
TECHNOLOGY,
GLOBALIZATION, AND
SUSTAINABLE DEVELOPMENT

Transforming the Industrial State

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Yale UNIVERSITY PRESS

New Haven & London

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0.1 INTRODUCTION

Like other books with the word “sustainability” in the title, the motivation of this work stems from a dissatisfaction with the current state of the world and from a desire to identify those policies and strategies that will transform firms, institutions, governments, and societies in a more positive direction. We will argue that the main driving forces that have sent us in the wrong direction are the same forces, but differently fashioned and designed, that could be used to reverse course and improve the state of the world. These forces fall under the broad heading of technology and trade or, more strictly speaking, technology and globalization. We hope that the prescriptions discussed in this work will not be regarded as utopian. Indeed, it may be difficult to decide precisely on the right course of action, but a major accomplishment would be to deepen our

understanding of, and refrain from continuing, those policies and strategies that are clearly wrongheaded. It is also important to acknowledge that there are many more ways to do it wrong than to get it right. But understanding the history, mistakes, and successes of industrialization, economic change, and policy formulation and implementation is an essential step in getting it right.

There are those who argue that the economic system and the political system are the things that primarily need fixing, and, to a certain extent, they are right. But, as will be shown, there is much more that needs fixing. Systemic difficulties are central to understanding the unsustainable industrial state, and both economic and political dynamics affect the extent and direction of technological advance and social change. But it is also true that social and cultural attitudes influence the direction of policy, both through markets

and through the political choices we make. Because there are important interacting elements that need to be put in place to achieve more sustainable transformations, we will argue that holistic and integrated policy design, as distinct from mere coordination of policies, is essential. As Costanza and Daly (1991) argue, achieving a more sustainable world requires transdisciplinary approaches involving democratic, participatory governance. A transdisciplinary perspective is what characterizes the analysis and recommendations emanating from this work.

0.2 THE MULTIDIMENSIONAL CHARACTER OF SUSTAINABILITY

The concept of sustainability and, indeed, most of the writings on sustainable development most often conjure up *environmental* sustainability. We will argue that the three essential pillars of sustainable development must necessarily focus on a broader set of policies for improving *competitiveness*;^{*} *the environment and public and worker health and safety*; and *meaningful and well-paid employment and earning capacity*.

The relationship between industrialization and its effects on the environment has captured the serious attention of national governments and international organizations, especially in light of increasing international trade and globalization. Sustainability in products, processes, and services has been increasingly emphasized by placing the environment (or at least climate change) at the center of some industrial transformations or on a par with competitiveness. The key to *environmental* sustainability was recognized early as involving the design and implementation of environmentally sound products, processes, and services rather than addressing environmental concerns as an afterthought in industrial systems. At the same time at which the environment has become more important in economic policy, European as well as American industrial economies have also begun to pay attention to the restructuring of labor markets to reflect changes brought about by or anticipated from new and emerging technologies, new environmental

priorities, particularly global climate change, and globalization. However, unlike recent initiatives addressing environmental issues, these policies have been largely reactive rather than proactive toward new job creation and better organization of work.

In addition to the environment, work and the workplace are essential elements of industrial and industrializing economies. Human effort (work) is combined with physical and natural capital to produce goods and services. The workplace is the marketplace where workers and owners or managers exchange their contributions, with the transfer of financial capital as wages providing purchasing power for those workers. Beyond markets, work provides both a means of engagement of people in society and an important social environment and mechanism for enhancing self-esteem. Finally, work is the main means of distributing wealth and generating purchasing power in dynamic national economic systems. There is a complex relationship between employment and the increasingly environmentally unsustainable and globalizing economy. The changing nature of industrial economies presents new challenges and opportunities for the organization of work, as well as for the environment, in both industrialized and industrializing countries.

Just as thinking about the environment before industrial development is planned and implemented is necessary to optimize environmental quality, consideration of labor concerns also requires deliberate and intelligent actions before embarking on (re)industrialization efforts in guiding industrial transformations. The recent downturn of the extraordinarily long economic boom and the financial crisis that began in 2008 might be expected to reveal fundamental structural employment problems in the industrialized world that were not previously appreciated. It is likely that employment considerations will be the central issue in the coming decade for countries in the expanding European Union, as well as for the United States and the developing world, and employment concerns will influence the nature and direction of (re)industrialization and the growth of the manufacturing and service economies. It is therefore timely to explore options and opportunities for co-optimizing economic development, environmental quality, and labor and employment concerns.[†]

* Competitiveness can have two different meanings: (1) improvements in “competition” that yield higher national or corporate revenues and market share, or (2) the ability of the nation-state to provide the necessary goods and services to the largest possible segment of its populations. As the remainder of this book will reveal, policies directed at these two different formulations of competitiveness can be very different and have different consequences.

† Co-optimization will be a central theme throughout this book and describes the fashioning and implementation of policies and initiatives that achieve multiple goals without sacrificing one for another, that is, reaching an optimum described as achieving “a proper balance,” that is, a compromise among goals.

0.3 THE UNSUSTAINABLE INDUSTRIAL STATE

Those who argue that the industrialized state, whether developed or developing, is currently unsustainable emphasize a number of problems. These are depicted schematically in Figure 0.1. A key problem is the failure of government to provide—either directly or indirectly through the private sector—an adequate supply of, and access to, essential goods and services for all its citizens. Here the term “adequate” can be considered to mean the ability of citizens to enjoy a decent standard of living. This, of course, constitutes

what is agreed to be acceptable minimum welfare and is likely to differ among countries and over time, but which can be determined for a specific context. Goods and services include manufactured goods, food, housing, transportation, and information and communication technology (ICT), among others. The environmental problems include toxic pollution (which directly affects public and worker health and safety), climate change, resource depletion, and problems related to the loss of biodiversity and ecosystem integrity. The environmental burdens—and efforts to ameliorate them—are felt unequally within nations, among nations, and among generations, giving rise

