The Ethics of Sustainability

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INTRODUCTION

Sustainability is an important concept that is widely referenced and that has achieved broad support. Yet it remains inherently difficult to implement because of its complexity and due to the enormous shifts in thinking that it proposes. Particularly challenging is the development and implementation of technology, the vast majority of which has significant potential negative consequences for the health of both people and planet. This book provides natural and social scientists, engineers, architects, builders and other technical professionals with a clear description of the meaning of sustainability and a practical guide to the ethical challenges involved in its promotion and achievement. It describes the ethical concepts and principles that are inherent in sustainability and is designed to aid these professions in evaluating and directing their activities, particularly when developing, deploying, and employing technology.

Sustainability is commonly understood to require the balanced pursuit of three goods: ecological health, social equity, and economic welfare. It is grounded on the ethical commitment to the well-being not only of contemporary populations but also the well-being and enhanced opportunities of future generations. The scientific and technical professions have a special responsibility in this regard because the knowledge and technologies they develop and employ have immense impacts on natural environments, economies, and the empowerment of citizens and societies. Moreover, their efforts and achievements can continue to produce effects, for good or ill, well into the future.

In articulating the challenge of pursuing both *inter*generational and *intra*generational benefits for environments, societies and economies, this book grounds practical decision-making in ethical concepts and values. Through exposure to a wide variety of concrete examples, case studies, moral debates, and exercises, readers will gain a nuanced understanding of the ethics of sustainability and develop a set of practical decision skills that may be employed in its pursuit. The book engages a broad range of applications such as nuclear and solar energy systems, biotechnology and genetic engineering, materials extraction, design and production, built environment design and construction, information technology and robotics, nanotechnology and communications technology, agricultural and forestry technologies. While addressing large-scale national and global issues such as climate change, higher energy costs, water and food shortage, poverty, species extinction, and resource depletion, *The Ethics of Sustainability* also brings home the personal impact scientists and technical professionals can have at the workplace, in their communities, and in their homes.

RATIONALE FOR THE ADOPTION OF THE SUSTAINABILITY FRAMEWORK

Sustainability is now a well-known and commonly accepted framework for guiding a wide variety of choices. Sustainability suggests that, in the decision making process, societies that have a good quality of life have an obligation to ensure both future societies and contemporary, less well off societies are also able to achieve a standard of living in which their basic needs are met. The Whistler 2020 (Canada) sustainable community movement describes sustainability as "… a minimum condition for a flourishing planet in the long term."[1] Communities are applying sustainability to solving energy problems, addressing waste disposal issues, developing greenspaces, planning urban areas, and

reinvigorating the local economy. Companies are using the concept of sustainability to expand the measure of success for their endeavors from the financial bottom-line to a triple bottom line that adds social and environmental performance to economic performance. Universities are applying sustainability to guide changes to their campuses, curriculum, governance, investments, procurement policies, and relationships to their local communities. In short, sustainability is a framework upon which can be built specific strategies for guiding decision making. For example, The Natural Step, developed in Sweden, is a sustainability-based strategy for making decisions about resources utilization and disposal. Numerous other strategies that have sustainability as their core concept have emerged and are being applied to guide decision making in the private and public sectors.

The future is becoming ever more complex and it is increasingly difficult to safely navigate through the maze of issues that confront us. Humanity faces a future of much more costly energy, potentially catastrophic consequences due to climate change, shortages of potable water, the blowback of effects from the vast array of synthetic chemicals developed over the past half-century, and depleted fisheries, to name but a few. And this is occurring in the face of still rapidly increasing numbers of humans and rising per capita consumption. New technologies abound, from genetically engineered seeds, to nanobots, nuclear fusion reactors, powerful antibiotics, autonomous robots, and a vast web of wireless systems interconnected by data highways. Deploying these technologies has been driven by a cost-benefit calculus that, in light of the consequences of many of these technologies, must be considered obsolete. Sustainability can provide many of the answers to how best to treat new technologies and how to change the basis of decision making such that technological benefits far outweigh the risk, for both the short and long term and for present and future societies.

REASON FOR DEVELOPING AN ETHICS OF SUSTAINABILITY

The best known definition of sustainability is the one stated in *Our Common Future*, more commonly known as the Brundtland Report: "..meeting the needs of the present without compromising the ability of future generations to meet their needs." Inherent in this definition is the proposed responsibility of contemporary society for the quality of life of today's population plus the preservation of resources, the environment, and other ingredients needed for future populations to also experience a good quality of life. This is an enormous and daunting task and requires enormous changes in thinking, policy, and basic assumptions about the economy for its full implementation. For the present, it would mean that wealthier, more technologically sophisticated societies would have to contribute materially and through a wide range of assistance programs to increase the wealth of poorer nations, to aid them in developing the capability to provide the basic needs of their population. For future generations it means ensuring the availability of a wide range of resources: natural, cultural, mineral, educational, food, clean air and water, genetic diversity, and numerous others that support a good quality of life. The natural question to ask is: why apply the sustainability framework? In answering this question, vocabulary such as rights, obligations, and interdependence must be used. Everyone on the Earth has a *right* to having their needs for food, shelter, and clothing met. Present people have an *obligation* to future generations to provide them an intact and functioning

planet in at least as good state as they received it. And we are all *interdependent*, present and future generations, but it is the present, wealthier countries that control the fate of everyone else, present and future. The application of the sustainability framework therefore requires a better understanding of the ethical concepts which support it. Among these ethical concepts are the Precautionary Principle, the Chain of Obligation, the Distributional Principle, the Land Ethic, and the Rights of the Other Species. Through a better understanding of the ethics of sustainability, it becomes clear why the sustainability framework is not only an approach to addressing and solving the many difficult problems facing us, but why it is in fact the right approach, the right thing to do.

