large economy is its manufacturing sector, and in particular, its machinery industries. These have been declining in the United States for many reasons: the federal government has supported military industrial production, which has made military producers less able to compete in civilian markets; the government has also helped companies to close civilian factories and open them up abroad; improvements in transportation, particularly large cargo ships and trucking logistics, have made it possible for companies to easily import goods produced abroad; and financial manipulation has become a faster way to make profits than the laborious task of innovating and producing real goods.

The market alone cannot rectify this situation, because trying to make a profit in a market is a relatively short-term, narrow process of planning, whereas what we need is a long-term, systemic redesign. But the logic of the conventional, dominant framework for understanding the processes of an economy lead to the conclusion that the market is to be trusted over the government. The framework for understanding must be changed; then we can get on with the task of actually fixing the problem. Manufacturing can be rebuilt in a particularly effective way if the government simultaneously rebuilds several parts of society, in particular, the transportation, energy, and urban systems. By buying the output of domestic factories making vehicles, energy generators, and buildings, and by providing financing for firms to expand, government can fix three problems at once: a declining industrial base, a crumbling infrastructure, and a disappearing middle class.

In the process of rebuilding the infrastructure, governments could intelligently design those systems to be ecologically sustainable as well. The word *sustainable*, like the word *system*, has many meanings (as can the term *intelligent design*). Here I wish to use the word *sustainable* to mean indefinite, that is, a system is ecologically sustainable if it can operate in its current state for thousands of years; a sustainable economy would have to pass the same test. This is quite a tall order, but it is achievable, and should be the goal of any morally defensible society. Why would we design a society that will collapse at some point in the future?

By discussing the problem of a declining economy, we took up the problem of manufacturing, which led us to the problem of a crumbling infrastructure, which led to the possibility of making the infrastructure and society sustainable. If we look at these issues separately, the solutions not only become harder, the solutions might exacerbate the problems of other systems. For instance, we could just blithely assume that oil will continue forever, and focus our manufacturing program on a resuscitation of a petroleum-based automobile industry; meanwhile, we could try to rebuild the roads, which require massive amounts of petroleum-based asphalt; and the pollution from cars might exacerbate problems of pollution and global warming. If oil becomes too expensive, the car industry will collapse anyway, asphalt for repairing the new roads will become too expensive, and we might make pollution worse by desperately looking for solutions like using dirtier, more expensive oils like tar sands or coal-to-oil technologies, or destroying more agricultural areas by growing corn ethanol.

On the other hand, we could focus on electrified trains. Trains can use electricity, and electricity can be generated with renewable, that is, sustainable technologies, such as wind and solar energy. Instead of roads, trains use steel rails; steel is very easy to recycle, and steel also uses electricity for its manufacture.

But to use trains, the urban structure needs to be changed. Trains are not very efficient if everybody is spread out in suburbs, and the stores are spread out in malls and giant big boxes; in dense cities like New York City, trains such as subways are the most efficient powered vehicles known, but subways don't work nearly as well in spread-out urban areas such as Los Angeles. So to stop using oil we need to move toward the use of trains; however, to fully embrace trains we need to move toward denser, more diverse urban structures.

Like manufacturing and transportation, the problems of the health system are connected to many different sectors. Most famously, there is a large conglomeration of power called the health insurance industry, which controls the federal government's health policies, and directs unto itself a significant percentage of the resources needed for the health sector. This is a political economic problem: as power concentrates in an industry, like health care, the process of concentration increases in speed, and soon only a few behemoths remain standing. Since corporations are essentially dictatorships, a few CEOs have the power to control governmental policy, because they can much more easily organize among themselves than hundreds of millions of health service users. They grab governmental power, which hands over yet more power, and we see the expense of the health sector increase even as millions more people are denied health care services.

This process of power leading to more power is an example of a *positive feedback loop*. In a positive feedback loop, the increase of something leads to a greater probability that something will increase even more—like a snowball rolling down a snow-covered mountain. On the other hand, in a *negative feedback loop*, an increase of something leads eventually to less of that something, as when a thermostat detects that a room is too hot and turns off a heating system.