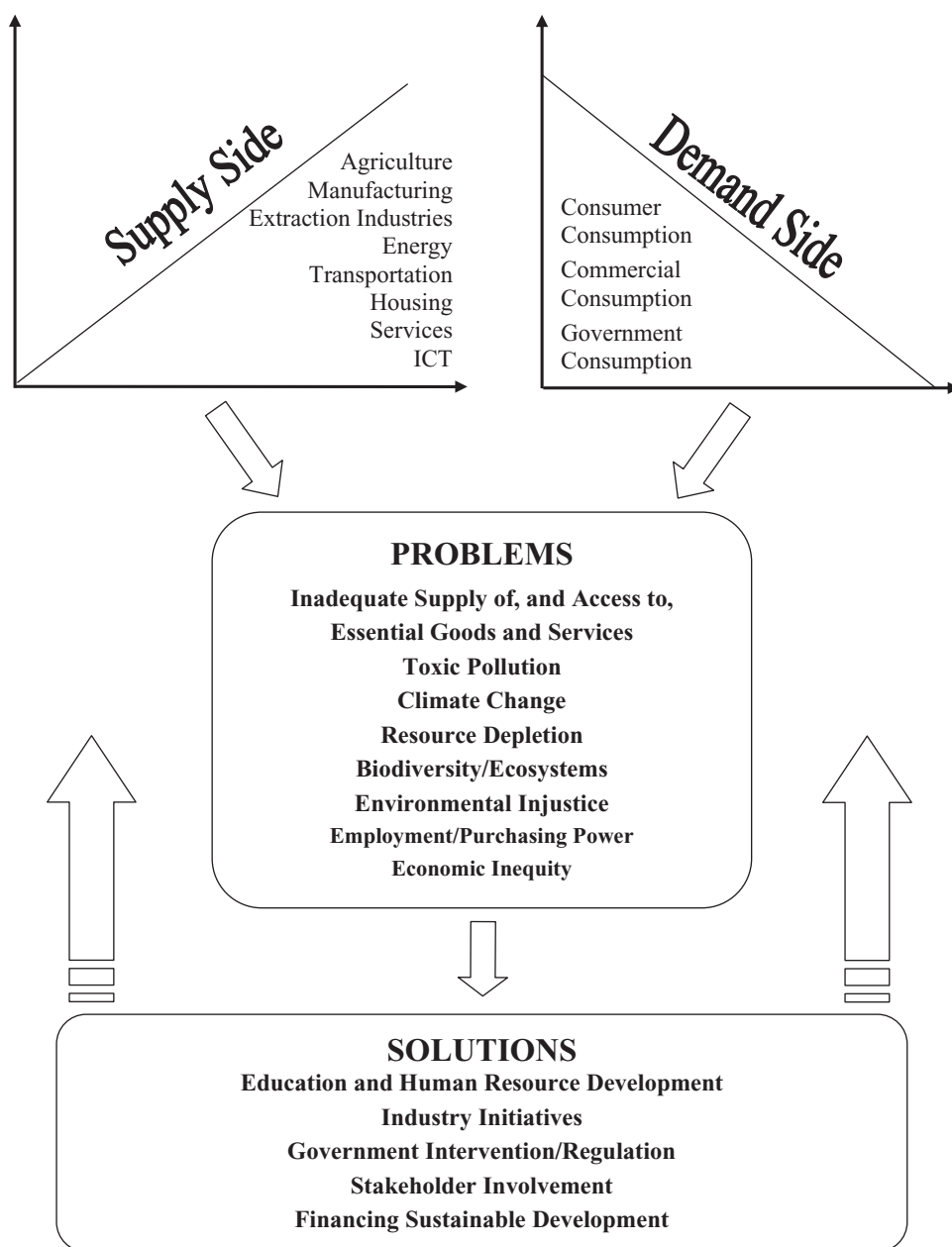


FIGURE 0.1: THE ORIGINS OF UNSUSTAINABILITY PROBLEMS IN THE INDUSTRIAL STATE AND POSSIBLE SOLUTIONS

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to international, intranational, and intergenerational equity concerns that are often expressed as “environmental injustice.” All three kinds of maldistributions are important.

The environmental problems stem from activities concerned with agriculture, manufacturing, extraction, transportation, housing, energy, and services—all driven by the demands of consumers, commercial entities, and government. In addition, there are effects of these activities on the amount, security, and skill of employment, the nature and conditions of work, and purchasing power associated with wages. An increasing concern is economic inequity stemming from inadequate and unequal purchasing power and earning capacity within and among nations and for the workers and citizens of the future.

Whether solutions involving education and human resource development, industry initiatives, government intervention, stakeholder involvement, and financing can resolve these unsustainability problems depends on their potential for correcting a number of fundamental flaws (the systemic problems mentioned earlier) in the characteristics of the industrial state:

1. *The fragmentation and inadequacy of the knowledge base*, resulting in a lack of understanding of the complex origin and interrelatedness of problems and the need for integrated solutions rather than unidisciplinarily designed and/or single-purpose solutions
2. *The inequality of access to economic and political power* among people and nations and between individuals and corporations or business organizations
3. *The tendency toward gerontocracy*, whereby there is technological and political lock-in, usually, but not always, accompanied by concentration of economic and political power
4. *The failure of markets* and of the policies that shape market transactions to price correctly the adverse human and environmental consequences of industrial activity
5. *The limitations of perfectly working markets* due to (a) *disparate time horizons*, whereby costs must be incurred now to solve problems whose solutions yield benefits later, sometimes in generations to come, which are discounted in value in present terms and therefore receive inadequate attention, and (b) *the delay in recognizing problems* with current industrialization and consumption, such that responses come very late (for example, the failure to perceive limits to growth), both of which cause inappropriate production and consumption patterns to persist
6. *The failure to engage individuals (workers and citizens) in society* to realize their human potential, resulting in social exclusion
7. *A high-throughput industrial system*, driven by ever-increasing material and energy consumption
8. *An addiction to growth and productivity*
9. *Corruption**

0.4 GLOBALIZATION

Globalization affects four major areas important for sustainable development: (1) the production of goods and services (which we will call industrial globalization), (2) the mobility of knowledge and information, (3) capital mobility, and (4) the international movement of labor and human resources, and migration. All these present opportunities and challenges for sustainable development.

The mobility of knowledge and information is facilitated both through changes in the locus of production and services (otherwise known as the international division of labor) and through advances in ICT, such as the Internet and wireless technologies. Capital mobility has in turn been greatly enhanced by ICT. Both financial and knowledge mobility allow almost instantaneous transfer of money and information, a radical departure from the industrial system of twenty years ago.