STATE OF THE WORLD AT THE START OF THE 21ST CENTURY

This book is being written at the start of the second decade of the 21st Century, a time as challenging as any in history, with the world facing some new, previously unknown challenges. The global financial system narrowly averted a total collapse, and although badly weakened and still not fully stable, it was saved by an enormous investment of public funds, particularly in the U.S. Just prior to the collapse, in July 2008, gasoline prices had reached an all-time high, about $4.08 per gallon in the U.S. Climate change continues, perhaps even accelerating, as the North Pole is clear of ice in the summer, enormous glaciers in Greenland and Antarctica break apart at an increasing pace, and island nations of the Pacific slowly sink into the rising ocean surrounding them. Rapidly melting glaciers in the Himalayas portend future enormous floods up to 1,000 kilometers away, and increased devastation for the already poverty stricken country of Bangladesh. The Himalayan glaciers, which regulate the water supply to these rivers, are believed to be retreating at a rate of about 10-15 meters (33-49 feet) per year.[2] In the long term it means the ultimate disappearance of the glaciers supplying the seven major rivers fed by the Himalayas (the Ganges, Indus, Brahmaputra, Mekong, Thanlwin, Yangtze and Yellow rivers) and which provide fresh water for a substantial fraction of the Earth's population. And this is just the current evidence of climate change. The forecasted effects of climate change present humanity with a potential disaster of historic proportions, with rising temperatures, much higher sea levels leading, the disappearance of substantial coastal zones, an inability to grow enough food to meet the world's needs, the destruction of the ocean conveyor belt of water movement, including the Gulf Stream, and new disease vectors, to name but a few of the effects. And in spite of this threat. the 2009 Copenhagen Summit on Climate Change resulted in essentially no significant agreement about how to proceed forward.

In addition to struggling with how to address climate change, the U.S. is engaged in a two-front war in Iraq and Afghanistan, the United Nations is struggling to prevent the development of nuclear weapons by Iran, peace in the Middle East remains as elusive as ever, and the world continues to deal with the aftermath of 9/11 and a global struggle against Islamic fundamentalists engaged in acts of terror. The high gasoline prices of 2008 likely mark the point in time of so-called Peak Oil, the time when oil production peaks and declines thereafter. The price of gasoline will likely rapidly increase well beyond the July 2008 peak due to decreased supplies and rising demand, threatening to dampen economic recovery.

In short, the world faces numerous political, economic, and social challenges that threaten to undermine the welfare of people all over the world. Sustainability provides just the type of approach needed to address these challenges and the ethics of sustainability gives sustainability legitimacy as a framework. The ethics of sustainability provides a clear sense of the principles that make sustainability more than just a simple problem-solving system, but make it an idea that is grounded in commonly understood ethical principles. In short, the ethics of sustainability provide the moral authority behind sustainability as a fair and equitable approach to making the world a better place.

ROADMAP TO THIS BOOK

This book is organized into three major sections. Part I, *Foundations of an Ethics of Sustainability*, provides the starting point for discussing the ethical context of sustainability. It include three chapters, starting with Chapter 1, *The Sustainability Framework*, which describes the rationale for sustainability as a paradigm for making decisions about a wide variety of issues, including, for example, developing and deploying technology. Because sustainability is a relatively complex notion, there are a number of definitions and meanings that have been associated with sustainability and these are addressed in Chapter 1, along with a history of this concept, and a discussion of several implementing frameworks that are based on the broad concept of sustainability. Applications of the sustainability to various sectors such as industry, agriculture, the public sector, and universities are described to demonstrate how various institutions implement sustainability in practice.

Chapter 2, *The Technology Challenge*, addresses one of the central quandaries that the sustainability framework is attempting to address, the development, deployment, and application of technology by the scientific, engineering, and other technical professions. An overview of technology, including its history and patterns of technology development are covered. The connection of sustainability to technology including the consequences of technology and risk assessment are addressed. Major contemporary technologies that are currently being deployed are described and the connection of these to sustainability are discussed. These technologies include genetic engineering, nanotechnology, robotics, biotechnology, and information/computer technology.

The final chapter of Part I, Chapter 3, *Making Ethical Decisions,* provides and overview of ethics from a general point of view. Ethical traditions, including religious and secular traditions, are described. An introduction to an ethics of sustainability, based on the three major components – environmental, social, and economics – is provided. Ethical concerns in sustainable decision making are discussed, leading to a fuller understanding of an ethics of sustainability and the start of an articulation of principles of an ethics of sustainability.

Part II, *The Ethical Principles of Sustainability*, is the core of the book, and the four chapters in this section lay out detailed descriptions, discussions, and applications of the set of principles that comprise the ethical framework of sustainability. Chapter 4, *Obligations to Future Generations and the Precautionary Principle*, describes three major ethical principles that are the core of the ethical framework of sustainability.

Chapter 5, *The Global Community, Social Justice, and the Distributional Principle,* covers the principles of the ethical framework of sustainability that link human behavior to the framework. It also focuses on the issues of present societies separated from us by social, political, economic, and geographic boundaries and who may not be capable of actively representing their own interests. Particularly important in this discussion is the distributional principle which addresses the fair distribution of advantages in society.