Although the health system is shaped by the positive feedback loop of the constantly increasing power of the health insurance companies, many of the causes of ill health emanate from the other systems we have been discussing. For instance, automobile accidents cause about 40,000 deaths per year, and hundreds of thousands of injuries; coal plants for generating electricity probably contribute a similar amount of death and destruction. If transportation was based on trains using cleanly generated electricity, the health system would not be burdened with two major causes of ill health. If agriculture was restructured to not use pesticides, artificial fertilizers, and livestock factories, and if corn was not subsidized to make processed foods and drinks so inexpensive, the health system could shrink to an even smaller size. If people lived in walkable communities instead of their having to drive everywhere, the resulting exercise would lead to the population's better overall health. And of course, if there was a universal health care system, tens of thousands of deaths and illnesses would be avoided.

Thus there is a positive feedback loop, or a self-reinforcing synergy, among the various subsystems of the system we call society. It



is actually easier to solve all of the various problems of society at the same time than to solve them piecemeal. Just as the whole can be greater than the sum of its parts, so fixing the whole would be easier than fixing its parts separately.

The transformation of a system from one structure to another is a long-term process, whether that transformation leads to an unsustainable system or whether the transformation moves society in a sustainable direction.

For instance, the late Professor Seymour Melman wrote a book in 1965 called *Our Depleted Society*<sup>2</sup>—depletion referring to manufacturing, a process that did not become evident until the turn of the millennium and still seems to have escaped the notice of much of the economics profession. The oil engineer M. King Hubbert predicted in 1956 that a peak in global oil supply would occur in about the year 2000; nobody believed him (they didn't believe his simultaneous prediction that U.S. oil production would peak around 1971, which it did).<sup>3</sup> It has taken decades to destroy most of the ocean's top predators and to reduce the world's forests to dangerous levels. We have been working for a couple of centuries on dumping pollution into the air and water, and emitting the greenhouse gases now threatening the long-term survival of civilization.

The design and construction of new, economically and ecologically sustainable energy, transportation, urban, manufacturing, and agricultural systems will be a long-term project as well. This program of economic reconstruction will consist of an enormous, upfront cornucopia of capital. Ironically, even though we live in a "capitalist" system, the concept of capital is not clearly understood.

## CAPITAL, THE POWER TO CREATE WEALTH

According to the way I will use the term, capital is the power to create wealth in a society. It is not the wealth itself that people use and consume, but the *generators* of that wealth.

Almost 200 years ago, the German economist Freidrich List wrote:

*The causes of wealth* are something totally different from wealth itself. A person may possess wealth, i.e. exchangeable value; if, however, he does not possess the power of producing objects of more value than he consumes, he will become poorer. A person

may be poor; if he, however, possesses the power of producing a larger amount of valuable articles than he consumes, he becomes rich . . . *The power of producing wealth* is therefore infinitely more important than *wealth itself* . . . This is still more the case with entire nations (who cannot live out of mere rentals) than with private individuals.<sup>4</sup>

Further, “the forces of production are the tree on which wealth grows, and . . . the tree which bears the fruit is of greater value than the fruit itself.”<sup>5</sup> If capital, the power to create wealth, is not maintained, is consumed, or is in any way destroyed, then eventually wealth itself will disappear.

There are three types of capital that are necessary in order to build a wealthy society: physical capital, human capital, and natural capital. Financial capital only reflects the other three, and has no power to actually create new wealth.

Physical capital, for the most part, is the machinery that is used to create goods and services, and the infrastructure that enables the use of those goods and services. The rise and decline of Great Powers, the most important nations in any given epoch, is caused by the rise and decline of their physical capital sectors. In the 20th century, the three or four countries that were the Great Powers at any particular time produced about 80% of global industrial machinery output.