In the context of industrial and commercial production, the term “globalization” has at least three distinct meanings (Gordon 1995), with different implications for the environment and for workers and working life. First, “internationalization” is the expansion of product and service markets abroad, facilitated by ICT and e-commerce, with the locus of production remaining within the parent country. Second, “multinationalization” occurs when a (multinational) company establishes production or service facilities abroad to be nearer to foreign markets and/or to take advantage of more industry-friendly labor, environmental, and tax policies while maintaining research-and-development (R&D) and innovation-centered activities in the parent country. The third meaning of industrial globalization is the creation of strategic

* Corruption is more than the misappropriation of funds or unjustifiably favoring a firm or person in government dealings. We argue that it includes the perversion of governmental responsibility implicit in the social contract, such as failing to enact, monitor, or enforce environmental, public health, antitrust, banking, economic, labor, social, and other regulations or legislation that protects or promotes the public welfare. In the United States, the 2008 financial and mortgage industry breakdown stands out as the most recent example.

alliances, what might be called “transnationalization,” in which two different foreign enterprises merge or share their R&D and other capabilities to create a new entity or product line or service. Those concerned with enhancing trade are especially worried about barriers to internationalization, while those concerned with possible erosion of labor and environmental standards bemoan the consequences of multinationalization. Multinationalization and transnationalization may lead to industrial restructuring, with unpredictable consequences for national economies. Indeed, some corporations doing business in the global marketplace have larger annual cash flows than many small countries. All three kinds of globalization raise questions of excessive market, and hence political, power where concerns for profits overwhelm democratic and ethical values, even if international non-governmental organizations, such as Greenpeace, or international institutions, such as the International Labour Organization (ILO), challenge their activities.

Globalization raises new challenges for governance, especially vis-à-vis the roles of government, workers, and citizens in the new economic order. Within nation-states, the extent to which the externalities of production—adverse health, safety, and environmental effects—are internalized differs according to the differential success of regulation and compensation regimes and the extent to which economies incorporate the ethics of fair play into their practices. There has been a constant struggle to establish good environmental and labor standards and practices within nations. With the advent of globalized, competition-driven markets, attention has now shifted to the harmonization of standards through multilateral environmental agreements and ILO conventions, with only a modicum of success. Countries are slow to give up national autonomy, and only where there is a trend toward significant economic integration (as in the European Union [EU]) are there successes at harmonization. But globalization has brought an even more complex set of challenges through the creation of trade regimes—such as the World Trade Organization (WTO), the Association of Southeast Asian Nations (ASEAN), and the North American Free Trade Agreement (NAFTA)—where the term “free trade” means the elimination (or equalization) of tariffs and so-called nontariff trade barriers, which, in practice, place environmental and labor standards at odds with trade objectives. Free trade may not be fair trade.

The trade regimes promote international *laissez-faire* commerce; and rights-based laws and protections and market economics have become competing paradigms for public policy and governance. Government

plays very different roles when it acts as a facilitator or arbitrator to resolve competing interests than when it acts as a trustee of citizen and worker interests to ensure a fair outcome of industrial transformations (N. A. Ashford 2002). The differences are pronounced when stakeholders have significantly disparate power, or when some are not represented in the political process, as in the case of emerging or new technology-based firms.

John Rawls argues that no transformation in a society should occur unless those who are worse off are made relatively better off (Rawls 1971). Operationalizing a Rawlsian world has its difficulties, but law operates to create certain essential rights that enable just and sustainable transformations.* These include the right to a healthy and safe environment, products, and workplace; citizen and worker right to know; the right to participate in decisions affecting one’s working and nonworking life; and the right to benefit from the transformation of the state or global economy. Struggles won at the national level are now being eroded by a shift in the locus of commerce. Without consensus about fair play and the trustee institutions to ensure fair distributions from, and practices in, the new global economy, equity and justice cannot be achieved. It is now agreed that future development must be “sustainable,” but that means different things to different commentators.

0.5 DRIVERS OF ECONOMIC GROWTH AND DEVELOPMENT

0.5.1 Strategies to Enhance Competitiveness

We have already argued that sustainable development must be seen as a broad concept, incorporating concerns for the economy, the environment, and employment. All three are driven or affected both by technological innovation (Schumpeter 1939) and by globalized trade (Diwan and Walton 1997; Ekins, Folke, et al. 1994). They are also in a fragile balance, are interrelated, and need to be addressed together in a coherent and mutually reinforcing way (N. A. Ashford 2001).

Technological innovation and trade drive national economies in different ways (Charles and Lehner 1998). The former exploits a nation’s innovative potential, the latter its excess production capacity. Innovation-based performance is enhanced by technological innovation and changing product markets,

* For an argument that law is essential for achieving just transformations, see Dernbach (2008).

characterized by fluid, competitive production, often with the upskilling of labor. Innovation-based strategies have positive impacts in both domestic and international markets. In contrast, cost-reduction strategies are enhanced by increased scales of production and/or automation, usually characterized by rigid, mature monopolistic production, the shedding and deskilling of labor, the saturation of domestic markets, increased reliance on trade, and the location of production where wages and health, safety, and environmental costs are minimized. Economies seeking to exploit new international markets may enjoy short-term benefits from revenues gained as a result of production using existing excess capacity, but they may ultimately find themselves behind the technological curve. In contrast, performance-driven markets, which capitalize on first-mover advantages, may be slower to gain profits but may outlast markets driven by cost-reduction strategies that are unable to compete with emergent and disrupting innovations.*

0.5.2 The Consequences of Different Industrial Strategy Options for Workers

Increasing labor productivity, defined as output per unit of labor input, is a concern in nations pursuing either strategy to encourage economic growth. But labor productivity can be improved in different ways: (1) by utilizing better tools, hardware, software, and manufacturing systems; (2) by increasing workers' skills; and (3) by a better matching of labor with physical and natural capital and with ICT. Theoretically, increasing worker productivity lowers the costs of goods and services, thereby lowering prices and ultimately increasing the demand for and sale of goods and services.† This optimistic scenario assumes a continual throughput society with increasing consumption. However, the drive toward increased consumption may

have dire consequences for the environment (Daly 1991). In addition, questions arise whether, in practice, (1) labor is valued and paid more or less after productivity improvements, (2) there are positive or negative effects on job tenure and security, and (3) more workers are hired than displaced. The answers depend on the sources of the increases in worker productivity and the basis of a nation's competitiveness. Giving workers better technologies to work with may increase their productivity, but not their *productiveness*; that is, the labor content of, and contribution to, the product or service may have actually decreased. Here it is *capital* productiveness that has increased. Increasing workers' skills, even if the technologies of production remain unchanged, can increase both worker productivity and worker productiveness, the latter reflecting an increase in the contribution that labor makes to the production of goods or services. Better matching of skills to technology artifacts may yield synergistic effects, increasing labor productivity and both labor and capital productiveness.