The ethical dimensions of our relations to other species and the community of life in general are addressed in Chapter 6, *Environmental Ethics: Other Species and the Community of Life*. The field of environmental ethics predates the concept of sustainability and has much to add to an ethics of sustainability. This chapter provides an overview of the major issues, thinkers, and theoretical approaches in environmental ethics. It also covers issues of special interest such as the role of scientific and ecological principles and ideas in environmental ethics. Additionally it addresses the relationships between social and ecological communities in relation to environmental justice.

The final chapter of Part II covers the third core concern of sustainability, the economy. Chapter 7, *Sustainable Economics*, describes the relatively new field of ecological economics, together with alternative measures of economic welfare, and several principles that provide the underpinnings of ecological economics. The theory and principles of ecological economics are reviewed, particularly limits on the scale of the economy, the role of natural capital as a true form of economic capital, and methods for changing incentives and shifting the burden of taxation such that positive outcomes for nature and society are incentivized. An overview of the history of ecological economics is also provided.

Part III of this book, *Translating Principles into Practices*, takes the principles from Part II that comprise the ethical framework of sustainability, and shows how to apply them in practice. The process of decision making is an important one and Chapter 8, *The Process of Decision Making*, describes this important process, especially its application to applying the principles of the ethical framework of sustainability to decisions about technology.

Chapter 9, *Turning Ethical Decisions into Professional Practices*, discusses how the principles of an ethics of sustainability can be used to improve decision making such that it supports sustainability. It starts with the individual making ethical decisions that strengthen sustainability and shows how group decision making can be influenced to also increase sustainability.

Applying sustainability ethics to professional decision making is important, but as important is that the professional applies these same principles in their personal lives and personal decision making. Chapter 10, *Personal and Planetary Sustainability*, covers this notion and describes how these principles can be applied in a consistent manner to the decisions of daily life.

SUMMARY
This book describes an ethics of sustainability that provides the rational and moral basis for implementing sustainability as a framework to improve decision making, particularly with respect to technology. The primary audience are scientists, engineers, technologists, mathematicians and other professions engaged in technology development, deployment, and employment. It proposes a set of principles that can be used to guide decision making such that the outcomes will improve the lot of today's disadvantaged societies as well as tomorrow's yet unborn people who are clearly at the mercy of our choices. More often than not these choices are about technology and the approach to allowing technologies to leave the laboratory without adequate debate and scrutiny is resulting in complex dilemmas for the global community. It is the hope of the authors of this volume that asking questions about technologies based on the ethics of sustainability described here will help change the decision making process and ensure that the benefits of technology to all generations far outweigh any negative consequences.

ENDNOTES

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[1] Whistler 2020 is the sustainability movement of Whistler, British Columbia, Canada. Information about this community sustainability movement can be found at www.whistler2020.ca

[2] From BBC News, "Himalayan Glaciers Melting Fast," 15 March 2005
http://news.bbc.co.uk/2/hi/science/nature/4346211.stm

CHAPTER 1
THE SUSTAINABILITY CONTEXT

Sustainability is a concept that, over the past two decades, has gained and continues to gain traction in a wide range of institutions and sectors, from national to local governments, from agriculture to tourism, and from manufacturing to construction. Several countries have articulated policies centered on sustainability, using it as a framework on which to base integrated strategies covering the environment, the economy and quality of life. For example, the United Kingdom embraces sustainability as part of its national policy as articulated in "Securing the Future – The UK Sustainable Development Strategy."[1] Similarly the European Union Sustainable Development Strategy describes the EU's approach to sustainable development and the seven key challenges facing its implementation.[2] A significant number of Fortune 500corporations, including Nike, Coca Cola, Dell Computer and Starbucks Coffee are embracing sustainability as a strategy in the form of Corporate Social Responsibility (CSR). Sustainability is a framework for ecological, economic, and social policies and programs that continues to grow in importance and is finding application in an ever wider range of circumstances. For example, the highly successful green building movement in the U.S. is based on the concept of sustainability, providing a useful template for implementation in other sectors.[3]

The most frequently cited definition of sustainable development is attributed to the Brundtland Report of 1987 – "[development] that meets the needs of the present without compromising the ability of future generations to meet their own needs."[4] There are at least 70 other documented definitions, some of which, like the Brundtland definition, are people-centered, and many others that are focused on the environment and ecological systems. The Brundtland definition provides a new vision of development, optimistic in its tone, but laced with challenges and contradictions. It suggests that in the process of developing we have a moral responsibility to consider both the welfare of both present and future peoples and the effects of present activities on the welfare of future inhabitants of our planet. Thus it could be said that sustainability addresses both intergenerational and intragenerational equity. This presents a huge challenge because we are clearly not meeting the needs of everyone in present generations much less being able to consider the quality of life of future peoples and their ability to survive. The challenge of both shifting development patterns to provide survivability for the populations of lesser developed countries while taking responsibility for the welfare of future peoples is daunting. Although not explicitly stated in the definition, the *carrying capacity*[5] of natural systems and the inherent need for nature to be protected is implicit because of the utter dependence of all human generations on the goods and services of nature for their survival.