More important than physical capital, however, is the human capital that knows how to put the physical capital together. During World War II, Japanese and German factories were devastated, but enough engineers survived the war that those countries were able to eventually become the top machinery makers in the world. On the other hand, when factories are closed down, the human capital of the skilled workers and operational managers can be lost. When companies fire workers, engineers and skilled production workers lose the knowledge that those employees have of the enterprise’s operations. Their wealth of experience is a form of human capital. Germany and Japan, which in their own ways make it difficult to fire employees, have reaped the benefits of the long-term development of human capital and now have the world’s best machinery industries. Their engineers and skilled production workers make up an anchor for their middle classes, while in the United States the middle class is slipping away.

Underlying all other capital is natural capital, that is, ecosystems and resources.<sup>6</sup> Food comes from ecosystems, whether from hunting

and gathering or from agriculture and gardening. Throughout history, societies that have depleted their natural capital—particularly, soil and water—have collapsed. The same could still happen today. Currently, we are busy destroying the natural capital of the oceans, which if intelligently managed, could easily provide much of the protein humans want. Other ecosystems, such as forests, provide services, like water management, prevention of soil erosion, and even generation of rainfall, as well as the genetic material for most of our food. Ecosystems also include the resources that we use, which are limited in nature, particularly fossil fuels.

Markets can create economic booms when investors become exuberant about new kinds of physical capital, like railroads, cars, or computers. Private firms can also liquidate their physical capital, allowing it to deteriorate, in order to milk factories for profit until they go bust. Governments have always played a critical role in building infrastructure; it is the hallmark of a declining civilization when their infrastructure is allowed to run down, as ours is now.

Governments are depended on to provide most of the human capital needed for the economy in the form of education. Business enterprises create an enormous amount of human capital as well, as people “learn by doing,” as the economist Kenneth Arrow put it, but businesses will also throw that human capital away if they are allowed to pursue the lowest wages across the globe, as ours have done.

Markets are just plain catastrophic when it comes to preserving natural capital. Mining is the extreme example; you are digging something out of the ground that cannot be regenerated, and you might destroy an ecosystem or two in the process. Destroying an ecosystem to generate output is an example of destroying or liquidating capital by turning it into short-term output, for example, by clear-cutting a forest and turning it into timber or sweeping everything from a particular area in the sea in the course of fishing. Often the natural capital could be harvested sustainably, that is, by taking only as much as would not decrease the capacity of the ecosystem to produce; but instead, societies often try to maximize output in the short run, and destroy the capital from which wealth comes. They kill the goose that lays the golden eggs.

All three market-based capital problems could be at least partly solved if most firms were employee-owned-and-operated. Because democratically run firms would not shut themselves down, but instead would do everything possible to keep a factory or office

open, then human capital would remain within the firm. The physical capital would be maintained, because it would be the key to the long-term future of the owner-employees. Employees come from the area in which they work; therefore, they would probably be more sensitive to the problem of destroying their natural environment as well.

## SUSTAINABLE DESIGN

The market cannot design a *sustainable* interdependent set of infrastructures and industries. The government as currently constituted cannot either, because the government has been, to a large extent, captured by “the market.” The market is essentially controlled by about 1,000 very powerful corporations, each managed by an omnipotent dictator called a CEO. So essentially, the government is serving the needs of 1,000 CEOs, not 200 million voters. And yet, it is up to the voters to remedy this situation; the democratic means exist for creating a citizen-controlled government, as opposed to a market-controlled one.

Assuming that we could have a citizen-controlled government, why would we then have a better chance to have a sustainable society? Much of the work of economic reconstruction will require large amounts of capital at the beginning, and generally governments have been the ones that can create, raise, or guarantee this capital, along with a hefty assist from the private sector.

After the initial continental systems of capital have been built, the general cost level of everyday necessities for most people will go down, and the standard of living will go up—but only if the synergies available when designing all of these systems simultaneously are captured.

To claim that the government must step in and design the basic structure of society certainly flies in the face of the last 30 years of the Reagan Revolution, which tried to sell the idea that the government can do no good (except when fighting wars). We see where this faith has left us; we also see that we face a set of crises that are not amenable to market-based solutions. We need a post-Reagan economics. What would a sustainable design of our infrastructure systems look like?