A sector or national economy that increases its competitiveness through innovation-based performance presents opportunities for skill enhancement and higher-paying jobs, whereas pursuing competitiveness through cost-reduction strategies focuses on lean production (with worker displacement), flexible labor markets, and knowledge increasingly embodied in hardware and software rather than in human capital. The consequences of these two strategies for workers are different. The former strategy rewards and encourages skill acquisition for many, with appropriate financial benefits for those workers. The latter creates a division between workers: some are necessarily upskilled, but the skill content of many is reduced. Different national strategies might be pursued, reflecting different domestic preferences and culture, but there are further implications, depending on the extent to which trade drives the economy. Interestingly, while the United States was globalizing and focusing on expanding markets abroad, the EU was selling a smaller amount and percentage of goods and services outside its borders and was focusing instead on integrating its internal markets in which its various members compete on performance (Kleinknecht and ter Wengel 1998). In the United States, wage disparities are large and increasing, while in some parts of the EU, notably the Netherlands, wage disparities are much smaller and decreasing. The economic crisis of 2008 has exacerbated disparities in income throughout the world.

Even before the crisis of 2008, the changing global economy presented challenges for all nations as con-

* See the discussion later in this chapter of the important distinction between sustaining and disrupting innovation.

† Robert Ayres (2006) observes, "Information technology has exemplified the feedback cycle and the rebound effect. Costs have fallen, prices have followed and demand has risen in consequence. But IT [information technology] is not the panacea for the economy as a whole, unless it results in dramatically lower costs and increased demand for all other tangible goods and services the society needs. Up to now the applications of IT outside its own sector seem to be eliminating more jobs than it creates, but without significant corresponding impacts on consumer demand for products and services that would create more jobs" (ibid., p. 1194)

cerns about the number of jobs, job security, wages, and occupational health and safety increased. In the private sector, labor needs a role in choosing and implementing information-based and labor-affecting technologies. In the public sector, there is a need to integrate industrial development policies with those of employment, occupational health and safety, and the environment. The following strategic changes are expected to influence firms to use labor more effectively:

- Distinguishing productiveness from productivity
- Striving for an innovation-enhancing rather than a cost-reduction strategy
- Investing in increasing the capacity of human resources rather than replacing labor with capital
- Paying attention to the human/technology interface
- Advancing beneficial industrial relations in the nation, sector, or firm
- Investing in education and training
- Using economic incentives to maximize human resource use and improvement
- Taxing pollution and carbon content of energy sources rather than labor

From the perspective of labor, the success of these strategies requires implementation of the right to know, the right to participate, and the right to benefit from industrial transformations.

The right to know has been described elsewhere (N. A. Ashford and Caldart 2008, chap. 10) and includes citizens' and workers' right to know and have access to scientific, technological, and legal information and manufacturers' and employers' corresponding duty to inform and warn workers about this information. Scientific information includes chemical or physical hazards or risk information related to product or material ingredients, exposure, health effects, and individual or group susceptibility (N. A. Ashford, Spadafor, et al. 1990). As important as information about hazards is, information about technology is key to enable citizens and workers to play a role in reducing risks. This kind of information includes not only knowledge about pollution and accident control and prevention technology, but also technology options for industrial, agricultural, and other kinds of commercial activity. Knowing how production and services might be changed to make them inherently cleaner, safer, and healthier and the source of more rewarding, meaningful work is a *sine qua non* of being able to participate meaningfully in firm-based decisions. Finally, information about legal rights and obligations is crucial for using legal and political ave-

nues for environmental and workplace improvement and redress from harm.

Workers' right to know is made operational through the right of workers to participate in (1) the technology choices of the firm (through technology bargaining and system design) (N. A. Ashford and Ayers 1987); (2) firm-based training, education, and skill enhancement; (3) the formation of national and international labor-market policies; and (4) the setting of national and international labor standards. Although national unions enable workers to work with employers through industrial relations systems, and the ILO uses a tripartite system that includes labor, management, and government, the trade regimes mentioned earlier give few or no participatory rights to labor (or environmentalists) in global economic activities that have potentially significant effects on wages and working conditions. As trade becomes an important part of national economies, this omission needs to be corrected (EC 2003, 2006). Ironically, under the WTO trade rules, importing countries can restrict imports or place countervailing duties on items that harm their environment, but it is unclear whether there is any equalizing action that can be taken if the exporting countries produce those goods unsafely or with adverse environmental effects within their own borders (see the discussion in Chapter 11). This reinforces nonenactment or nonenforcement of national health, safety, or environmental laws in the exporting countries, to the detriment of their own citizens and workers. Further, countries may be reluctant to ratify or adopt international accords, including multilateral environmental agreements or ILO conventions, in hopes of maintaining or gaining short-term competitive advantage (see the discussion in Chapter 10).

Finally, and at the core of justice in the global work life, is the right of working people to benefit from industrial transformations. The right to know and the right to participate are essential, but the ultimate rights are those of a fair division of the fruits of the industrial or industrializing state, as well as a safe and healthful workplace. This translates into sufficient job opportunities, job security, and purchasing power, as well as rewarding, meaningful, and safe employment. This cannot be left to chance or serendipitous job creation. In formulating policies for environmental sustainability, economic growth and environmental quality should be simultaneously optimized rather than having environmental interventions occur after harmful technologies are in place. Instead, we need to design and implement cleaner and inherently safer production. Employment concerns deserve no less a place in center stage; competitiveness,

environment, and employment must be *co-optimized*. Systemic changes must be pursued and selected that intentionally benefit both the environment and employment. Even with better prospects for employment, in an industrial system that continues to replace labor with physical capital, increasing worker capital ownership and access to credit (R. Ashford 1998) that turns workers into owners may be an additional and necessary long-term option if disparities of wealth and income prevail.