In spite of these challenges the concept of sustainability has evolved to become a framework for making complex and difficult decisions. Contemporary sustainability borrows some of the main ideas of sustainability from the Brundtland Report, especially the notion that the needs of both present and future generations should be considered in decision making. It adds to this notion the need to balance environmental protection and

restoration with the requirements of a healthy economy and the needs of human society. At the heart of this evolved notion of sustainability are several ethical issues, among them the rights of future peoples, the obligation to consider the impacts of technology, the rights of non-human species, and others. This chapter describes the concept of sustainability, the rationale for its application, discusses other frameworks based on sustainability, and describes the ethical context that is at the heart of this concept.

DEFINITIONS AND MEANINGS OF SUSTAINABILITY

One of the reasons for the widespread application of the sustainability framework is that there are a variety of definitions. David Pearce, the eminent economist from University College London, and his colleagues developed a gallery of 40 definitions for sustainability.[6] Definitions of sustainability may cover all three systems comprising this framework (social, environmental, or economic) or may be skewed to one of them; they may or may not address future generations; and they may address technology, resources, waste, pollution or other issues. The following are some definitions of sustainability and some thoughts about this concept:[7]

"[Development] that meets the needs of the present without compromising the ability of future generations to meet their own needs."
The Brundtland Report

"Sustainable design is the set of perceptual and analytic abilities, ecological wisdom, and practical wherewithal essential to making things that fit in a world of microbes, plants, animals, and entropy. In other words, (sustainable design) is the careful meshing of human purposes with the larger patterns and flows of the natural world, and careful study of those patterns and flows to inform human purposes."
David Orr, Professor, Oberlin College, Ohio

"Sustainability is equity over time. As a value, it refers to giving equal weight in your decisions to the future as well as the present. You might think of it as extending the Golden Rule through time, so that you do unto future generations as you would have them do unto you."
Robert Gilman, Director, Context Institute

"A transition to sustainability involves moving from linear to cyclical processes and technologies. The only processes we can rely on indefinitely are cyclical; all linear processes must eventually come to an end."
Dr. Karl Henrik-Robert, MD, founder of The Natural Step, Sweden

"Actions are sustainable if:
There is a balance between resources used and resources regenerated.
Resources are as clean or cleaner at end use as at beginning.
The viability, integrity, and diversity of natural systems are restored and maintained.
They lead to enhanced local and regional self-reliance.
They help create and maintain community and a culture of place.
Each generation preserves the legacies of future generations."

David McCloskey, Professor of Sociology, Seattle University

"Clean air, clean water, safety in city parks, low-income housing, education, child care, welfare, medical care, unemployment (insurance), transportation, recreation/cultural centers, open space, wetlands..."
Hazel Wolf, Seattle Audubon Society

"Leave the world better than you found it, take no more than you need, try not to harm life or the environment, make amends if you do. "
Paul Hawken, The Ecology of Commerce

The wide variety of definitions for sustainability is both a blessing and a curse. It has something for everyone. Sharachchandra Lélé described this phenomenon as follows:[8]

> Sustainable development is a 'metafix' that will unite everybody from the profit-minded industrialist and risk-minimising subsistence farmer to the equity-seeking social worker, the pollution-concerned or wildlife-loving First Worlder, the growth-maximising policy maker, the goal-oriented bureaucrat and, therefore, the vote-counting politician.

THE RATIONALE FOR SUSTAINBILITY

The concept of sustainability has its roots in what might be called "the crisis of development," that is the failure since World War II of international development schemes intended to improve the lot of impoverished peoples around the world. The failure of these initiatives means that the proportion of those living in abject poverty has remained relatively steady over the past 60 years, around 1 in 5 people. The poor continue to live on the edge of survival, with abominable living conditions, malnutrition, disease, and little prospect for a better future. Often they live in countries crushed by the burden of debt, with poor infrastructure, almost no educational system, the lack of a functioning justice system, and in the shadow of omnipresent violence. In the favelas of Brazil and the slums of Manila whole families survive by gathering and selling metal and other materials from garbage dumps. Simultaneously the world is facing environmental crises and resource shortages that compound the problem for the world's poorest and place stress on even the wealthier nations as energy prices rise, climate patterns shift, and the Earth's dowry of biodiversity dwindles.

The 1987 Brundtland Report identified this state of the world as stemming from a shift in the relationship between the world's natural systems and humanity which depends on these systems for its survival. The rapid growth in population and consumption has resulted in a mismatch between the capacity of natural systems and human activities that are constrained to functioning within these natural systems. The Brundtland Report suggests there are two main imperatives needed to correct this imbalance. First, the basic needs of all human beings must be met and poverty must be eliminated. Second, there must be limits placed on development in general because nature is finite. The ability to meet the basic needs of everyone is bounded by the capacity of nature to help meet those needs. Technology must be developed and applied judiciously to help meet the first

imperative without adversely affecting the capacity of nature, either due to depletion by excess usage, or via destruction due to the negative consequences of some technologies. The following sections describe some of the issues that are forcing a rethinking of conventional approaches to policy, production, and consumption and for which sustainability provides some answers.

Population and Consumption

Much has been said about the role of population as the cause of many global problems due to the need to feed, clothe, and house Earth's still rapidly growing human population. In fact the combination of population and per capita consumption is challenging the carrying capacity of the planet. In addition to the burden of a rapidly growing global population on relatively scarce food, water, land, and materials resources, the wealthier nations consume far more per capita than the poorer countries. The world's wealthiest countries, with less than 20 percent of the world's population, contribute roughly 40 percent of global carbon emissions, and they are responsible for more than 60 percent of the total carbon dioxide that fossil fuel combustion has added to the atmosphere since the Industrial Revolution began. But this picture is now changing rapidly, particularly in China, where emissions are now rising at 10 percent a year, 10 times the average rate in industrial nations. By 2007 China's fossil fuel emissions exceeded those of the United States and continue to grow rapidly.[9] Global population continues to grow at an alarming rate, with a population the size of Mexico's (about 80 million) being added to the planet each year and almost 1 billion people per decade.