The transportation, energy, and urban systems would ideally be designed as a set of interconnected systems. If buildings within cities

were close enough together to enable the use of electrified mass transit, then we could wean ourselves away from oil and make the transportation system electric. In order to be ecologically sustainable, that electricity would have to be generated by renewable sources: an Interstate Wind System, solar panels installed on most buildings, and geothermal energy. In order to take advantage of the fact that wind is always blowing somewhere, we would need an Interstate Smart Transmission system. To minimize the use of electricity and natural gas, we would want to make buildings self-sufficient, at least in terms of heating and cooling, by giving most of them energy retrofits, geothermal heat pumps under them, and solar hot water and photovoltaic systems on top.

With a dependable system of renewable electricity, and denser, walkable communities, we could provide for relatively small, slow, short-distance all-electric cars and trucks, which along with electrified Interstate Freight Rail and Interstate High-speed Rail Systems, would eliminate most of the need for oil for cars, trucks, and planes. If farms and factories were close to cities, the freight system could be even smaller and less energy-intensive. Agriculture that rebuilds the soil, doesn't use pesticides and artificial fertilizers, and uses recycled organic material from a close-by set of cities and towns, and a manufacturing system that uses recycled materials, doesn't pollute, and creates goods that are easy to recycle, would make the entire production system eminently sustainable for the foreseeable future.

All of these systems need a thriving and competent manufacturing sector to build the necessary machinery and infrastructure. Manufacturing does not take care of itself, any more than any other part of the economy, and historically governments have been very motivated to ensure that the manufacturing base should be as competent as possible. In the case of the United States, rebuilding the manufacturing economy would require providing a stable market for private firms, so that they could plan on a steady supply of orders, and could confidently hire and train skilled workers and engineers. By planning for the construction of all of the various systems that I have outlined above, all of the parts of a manufacturing sector should be able to rebuild and grow.

Most of the government spending for a program of economic reconstruction should require that only domestic producers could participate; this means that foreign producers in the U.S. would qualify, because now many types of industry have disappeared from the United States. The government could require foreign firms to

hire locally, or even engage in joint ventures with U.S. firms, or to work with new, employee-owned, and employee-controlled firms. As in Scandinavia, policies could be put into place to insure a high wage and salary level. Firm owners use more machinery in order to offset higher wages if the firms cannot move overseas, and this focus on using more machinery leads to more innovation and productivity, which in turn helps to rebuild the middle class.

Building a green economy is a golden opportunity to rebuild the manufacturing sector. Since so much capital needs to be provided up front, a citizen-controlled government should design and finance a long-range program of economic reconstruction, not the big banks and wealthy global investors.

The role of the financial system is to recycle wealth into the best possible investment. I have just outlined the best possible use of wealth in our society, the reconstruction of the economy to be sustainable. This means that in the medium term, most investment capital should be funneled through citizen-controlled government to reconstruct the society—that would imply the need for much heavier taxes on wealthy individuals and companies, and for a public banking system that could create the money needed for reconstruction. Ideally, national debt payments could be eliminated by replacing the debt with new money printed by the government, not the Federal Reserve, the way Lincoln financed the Civil War with greenbacks. Logically, the huge military-industrial complex should be converted into an infrastructure-industrial complex, since the long-term national security of a country is dependent on a sustainable infrastructure and economy.

At this point, the perceptive reader might be asking, “How could this possibly happen in our current political environment?” The answer is that, in the current political environment, this can’t happen. The first step in changing the political environment, however, is to have a vision of where to go and how to get there. Part of that vision has to include an understanding of how the economy, infrastructures, ecosystems, and political system are all interconnected; that understanding will be the task of this book.

## **AN ECOSYSTEMS PERSPECTIVE**

As I argued earlier, using the concept of a system is very useful for understanding complexity. Every theory, including mainstream

economics, is based on some conception of what a system is. A theory, or paradigm, is a kind of system, at the heart of which is a model of a system.