0.6 CONCEPTUALIZATIONS OF SUSTAINABLE DEVELOPMENT

0.6.1 The Interrelatedness of the Economy, of the Environment, Health, and Safety, and of Employment and the Need to Address Them Together

It makes quite a difference whether one looks at sustainable development as just an environmental issue or as a multidimensional challenge in three dimensions: economic, environmental, and social.* We argue that competitiveness, the environment, and employment are the *operationally important* dimensions of sustainability, and these three dimensions together drive sustainable development along different pathways and go to different places than environmentally driven concerns alone, which may otherwise require trade-offs, for example, between environmental improvements and jobs. The interrelatedness of competitiveness, the environment, and employment is depicted in Figure 0.2. (In Section 12.11 in Chapter 12, we address the broader issue of enhancing

* The sustainability triangle is often depicted as the economy, the environment, and *social concerns*, or the economy, the environment, and *equity*. Because all policies that affect the economy and environment have social effects and because the distributional consequences of differential access to necessary goods and services and different environmental burdens have significant equity consequences, we do not relegate the third corner of the triangle to either. Instead, we argue that *employment* should occupy the third corner of the triangle because employment is the enabling activity that allows workers and citizens to achieve economic, environmental, and social well-being and because employment is the focus of traditional government concerns and policies, along with economic and environmental policies. Because an important aspect of this book focuses on changes in current government policies, the depiction of a triangle that is consistent with policy areas better serves our purposes. We argue for attention to equity within each corner and further acknowledge the importance of culture in interpreting the triangle. What is an acceptable distributional disparity in one culture is different in another, and the importance work and environment have in one system may be very different in another. Broad, participatory mechanisms of affected stakeholders are needed to account for the acceptability of different policy mixes and outcomes.

earning capacity by changes in capital ownership which can supplement or even supplant wages.)

A *sustainable development* agenda is, almost by definition, one of systems change. This is not to be confused with a (*health, safety, and*) *environmental policy* agenda (depicted in Table 0.1), which is explicitly effect based, and derived from that, a program of policies and legislation directed toward environmental improvements, relying on specific goals and conditions.

The *environmentally* sustainable development policy agenda focuses at least on processes (for example, related to extraction, manufacturing, transport, agriculture, energy, and construction) and may extend to more cross-cutting technological and social systems changes, but an all-encompassing sustainable development agenda deals with more than health, safety, and the environment.

In Table 0.2, note that *current strategy agendas*, even those that go beyond environmental goals, are defined as those that are focused on those policies that (1) improve profit and market share by improving performance and efficiency in current technologies or by cutting costs; (2) control pollution, make simple substitutions and changes to products and processes, conserve energy and resources, and find new energy sources; and (3) ensure an adequate supply of appropriately skilled labor, confer with workers, and provide safer and healthier workplaces. We describe these strategies as reactive vis-à-vis technological change, rather than proactive. They are usually pursued separately and by different sets of government ministries and private-sector stakeholders. At best, policies affecting competitiveness, the environment, and employment are coordinated but not integrated.

In contrast, *sustainable agendas* are those policies that focus on (1) technological changes that alter the ways goods and services are provided, (2) the prevention of pollution and the decreased use of energy and resources through more far-reaching system changes, and (3) the development of novel sociotechnical systems—involving both technological and organizational elements—that enhance the many dimensions of meaningful and rewarding employment through the integration rather than the coordination of policy design and implementation.

0.6.2 Sustaining and Disrupting Innovation Distinguished

The kind of innovation likely to be managed successfully by industrial corporations is relevant to the differences between current and sustainable technology agendas. We argue that the needed major product,

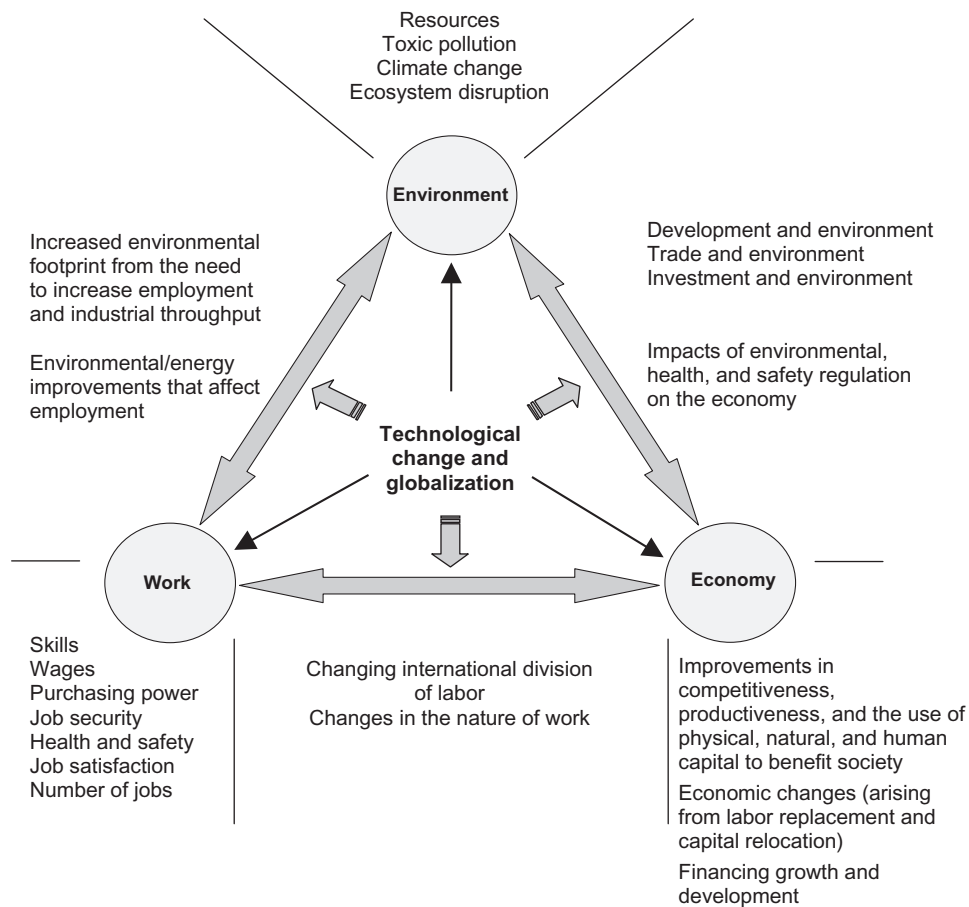


FIGURE 0.2: TECHNOLOGICAL CHANGE AND GLOBALIZATION AS DRIVERS OF CHANGE WITHIN AND BETWEEN THREE OPERATIONALLY-IMPORTANT DIMENSIONS OF SUSTAINABILITY

TABLE 0.1: EVOLUTION OF APPROACHES TO HEALTH, SAFETY, AND ENVIRONMENTAL PROBLEMS

APPROACH	OBSERVATIONS
Dispersion of pollution and waste	The solution to pollution is dilution (ultimately leading to trans-boundary pollution)
End-of-pipe pollution control	Collecting wastes; workplace ventilation and protective equipment No fundamental changes in inputs, final products, or production technology Media shifting: air and water pollution → waste and workplace exposures Problem shifting: toxicity → accident potential
Industrial ecology: waste and material exchange and consolidation	No fundamental changes in inputs, final products, or production technology
Pollution prevention and cleaner technology	Improvements in eco-efficiency and energy efficiency; fundamental changes in inputs, final products, or production technology
Shifts to product services, system changes, and sustainable development	Restructuring of industrial, agricultural, and service industry actors and relationships involving new collaborations and actors; changes in the nature of consumer and business demand