Consumption is another side of the problem, especially per capita consumption of key natural resources which varies greatly around the world. Typically, the citizens of rich industrialized nations use more of the world's resources and produce more waste. As a result they sometimes deplete their own resources and often the resources of other countries.

For many resources, the U.S. is the world's largest consumer in absolute terms and for others it is the largest per capita consumer. For 11 out of 20 major traded commodities, the U.S. is the greatest consumer. These include commodities such as corn, coffee, copper, lead, zinc, tin, aluminum, rubber, oil seeds, oil and natural gas.[10]

A typical example is meat. China, with the world's largest population, is the highest overall producer and consumer of meat, but the highest per-capita consumption in the world is that of the United States. The average United States citizen consumes more than three times the global average of 37 kilos per person per year. Africans consume less than half the global average, and South Asians consume the least, under 6 kilos per person per year. Other resources are used much more variably, depending on local circumstances. Fish, for instance, has been a cheap source of protein for hundreds of millions of poor people wherever it has been available. The highest consumption levels are in some of the world's poorest states, such as the Maldives or Kiribati, where fish is plentiful. Per-capita consumption is also very high in rich nations with well-established fishing traditions -- 91 and 66 kilos per capita in Iceland and Japan respectively; way above the global average of 16 kilos per capita per year.[11]

To pursue sustainability, the so-called "twin horns of the dilemma," population and consumption, must both be addressed.

Climate Change

Changes in the Earth's climate are the rule rather than the exception and there is ample evidence that over the past several million years there have been significant shifts in the Earth's average annual temperature.

As defined by the National Oceanographic and Atmospheric and Administration (NOAA), *climate change* consists of long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate. The United Nations Framework Convention on Climate Change describes the phenomenon as a change of climate attributable directly or indirectly to human activity that alters the composition of the global atmosphere, and that is, in addition to natural climate variability, observable over comparable time periods. The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization (WMO) and the United Nations (UN) in 1988 to assess, on a comprehensive, objective, open, and transparent basis, the scientific, technical, and socioeconomic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. The Fourth Assessment Report of the IPCC, published in 2007, concludes that the globally averaged surface temperatures have increased by 0.3 ± 0.1°F (0.6 ± 0.2°C) over the twentieth century. For a range of scenarios, the globally averaged surface air temperature is projected by models to warm 0.8 to 3.2°F (1.4°C to 5.8°C) by 2100 relative to 1990. Furthermore, globally averaged sea level is projected by models to rise 0.30 to 2.9 feet (0.09 to 0.88 meters) by 2100. These projections indicate that the warming would vary by region and be accompanied by increases and decreases in precipitation.[12]

Moreover, there would be changes in climate variability, as well as in the frequency and intensity of some extreme climate phenomena. It is important to note that the behavior of global systems such as climate are nonlinear. Each increase in carbon dioxide will not necessarily produce a proportional change in global temperature. However, the dynamic, chaotic character of the Earth's climate is such that climate can suddenly "flip" from one temperature regime to another in a relatively short time. Indeed, fossil records indicate that previous flips have occurred, with temperature increasing or decreasing almost 10°F (5.6°C) in about a decade. The potential for climate change has profound implications for every aspect of human activity on the planet. Shifting temperatures, more violent storms, rising sea levels, melting glaciers, and other effects will displace people, affect food supplies, reduce biodiversity, and greatly reduce the quality of life.

Mineral Resource Depletion

The depletion of key resources needed to support the energy and materials requirements of today's technological, developed world societies, is a threat to the high quality of life enjoyed by North Americans, Europeans, Japanese, and the other countries that make up these societies. Evidence to-date seems to indicate that we have maximized our ability to

extract oil and that we are in an era of probably far higher prices for oil-based products, among them gasoline, diesel, jet fuel, and oil-based polymers. A similar scenario is playing out with other key resources, most notably metals. A recent study of the supply and usage of copper, zinc and other metals has determined that supplies of these resources--even if recycled--may fail to meet the needs of the global population.[13] Even the full extraction of metals from the Earth's crust and extensive recycling programs may not meet future demand if all countries try and attain the same standard of living enjoyed in developed nations. The researchers, Robert Gordon and Thomas Graedel, based their study on metal still in the Earth, in use by people and lost in landfills. Using copper stocks in North America as a starting point, they tracked the evolution of copper mining, use and loss during the 20th century. They then applied their findings and additional data to an estimate of global demand for copper and other metals if all nations were fully developed and used modern technologies. The study found that all of the copper in ore, plus all of the copper currently in use, would be required to bring the world to the level of the developed nations for power transmission, construction and other services and products that depend on copper. Globally, the researchers estimate that 26 percent of extractable copper in the Earth's crust is now lost in non-recycled wastes; while lost zinc is estimated at 19 percent. Interestingly, the researchers said that current prices do not reflect those losses because supplies are still large enough to meet demand, and new methods have helped mines produce material more efficiently. While copper and zinc are not at risk of depletion in the immediate future, the researchers believe scarce metals, such as platinum, are at risk of depletion in this century because there is no suitable substitute for their use in devices such as catalytic converters and hydrogen fuel cells. And because the rate of use for metals continues to rise, even the more plentiful metals may face similar depletion risks in the not too distant future. The impacts on metal prices due to a combination of demand and dwindling stocks has been dramatic. In a single year 2005-2006, zinc and copper experienced a 300% rise, and metals such as nickel, brass and stainless steel rose by about 250%. The good news is the there is a renewed emphasis on recycling, using only the exact quantity of metals required, and insuring that all in-plant scrap is recovered during manufacturing.[14]