A system contains elements, which may themselves be systems, and a system has a structure, a way in which the elements are ordered relative to each other. The model of an economic system in neoclassical economics doesn't have a structure, because a large number of identical firms are modeled as interacting in the same way, like a ball of gas or water. In ecosystems, there is much more structure, because each part, or niche, of the ecosystem fills a function; in a body, each organ also fills a function, but in an ecosystem, much as in an economy, the structure is much "looser," that is, there is not nearly the kind of coordination that there is in a body.

It would be better to choose a model of a system for an economic theory that is not too tightly interconnected, as in a body, and not too loose, as in a ball of gas, but that is more like an ecosystem—just right. Economies are more coordinated than a truly wild ecosystem—governments can and always have tried to shape and design their economies. A closer analogy, then, for an economy would be an ecosystem, like a national park that is closely managed by the National Park Service. Usually, the park ecosystem runs pretty much by itself—certainly the vast majority of actions take place without human interference. But when something is out of whack, does not fit together, or is making the system as a whole malfunction, then the Park Service steps in and makes some changes.

An economic system is part of a larger system, a political-economic system. The other subsystem, the political system, has its own dynamics. A domestic political system can be beset by a positive feedback loop; that is, those who have power tend to have the capability to gain even more power, which eventually results in dictatorship. In addition, the government can, because of its growing power, suck all of the economic resources out of the economy, particularly as it attempts to increase its means of expanding power militarily. Only a democratically structured political system can break these cycles, although democracy does not guarantee a positive outcome.

The production system stands at the center of the economy, and is the underlying cause of economic growth and the rise and decline of nations as well as of ecological collapse. The production system is itself made up of three levels, which are also systems. At the

outermost level we have the production of goods and services, as well as the infrastructure. But what makes these goods and services? For the most part, machinery is used to make the goods and services we use. The second level is therefore what I will call the “production machinery” level. But what makes this production machinery?

At the center of the production system is a self-reproducing system, which I will call the “reproduction machinery” system, composed of a set of machinery which collectively reproduces itself. While in natural systems, organisms (like rabbits) have sex to reproduce, in the human production system, a certain set of machinery does the same thing. For instance, there is a set of machines called machine tools that shape and cut metal to make the parts for machines—including more machine tools. They also make the parts for other kinds of reproduction machinery, such as steel-making machinery, which makes the steel for more steel-making machinery, which also make the steel for more machine tools.

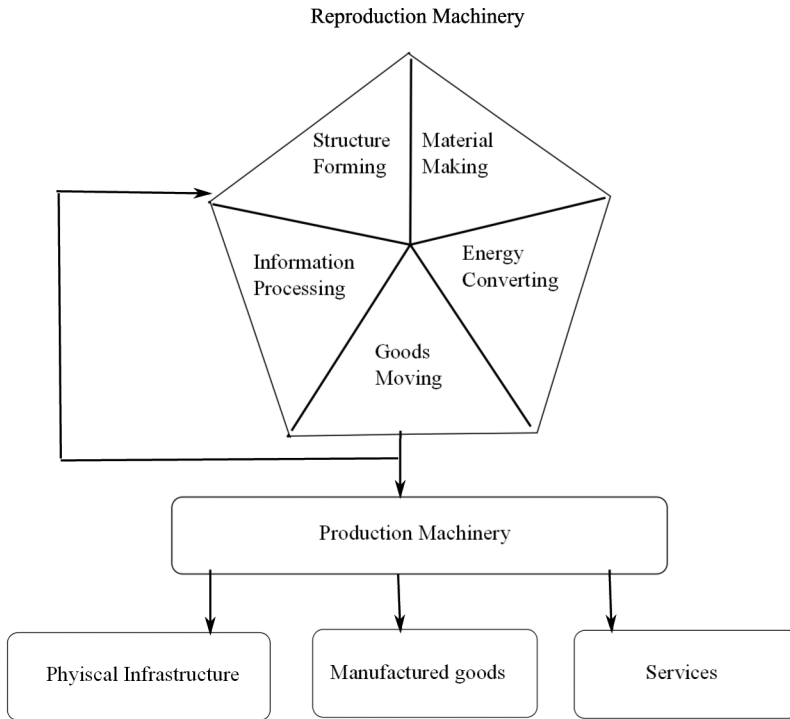
Part of the task of societal transformation will be to change the main reproduction machinery used for electricity generation, turbines, to wind turbines and solar panels, which will provide the energy for their own reproduction as well as the energy to run the other kinds of reproduction machinery, and the electricity for the production machinery used in factories, as well as the electricity used for consumer goods and services.