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TABLE 6.2: COMPARISON OF CURRENT AND SUSTAINABLE POLICY AGENDAS

AGENDA	COMPETITIVENESS (Economic development)	ENVIRONMENT	EMPLOYMENT
Current	Improve performance and efficiency Cut costs	Control pollution Make simple substitutions or changes to products and processes Conserve energy and resources; find new energy sources	Reduce worker hazards Maintain dialogue with workers on working conditions and terms of employment Ensure supply of adequately trained people
Sustainable	Change the nature of meeting market needs through radical or disrupting innovation (a systems change) Transition toward product services Change the nature of demand by cultural transformation	Prevent pollution through system changes Design environmentally-sound products and processes Decrease resource and energy dependence	Radical improvement in human-technology interfaces (a systems change) Design inherently safe products and processes Create meaningful and rewarding jobs

process, and system transformations may be beyond those that the dominant industries and firms are capable of developing easily, at least by themselves. Further, industry and other sectors may not have the intellectual capacity and trained human resources to do what is necessary.

This argument is centered on the idea of “the winds of creative destruction” developed by Joseph Schumpeter (1939) in explaining technological advance. The distinction between incremental and radical innovations—be they technological, organizational, institutional, or social—is not simply line drawing along points on a continuum. Incremental innovation generally involves continuous improvements, while radical innovations are discontinuous (Freeman 1992), possibly involving *displacement* of dominant firms, institutions, and ideas rather than evolutionary transformations. In semantic contrast, Christensen (2000) distinguishes continuous improvements as “sustaining innovation” and uses the term “disrupting innovation” rather than radical innovation, arguing that both sustaining and disrupting innovations can be either incremental or radical, where the term “radical” is reserved for rapid or significant performance changes *within* a particular technological trajectory.

Thus in Christensen’s terminology, radical sustaining innovation is a major change in technology along the lines which technology has been changing historically—for example, a much more efficient air-pollution scrubber—and is often pioneered by incumbent firms. A major innovation that represents an

entirely new approach, even if it synthesizes previously invented artifacts, is termed “disrupting,” and in product markets, it usually is developed by firms not in the prior markets or business. This is consistent with the important role of outsiders—both to existing firms and as new competitors—in bringing forth new concepts and ideas (van de Poel 2000).

Counting only or mainly on existing industries or traditionally trained technical expertise for a sustainable transformation ignores increasing evidence that not just willingness, opportunity, and motivation are required for needed change, but a third crucial condition—the ability or capacity of firms and people to change—is essential (N. A. Ashford 2000). Incumbent firms may develop disrupting innovations in response to a strong signal from society or the market, but such occurrences appear to be uncommon.

We argue here that the same holds true for government and societal institutions faced by the triple challenge emanating from new demands in the areas of competitiveness, the environment, and employment. Intelligent government policy is an essential part of encouraging appropriate responses of the system under challenge, and of assisting in educational transformations as well.

An essential concept in fostering innovative technical responses is that of “design space.” As originally introduced by Allen, Utterback, et al. (1978) of MIT, design space is a cognitive concept that refers to the dimensions along which the designers of technical systems concern themselves. Especially in industrial

organizations that limit themselves to current or traditional strategies or agendas, there is a one-sided use of the available design space. Solutions to design problems are sought only along traditional engineering lines. In many cases, unconventional solutions—which may or may not be high-tech—are ignored. For that reason, radical, disrupting innovations are often produced by industry mavericks or as a result of some disruptive outside influence (such as a radically different or more stringent environmental regulation, foreign competition, or the influence of an outsider on the organization).

0.6.3 A Capsule Definition of Sustainable Development

To summarize the discussion so far, sustainable development decries a simplistic definition and rather is a multidimensional concept characterizing development that seeks to

- meet needs and avoid adverse effects of industrialization within and among nations and on subsequent generations;
- provide an adequate supply and fair distribution of essential goods and services;
- provide for good health, safety, and an environment without environmental injustices;
- provide for fair working conditions and occupational health and safety;
- provide for fair and meaningful employment;
- provide for adequate and fair purchasing power;
- meet and expand the potential for a nation's self-reliance, capacity for innovation, and participation in the global economy; and
- engage individuals in society to realize their human potential (that is, social inclusion).

0.7 GOVERNANCE OPTIONS FOR ACHIEVING A TRANSFORMATION TO A MORE SUSTAINABLE STATE

Various commentators offer a range of strategies to improve the sustainability of the world's economies. These include (1) collaborative approaches among stakeholders, locally, nationally, and internationally; (2) mobilization of public opinion, especially at the grassroots level, to provide pressure on government and the private sector and to shift the nature of the demand for goods and services; and (3) government intervention in areas from environmental protection to energy supply, antimonopoly action, and job creation.

Government action has not been particularly popular among free-market advocates, although recent events have increased the demand for more government involvement.

Although we are strong advocates of civic engagement and participatory democracy, we contend that their power is seriously compromised by vested financial and political interests, the power of the corporate sector, the influence of advertising and ideological broadcast and electronic media, and the buying of elected officials through campaign contributions. One needs only to examine the results of negotiated regulation in U.S. environmental and safety areas to be convinced of the inadequacy of the collaborative approach at the national level (N. A. Ashford and Caldwell 2005).^{*} The unimpressive commitments made at Copenhagen speak for themselves in the international climate-change debate.[†] The U.S. national health-care and climate-change debates continue to be so fraught with misinformation and so influenced by vested private-sector money that the public remains confused and suspicious, especially of government. The intended outcome of these orchestrated and well-funded misinformation campaigns is to weaken the case for strong government oversight and action.

Although the recent election of a new U.S. president was accomplished by grassroots, Internet-aided communication and fund-raising, this success is now challenged by so-called grassroots rebellions in elections and town-hall meetings that are encouraged, if not funded, by an opposition exploiting an angry, uninformed, and/or manipulated polity. The facts and details of private-sector malfeasance are there to be found, but they are so overwhelmed by propaganda that hopes for public enlightenment fade quickly. The recent U.S. Supreme Court decision in *Citizens United* (*Citizens United v. Federal Election Commission*, S. Ct. 2010) establishing almost unlimited constitutional protection that “money is speech” does not bode well for the democratic process.