Loss of Biodiversity

Biodiversity refers to the number and variety of living organisms and the ecosystems in which they occur. The concept of biodiversity encompasses the number of different organisms, their relative frequencies, and their organization at many levels, ranging from complete ecosystems to the biochemical structures that form the molecular basis of heredity. Thus, biodiversity expresses the range of life on the planet, considering the relative abundances of ecosystems, species, and genes. Species biodiversity is the level of biodiversity most commonly discussed. An estimated 1.7 million species have been scientifically documented out of a total estimated number of between 5 million and 100 million species. However, deforestation and climate change are causing such a rapid extinction of many species that some biologists are predicting the loss of 20 percent of existing species over the next 20 years.

Deforestation is particularly devastating, especially in rainforests, which comprise just 6 percent of the world’s land but contain more than 500,000 of the planet’s species.

Biodiversity preservation and protection is important to humanity since diverse ecosystems provide numerous services and resources, such as protection and formation of water and soil resources; nutrient storage and cycling; pollution breakdown and absorption; food; medicinal resources; wood products; aquatic habitat; and undoubtedly many undiscovered applications.[15] Once lost, species cannot be replaced by human technology, and potential sources of new foods, medicines, and other technologies may be forever forfeited.

Furthermore, degradation of ecosystems contributes to the emergence and spread of infectious diseases by interfering with natural control of disease vectors. For example, the fragmentation of North American forests has resulted in the elimination of the predators of the white-footed mouse, which is a major carrier of Lyme disease, now the leading, vector-borne infectious illness in the United States. Finally, species extinction prevents discovery of potentially useful medicines such as aspirin, morphine, vincristine, taxol, digitalis, and most antibiotics, all of which have been derived from natural sources.[16]

Overfishing

The Earth's ocean ecosystems contain a majority of all life found on earth and other bodies of water contain over 22,000 species of fish and ocean mammals, ranging in size from the 150 ton, 40 meter long blue whale to very small fish that feed on microscopic phytoplankton. Unfortunately the world's fishing fleets are two to three times larger than the level that would produce a sustainable yield of fish, that is, a yield that does not deplete the stocks of fish or destroy the biodiversity of the oceans. The methods used by large commercial fishing are destructive in two ways: they result in overfishing and they decimate the ocean bottom due to the use of bottom trawling. Overfishing can be defined in terms of biological impacts or economic impacts. In an economic sense overfishing occurs when the stocks of desirable fish have been depleted to a level that makes it unprofitable for fishing companies to operate. Biologically, overfishing has occurred when the stocks of fish have become so depleted that the survival of the species is in question or the recovery of the fishery will take an extraordinarily long time. Much of the world's human population relies on fish, both from marine capture and from aquaculture for their nutrition. In a report published by the UN Food and Agriculture Organization, the scientists reported that 52% of fish stocks are fully exploited, 17% are over-exploited, 7% are depleted, and 1% are recovering from depletion.[17]

Desertification, Eutrophication, and Acidification

In arid and semiarid regions land degradation results in *desertification*, or the destruction of natural vegetative cover, which promotes desert formation. The United Nations Convention to Combat Desertification, formed in 1996 and ratified by 179 countries, reports that over 250 million people are directly affected by desertification.[18] Furthermore, drylands susceptible to desertification cover 40 percent of the Earth's surface, putting at risk a further 1.1 billion people in more than 100 countries dependent on these lands for survival. China, with a rapidly growing population and economy, loses about 300,000 acres of land each year to drifting sand dunes.

Two environmental conditions that frequently threaten water supplies are eutrophication and acidification. *Eutrophication* refers to the over-enrichment of water bodies with nutrients from agricultural and landscape fertilizer, urban runoff, sewage discharge, and eroded stream banks. Nutrient oversupply fosters algae growth, or algae blooms, which block sunlight and cause underwater grasses to die. Decomposing algae further utilize dissolved oxygen necessary for the survival of aquatic species such as fish and crabs. Eventually, decomposition in a completely oxygenless, or *anoxic,* water body can release toxic hydrogen sulphide, poisoning organisms and making the lake or seabed lifeless. Eutrophication has led to the degradation of numerous waterways around the world. For example, in the Baltic Sea, huge algae blooms, now common after unusually warm summers, have decreased water visibility by 10 to 15 feet in depth.