Changes in these most fundamental reproduction machinery technologies give birth to whole new eras—as we are witnessing with the introduction of semiconductor-making equipment, whose advances in technology have driven the computer and communications revolutions. In turn, changes in one kind of reproduction machinery reverberate to all the other kinds of reproduction machinery. For instance, changes in semiconductors accelerate technological change in the machine tool industry, just as changes in particular kinds of machine tools, such as grinders for optical equipment, make more powerful semiconductors possible.

We can further divide the reproduction machinery system into five separate niches—the machine tools are examples of “structure-forming” production, steel-making machinery is used for “material-making” production, the turbines (wind or steam) are for “energy-conversion” production, assembly lines are examples of “goods-moving” machinery, and the semiconductor-making equipment is for “information-processing” production (see Figure 1.2).



**Figure 1.2** Reproduction underlies economic growth



Thus, sitting at the center of the production system, reproduction machinery makes possible the positive feedback loops that both accelerate technological change, and also create the kinds of exponential (that is, constantly increasing) growth that we have been experiencing, particularly since the advent of the Industrial Revolution.

In other words, there are two kinds of economic growth: quantity-based and quality-based. We can spit out more and more machinery, and make more and more things, because reproduction machinery gives us the capability to do so. If those produced things—manufactured goods—use new raw material every time they are made, and pollute and spew carbon dioxide into the atmosphere, then quantity-based growth will be a source of more wealth for the society, but also is self-limiting because we will run out of the resources that are constantly being used up, as well as fundamentally changing the ecosystems that we’re pouring waste into (such as in the case of global

warming). A quantity-based economic system will rise and lead to its own decline.

The other source of economic growth consists of increases in quality, as when a semiconductor becomes more powerful or a machine tool becomes more precise, or even when we can produce more electricity with fuel-less energy-converting technology, such as wind power.

The inner two levels of the production system—production machinery and reproduction machinery—are the key elements of the manufacturing sector. Without them, the rest of the economy, and indeed, modern society, is impossible. They serve the specific functions of creating the means of production. They cannot be eliminated and the rest of the economy, such as services, is directly affected by technological changes in machinery. In fact, the most important technological changes are the changes in machinery technologies.

Services, for the most part, are what we do with machinery and manufactured goods. That is why 80 percent of world trade is in goods; it is difficult to trade something that is an action. The vast majority of the service economy is dependent on machinery. Then indirectly, the financial system is dependent on machinery to create the goods and services which then become the economic surplus that the financial system recycles back into the production system—or keeps for itself, as happens more and more, since the financial system can control the flow of those surplus resources.

The government also uses those goods and services to support its vast bureaucracy of employees, which then ideally manage the economic system in such a way that the economic system can expand, again ideally, in a sustainable way. The government often uses vast amounts of the goods and services produced by the machinery sectors to build military equipment, as the United States is doing today and the former Soviet Union fatally did after World War II.

The entire point of a military establishment is to destroy. But ironically, to destroy something you have to create the means of destruction, using, in particular, reproduction machinery. This is why machine tools, steel plants, and electrical generation have been the priority of any country trying to build an independent military capability. The United States, with the largest military establishment in world history, is losing the capacity to build its own military equipment; in other words, the United States is declining in its long-term capability to be a “Great Power.”