Although stakeholder involvement and enhancing public awareness are essential elements of a needed transformation, these vehicles move too slowly and ineffectively to address the challenges brought on by

^{*} Collaboration and negotiation may well be successful at the local level, where public concern about local pollution or economic issues makes political accountability more visible and important.

[†] At the international level, because supranational governmental authority rarely exists, collaboration and negotiation among stakeholders may be valuable, but whether voluntary or mandatory agreements are negotiated, national governmental action must follow lest those agreements remain a paper tiger.

the tipping points immediately ahead. National health care, environmental protection, the creation of needed jobs, the saving of people's homes, and the creation of real incentives to stem financial manipulation cannot wait for enlightenment and public involvement processes. In the end, even strong leadership from the executive branch of government, in combination with public participation and increased awareness, may not come quickly enough to avoid serious consequences, but strong and deliberate executive leadership and aggressive initiatives by the administrative agencies of government already legally empowered to act are certainly necessary components worthy of resurrection in the political process.

Further, industrial policy, environmental law and policy, and trade initiatives must be "opened up" by expanding the practice of multipurpose policy design and that these policies must be integrated as well. Sustainable development requires stimulating revolutionary technological innovation through environmental, health, safety, economic, and labor market regulation. Greater support for these changes must be reinforced by "opening up the participatory and political space" to enable new voices to contribute to integrated thinking and solutions. This may require political, institutional, and social innovation as well.

0.8 THE ROLE OF GOVERNMENT

In this book, we will argue that national government support and intervention are essential for achieving the kinds of industrial transformations that are desirable from an economic perspective, but that are also fair and just in their production and delivery of essential goods and services. Among the suggested general functions of government are the following:

- To provide the necessary physical/legal infrastructure
- To support basic education and skills acquisition (human resource development)
- To invest in pathbreaking science and technology development to enhance competitiveness, environmental improvement, and job design
- To sustain a healthy economy that creates rewarding and meaningful employment with sufficient purchasing power, reduces poverty, and provides the opportunity for a high quality of life for all
- To protect the environment and ensure that every person benefits from clean air, clean water, and a healthy home, work, and leisure environment
- To regulate deceptive and inaccurate advertising, as well as to provide counteracting government messaging to discourage unsustainable consumption

- To act as a facilitator or arbitrator of competing stakeholder interests to ensure a fair process
- To act as a trustee of (underrepresented) present and future worker and citizen interests to ensure a fair outcome in transformations of the economy
- To act as a trustee of new technologies
- To act as a force to integrate, not just coordinate, policies;
- To ensure a democratic political process, free from corruption and undue influence of vested interests which act to the detriment of the rest of society.

More specifically, depending on the specific transformation desired, there is a role for government from the direct support of R&D and incentives for innovation through appropriate tax treatment of investment to the creation and dissemination of knowledge through experimentation and demonstration projects; the creation of markets through government purchasing; the removal of perverse incentives of regulations in some instances and the deliberate design and use of regulation to stimulate change in others; training of owners, workers, and entrepreneurs; and education of consumers. The role of government should be considered beyond simply creating a favorable climate for investment. Although it is true that the government may not be competent to choose winners, it can create winning forces and provide an enabling and facilitating role by creating visions and scenarios for sustainable transformations.

There is continuing debate about the appropriate role of government in encouraging industrial transformations (N. A. Ashford 2000). Major differences revolve about two competing philosophical traditions: the dominance of unfettered market approaches and a more interventionist, directive role for government through laws and regulation. Market approaches concentrate on "getting the prices right," ensuring competition in capital and labor markets, and increasing demand for a clean environment, product safety, and good working conditions through providing information and education. In contrast, government-intervention approaches focus on establishing minimum environmental, product-safety, and labor standards and practices; requiring full disclosure by employers and producers of information needed by consumers, citizens, and workers to make informed choices and demands; encouraging technology development, transfer, and infrastructure through a deliberate industrial policy; and requiring decision bargaining in industrial relations.

Alternative roles for government in promoting sustainable development accomplish different things:

- *Correcting market failures* by regulating pollution and by addressing inadequate prices, monopoly power, uncompetitive labor markets, and lack of information *achieves static efficiency* through better working markets.
 - Acting as a *mediator or facilitator of environmental and labor* disputes and conflicts among the stakeholders *achieves static efficiency* through reducing transaction costs.
 - Facilitating an industrial transformation by *encouraging organizational learning, pollution prevention, and dialogue with stakeholders* leading to win-win outcomes—based on the concepts of *ecological modernization* (Jänicke and Jacob 2005; Mol 2001) or *reflexive law* (Teubner 1983)—relies on *rational choice and evolutionary change* that moves toward a more *dynamic efficiency*, usually over many decades.
 - Moving beyond markets and *acting as a trustee for minority interests, subsequent generations, and new technologies* by forcing and encouraging innovation through coordinated regulatory, industrial, employment, and trade policy transcend markets, *moving toward dynamic efficiency* within a shorter time horizon.
2. establishing mechanisms for democratic, participatory governance; reducing channels of influence by concentrated sources of power and wealth;
 3. stimulating technological, institutional, organizational, and social innovation;
 4. getting prices right—or least not wrong—through effective corrective tax and other policies;
 5. transcending markets and implementing farsighted and integrated policies;
 6. instituting deliberate policies and strategies for the development and utilization of human resources, that is, education (for both skills and citizenship), training, and job creation;
 7. enforcing anti-corruption, anti-monopoly, fair-trade, and advertising law; undertaking serious campaign finance reform and disclosure legislation; considering term limits for elected officials; establishing accountability and whistle-blower protection measures; reforming the chartering of corporations;
 8. encouraging innovation in material and energy use; taxing unsustainable extraction, production, products, and services; educating citizens and consumers; and
 9. replacing GDP, labor productivity, and other inappropriate measures of progress with more sustainability-relevant metrics; reforming the reward structure that encourages unsustainable growth.

These options are listed in increasing order of intervention, and different stakeholders will, of course, have different preferences according to their ideology and self-interests. As a practical matter, we will argue in this book that extensive intervention is needed to address the nine systemic problems discussed in Section 0.3. Some of the specific interventions that are needed are, respectively:

1. adopting a transdisciplinary approach to sustainable development;*

* Appreciating the distinctions among inter-, multi-, and transdisciplinary approaches is essential to understanding why well-meaning efforts to solve complex problems by assembling professionals from different disciplines or to expand traditional education in a particular direction often lead to disappointing results.