Acidification is the process whereby air pollution in the form of ammonia, sulphur dioxide and nitrogen oxides, mainly released into the atmosphere by burning fossil fuels, is converted into acids. The resulting *acid rain* is well known for its damage to forests and lakes. Less obvious, however, is the damage caused by acid rain to freshwater and coastal ecosystems, soils, and even ancient historical monuments. The acidity of polluted rain leaches minerals from soil, causing the release of heavy metals that harm microorganisms and affect the food chain. Many species of animals, fish, and other aquatic animal and plant life are sensitive to water acidity. As a result of European directives that forced the installation of desulphurization systems and discouraged the use of coal as a fossil fuel, Europe experienced a significant decrease in acid rain in the 1990s. Nonetheless, a 1999 survey of forests in Europe found that about 25 percent of all trees had been damaged, largely due to the effects of acidification.[19]

Destruction of Environmental Amenity and Environmental Services

As the planet is transformed by the conversion of forests and habitat by agriculture, extraction, and development, the inherent qualities of nature that humans enjoy for recreation and in which they find wonder, peace, and relaxation, are disappearing at alarming rate. These qualities are sometimes referred to as *environmental amenity* and include the services of natural systems such as providing clean air and clean water. . The destruction of forests and other ecological biomes, together with human impacts on seas, oceans, lakes, rivers, and other bodies of water causes a reduction in the wide range of services provided by ecosystems. Ecosystems provide a wide range of goods and services to humankind at no cost that would otherwise be technically difficult and costly to replace. These goods and services include production of food and water; control of climate and disease; support from the major global-geochemical and nutrient cycles; crop pollination; spiritual and recreational benefits; and the maintenance of biodiversity. In a study conducted by Robert Costanza and his colleagues in 1997, they estimated the economic value of these services was estimated to be almost double global Gross Domestic Product.[20] Over the past 2000 years, approximately 40-50% of Earth's ice-free land surface has been heavily transformed or degraded by anthropogenic activities, 66% of marine fisheries are either overexploited or at their limit, atmospheric CO_2 has increased more than 30% since the advent of industrialization, and nearly 25% of Earth's bird species have gone extinct.[21] The loss of both temperate forests and rainforests is a major component of the loss of this amenity. Rainforests, which support 60% of the

world's species, are disappearing at a rate of 15 million hectares per year.[22] Temperate forests found mostly in the U.S., Europe, and Russia, are being destroyed at an even greater pace, with only 1% of the original U.S. and European forests remaining. One of the outcomes of deforestation is the loss of animal habitat and unique flora and fauna which future generations will not be able to experience.

Poverty and the Maldistribution of Wealth

The Brundtland Report was the result of an effort by the United Nations to determine how to break the persistent grip of poverty on the vast majority of the world's population. Poverty depends on a wide range of variables and from country to country. The poverty threshold or poverty line is generally accepted as a measure of poverty in any given country and it is defined as the minimum income required to achieve an adequate standard of living in that country. The standard of living is generally accepted as the value of all resources consumed by a typical individual in one year and includes rent and transportation. Adjustments are made to the standard of living based on status (single, married, elderly), and other circumstances. In 2007, for example, the poverty threshold for a single person under 65 was $10,787 in the United States. For a family group of four, including two children, the poverty threshold was determined to be $21,027.[23]

Poverty in developed countries tends to be cyclical, that is, the number of impoverished people rises and falls with economic conditions and unemployment. In the less developed countries, poverty tends to be persistent. The terms absolute poverty and extreme poverty are sometimes used to define the form of persistent poverty which is independent of time and place. According to the United Nations, absolute poverty is "a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health shelter, education, and information. It depends not only on income but also on access to services." Absolute poverty can be defined as the absence of any two of eight basic needs:[24]

- *Food:* Body Mass Index must be above 16.
- *Safe drinking water:* Water must not come from solely rivers and ponds, and must be available nearby (less than a 15 minutes walk each way).
- *Sanitation facilities:* Toilets or latrines must be accessible in or near the home.
- *Health:* Treatment must be received for serious illnesses and pregnancy.
- *Shelter:* Homes must have fewer than four people living in each room. Floors must not be made of dirt, mud, or clay.
- *Education:* Everyone must attend school or otherwise learn to read.
- *Information:* Everyone must have access to newspapers, radios, televisions, computers, or telephones at home.
- *Access to services:* Access to typical services such as education, health, legal, social, and financial (credit) services.

For the purpose of global aggregation and comparison, the World Bank uses reference lines set at $1.25 and $2 per day. Poverty estimates released in August 2008 showed that about 1.4 billion people in the developing world were living on less than $1.25 a day in 2005, down from 1.9 billion in 1981. This amounts to a reduction of absolute poverty

from 1 in 4 people in 1981 to 1 in 2 people in 2008. The international poverty line of $1.25 a day at 2005 prices is the mean of the national poverty lines for the 10-20 poorest countries of the world.

In 2001, the then 192 United Nations member states adopted the United Nations Millennium Declaration which laid out eight major development goals to be achieved by 2015. Goal 1 of the United Nation's Millennium Development Goals is to eradicate extreme poverty and hunger. According to the World Bank, the developing world as a whole remains on track to meet the first Millennium Development Goal which is to halve extreme poverty from its 1990 levels by 2015.[25] It could be said that global efforts to reduce poverty are having some success based on these statistics. However the world is entering an era of diminishing resources, including oil, metals, food, potable water and output from fisheries. The world's population continues to grow at a rate of about 1.7% year, straining natural and mineral resources. The result could be a reversal in these positive trends if population and consumption continue on their present trajectories.

CONTEMPORARY SUSTAINABILITY- BASED FRAMEWORKS

In addition to being the metafix described by Sharachchandra Lélé, sustainability is a broad concept upon which others can be constructed. The following sections describe four of these sustainability-based frameworks: The Natural Step, The Hannover Principles, The Three-Legged Stool, and Corporate Social Responsibility.