In the short term, international power depends on military power, that is, the amount of destruction machinery at hand. But in the long term, since destruction machinery is produced by production and reproduction machinery, international power is based on civilian machinery. This is why the United States, which had a tiny military just before World War II, created the largest military system in world history during four years in World War II, because of its huge reserves of physical, human, and natural capital.

The military subsystem of the political system, and the financial subsystem of the economic system, both of which are completely dependent on the production system for their existence, do everything they can to rob that production system of resources so that they can expand their own power, thus leading eventually to their own downfall.

The financial system is particularly dangerous because of the speed with which its power can be extended, particularly in the era of high-speed computers. By contrast, a firm that controls factories controls something that takes much longer to use for the purposes of the projection of power.

In general, if a government or industry can increase their power by consuming, or *liquidating* capital, and thereby gain a short-term advantage over those who are *maintaining* their capital, the liquidators can use their short-term advantage to overwhelm the long-term maintainers. All societies contain this contradiction, and all societies, if they are to survive, must overcome it.

## **YES, WE CAN BUILD A SUSTAINABLE WORLD**

The production system has a certain structure—it is made up of stages of production, from reproduction machinery to production machinery to final goods and services. The reproduction machinery subsystem is full of positive feedback loops, both in production and in technological innovation. The production machinery industries depend on reproduction machinery innovations to propel their own advances, as well as developing some of their own, which can then be used to create better goods and services. All of these parts of the production system are interconnected, and all of them should be in close proximity to each other to maximize the speed with which innovations and production occur if we want to maximize economic growth. Therefore, a production system needs to be situated in a

territory within which there is free trade among the various parts, the territory should be *large* enough to encompass a full suite of industries, and the territory should be *small* enough that the various parts are in close enough proximity that innovation and production are maximized. This means that a “natural” production system is continental, or in the case of the supercontinent of Asia, subcontinental in size—but not global.

If economies need to be continental, then for the poorer parts of the world to develop, they need to form economic unions, just as the Europeans have done. We are entering the era when a continental political economy must be spanned by large, sophisticated, sustainable infrastructural networks and policies. The basic structure of the production system cannot be left to the market, even though within each particular industry, the market will dominate. Government policy should ensure economic sustainability as well as ecological sustainability. The infrastructure systems cannot be built without a strong manufacturing base, and a strong, sustainable manufacturing base requires a strong, sustainable infrastructure.

The care and feeding of a continent-wide, manufacturing-centered economic system, along with the green transformation of energy, transportation, building, and agricultural systems, would expand and lay the foundations for the long-term maintenance of the physical, human, and natural capital of society. The motto of every world region should be, “unify, democratize, industrialize—for the long-term.”

How might all of this be paid for? The U.S. economy is very concentrated right now, and with that concentration goes extraordinary political power, which is used to prevent the government from using the resources currently controlled by those with economic power to reconstruct the society.

Mountains of finance capital and government subsidies are currently controlled by several sectors: the military, currently running close to \$1 trillion in yearly expense<sup>7</sup>; the health insurance industry; the oil, coal, and natural gas industries; much of the for-profit utility industry; the large amounts of taxes that the richest few percent of the population should be paying; the large amounts of taxes that the large corporations used to pay but don’t pay anymore; much of the financial industry; the real estate industry; and the industrial agricultural complex.

It is because of these large concentrations of power that Al Gore can correctly state that, in the case of global warming, “The

maximum that seems politically feasible still falls far short of the minimum that would be effective in solving the crisis.”<sup>8</sup> Going further, Wackernagel, Rees, and Testemale state, “In today’s materialistic, growth-bound world, the politically acceptable is ecologically disastrous while the ecologically necessary is politically impossible.”<sup>9</sup>

Although the current political situation may seem frustrating or even hopeless, we don’t know for certain what is politically possible, in the long term. Why not *first* investigate what is “ecologically necessary” and economically essential, and *then* adopt a long-range strategy to make that plan of action politically possible? Hope is a rather vague concept; why not have the audacity to design a sustainable civilization?