Interdisciplinary research (and teaching)—literally “between disciplines”—often precedes the creation of a new, well-defined field. Thus biochemistry begins with a focus on traditional chemistry principles and knowledge applied to understanding biological systems; it adapts and grows; and the intellectual boundaries are refocused and redrawn. Finally, biochemistry becomes a field of its own, different from but not necessarily broader or narrower than the parent disciplines that spawned it.

Multidisciplinary research (and teaching)—literally “several or many disciplines”—brings together several disciplinary foci and thus deals with more than one traditional concern. For example, costing out different energy options necessarily involves knowledge of both energy technology and economics. Multidisciplinary research and teaching can be carried out by multidisciplinary teams or by one individual who has been trained in more than one discipline.

Transdisciplinary research (and teaching)—literally “across disciplines”—transcends the narrow focus of one or more disci-

In addition to national responsibilities in a world of increasingly globalized commerce, information, finance, and interconnectedness, national governments also have a responsibility to

- reform institutions at the global level to ensure that developing nations have equitable access to international markets, technology, and information;
- establish trade and foreign policies that further the achievement of sustainable development;
- ratify, implement, and enforce international treaties and accords designed to protect the environment, workers, and human rights; and
- ensure peace and tranquility.

These and other interventions will be explored throughout this book, but especially in the last chapter where our policy recommendations are organized and discussed in greater depth.

plines and is not constrained to adopt preexisting models for problem definition or solution. Boundaries might necessarily have to be drawn as a practical matter, but they are not dictated by limitations of the analyst or designer. Where broad system changes are desirable, transdisciplinary approaches are essential. Transdisciplinary approaches open up the problem space of the engineer. By their nature, transdisciplinary approaches synthesize and integrate concepts whose origins are found in different disciplines, and system innovation requires synthesis.

0.9 THE WAY FORWARD

If we recall that a sustainable future requires technological, organizational, institutional, and, social changes, it is likely that an evolutionary pathway is insufficient to achieve the needed factor ten or greater improvements in ecological and energy efficiency and reductions in the production and use of, and exposure to, toxic substances. Nor are fundamental changes in the organization of work likely to emerge through evolutionary change. Such improvements require more systemic, multidimensional, and disruptive changes. We have already asserted that the capacity to change can be the limiting factor. This is often a crucial missing factor in optimistic scenarios.

Such significant industrial transformations occur less often from dominant technology firms—or in the case of unsustainable practices, problem firms' capacity-enhancing strategies—than from new firms that displace existing products, processes, and technologies. This can be seen in examples of significant technological innovations over the last fifty years, including transistors, computers, and polychlorinated biphenyl (PCB) replacements.

Successful management of disruptive product innovation requires initiatives from outsiders to produce the expansion of the design space that limits the dominant technology firms (van de Poel 2000). Especially in sectors with an important public or collective involvement, such as construction and agriculture, this means that intelligent government policies are required to bring about necessary change.

Rigid industries whose processes have remained stagnant also face considerable difficulties in becoming significantly more sustainable. Shifts from products to product-services rely on changes in the use, location, and ownership of products in which mature product manufacturers may participate, but this requires significant changes involving managerial, institutional, organizational, and social (customer) innovations. Changes in sociotechnical systems, such as transportation or agriculture, are even more difficult. This suggests that the creative use of government intervention is a more promising strategic approach for achieving sustainable industrial transformations than the reliance of the more neoliberal policies relying on firms' more short-term economic self-interest.

This is not to say that enhanced analytic and technical capabilities on the part of firms; cooperative efforts and improved communication with suppliers, customers, workers, and other industries; and environmental, consumer, and community groups are not valu-

able adjuncts in the transformation process. But in most cases these means and strategies are unlikely to be sufficient by themselves for significant transformations, and they will not work without clear mandated targets to enhance the triple goals of economic development, environmental quality, and enhancement of employment and earning capacity.

The history of innovation has amply demonstrated that disruptive innovations are feasible, and they may bring substantial payoffs in terms of triple sustainability. They are within the available but unused design space. However, the general political environment, governmental dedication, and the incentive structure have to be right for the needed changes to occur.

We have already argued that government has a significant role to play, but the government cannot simply serve as a referee or arbiter of existing competing interests, because neither future generations nor future technologies are adequately represented by the existing stakeholders. Government should work with stakeholders to define far-future targets—but without allowing the agenda to be captured by the incumbents—and then use its position as trustee to represent the future generations and the future technologies to backcast what specific policies are necessary to produce the required technical, organizational, and social transformations. Backcasting enables policy makers to look back from a desirable future to create strategies that will, it is hoped, enable the future visions to materialize. This approach is in contrast to current planning processes that develop strategies based on forecasts. The backcasting approach adopted will have to be of a next-generation variety. It has to go beyond its historical focus on coordinating public- and private-sector policies. It must be multidimensional and directly address the present fragmentation of governmental functions, not only at the national level but also among national, regional, and local governmental entities. In this book, we will argue that what is needed is stronger and smarter government. However, this does not necessarily mean bigger government if integration and coordination of the functions that government can provide are achieved. (For a concise treatment of the role that government might play, based on this book, see Ashford and Hall 2011.)

There is a great deal of serendipity and uncertainty in the transformation process, and the long-term prospects may not always be sufficiently definable to suggest obvious pathways or trajectories for the needed transformations. Thus it may be unreasonable to expect that government can always play a definitive futures-making role. What follows from this is that

rather than attempting tight management of the pathways for the transformations that are sustainable in the broad sense in which we define that term in this work, the government's role might be better conceived as one of enabling or facilitating change while at the same time lending visionary leadership to co-optimize competitiveness, the environment, and employment and earning capacity. This means that the various policies must be mutually reinforcing. This newly conceptualized leadership role—focused on opening up the problem space of the engineer, designer, or policy maker—is likely to require participation of more than one ministry or department. In parallel with this, the “participatory and political space” needs to be opened up to enable new voices to contribute to integrated thinking and solutions.

Increasingly, ministries or departments of commerce and economic affairs and of the environment are working together to fashion a vision of *environmental* sustainability. What has been missing is a similar proactive role of ministries or departments of labor to interface and integrate *employment-related policies* into the national and global policy agendas. Finally, in an increasingly global marketplace, the integration of trade, industrial, employment, and environmental policies has to receive major attention lest strictly national efforts are undercut by global economic and political forces.

Readers should frequently consult the website associated with this work (www.yalebooks.com) to access an extended Primer on Sustainable Development and to view any updates to the text. The website will also provide educators with access to book-related teaching materials.

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