The Natural Step

The Natural Step (TNS), which is based on four scientifically derived "System Conditions," was developed in the 1980s by Dr. Karl Henrik Robèrt, a Swedish oncologist. These Systems Conditions are as follows:[26]

1. In order for a society to be sustainable, nature's functions and diversity are not systematically subjected to increasing concentrations of substances extracted from the Earth's crust. In a sustainable society, human activities such as the burning of fossil fuels and the mining of metals and minerals, will not occur at a rate that causes them to systematically increase in the ecosphere. There are thresholds beyond which living organisms and ecosystems are adversely affected by increases in substances from the Earth's crust. Problems may include an increase in greenhouse gases leading to global climate change, contamination of surface and groundwater, and metal toxicity, which can cause functional disturbances in animals. In practical terms, the first condition requires society to implement comprehensive metal and mineral recycling programs and decrease economic dependence on fossil fuels.

2. In order for a society to be sustainable, nature's functions and diversity are not systematically subjected to increasing concentrations of substances produced by society. In a sustainable society, humans will avoid generating systematic increases in persistent substances such as DDT, PCBs, and freon. Synthetic organic compounds such as DDT and PCBs can remain in the environment for many years, bioaccumulating in the tissue of organisms, causing profound deleterious effects on predators in the upper levels of the food chain. Freon, and other ozone-depleting compounds, may increase the risk of cancer

due to added ultraviolet radiation in the troposphere. Society needs to find ways to reduce economic dependence on persistent human-made substances.

3. *In order for a society to be sustainable, nature's functions and diversity are not systematically impoverished by overharvesting or other forms of ecosystem manipulation*. In a sustainable society, humans will avoid taking more from the biosphere than can be replenished by natural systems. In addition, people will avoid systematically encroaching upon nature by destroying the habitat of other species. Biodiversity provides the foundation for ecosystem services that are necessary to sustain life on this planet. Society's health and prosperity depend on the enduring capacity of nature to renew itself and rebuild waste into resources.

4. *In a sustainable society resources are used fairly and efficiently in order to meet basic human needs globally.* Meeting the fourth system condition is a way to avoid violating the first three system conditions for sustainability. Considering the human enterprise as a whole, we need to be efficient with regard to resource use and waste generation in order to be sustainable. If 1 billion people lack adequate nutrition while another billion have more than they need, there is a lack of fairness with regard to meeting basic human needs. Achieving greater fairness is essential for social stability and the cooperation needed for making large-scale changes within the framework laid out by the first three conditions. To achieve this fourth condition, humanity must strive to improve technical and organizational efficiency around the world, and to live using fewer resources, especially in affluent areas. System condition number four implies an improved means of addressing human population growth. If the total resource throughput of the global human population continues to increase, it will be increasingly difficult to meet basic human needs, as human-driven processes intended to fulfill human needs and wants are systematically degrading the collective capacity of the Earth's ecosystems to meet these demands.

In addition to the Systems Conditions, TNS provides a systematic approach to implementation by which corporations can progress to a point where they are essentially following the four systems conditions. The system is setup so that companies progress from Level 1 to Level 5, and at each level they are decreasing their impacts in accordance with the Systems Conditions. The five level are outlined in brief below:[27]

Level 1: Implement a policy of year by year reductions in emissions of synthetic and substances from the earth's crust, including solid waste, thereby avoiding local accumulation.

Level 2: Continue increasing the ratio of recycled to virgin materials, decreasing dependence on materials extraction.

Level 3: Maximize resource efficiency and introduce analysis to assist in reducing the non-renewable portion of the materials stream.

Level 4: Introduce Life Cycle Assessment (LCA) analysis to provide a more detailed understanding of the impact of production decisions.

Level 5: Set effective limits on materials extraction from the earth's crust and the use of these materials. Consider use of land and set limits on the use of land for production.

TNS provides more of an educational than a practical framework for companies to use to progress toward sustainability. It sets limits that are difficult to determine much less attain. In spite of its shortcomings, TNS has become a very popular and well-recognized sustainability based framework that provides insights on limits that society will have to face or suffer the consequences of ignoring them.

The Hannover Principles

In 1992, the city manager of Hannover, Germany, Jobst Fiedler, commissioned William McDonough, one of the early major figures in the emergence of green buildings, to work with the city to develop a set of principles for sustainable design for the year 2000 Hannover World Fair. The principles were not intended to serve as a how-to for ecological design but as a *foundation* for ecological design. One of the contributions that emerged from this relatively early attempt to articulate principles for the green building movement was a definition of *sustainable design* as the "conception and realization of ecologically, economically, and ethically responsible expression as part of the evolving matrix of nature." These principles, commonly known as the Hannover Principles, are listed in Table 1.1.[28]

Table 1.1 The Hannover Principles

1. Insist on the rights of humanity and nature to coexist.
2. Recognize interdependence.
3. Respect relationships between spirit and matter.
4. Accept responsibility for the consequences of design.
5. Create safe objects of long-term value.
6. Eliminate the concept of waste.
7. Rely on natural energy flows.
8. Understand the limitations of design.
9. Seek constant improvement by the sharing of knowledge.

In some respects the Hannover Principles could be said to extend the definitions of sustainability by explicitly addressing the non-material world of spirit, describing the importance of design, explaining how designers have a responsibility for creating devices and objects that are culturally significant and of value to society. It could be said that the problems being addressed by sustainability are indeed problems of poor design. At the 2007 meeting of the International Council of Societies of Industrial Design, Nathan Shedroff said, "Design is a big part of the sustainability problems in the world. Design has been focused on creating meaningless (often), disposable (though not responsibly so), trend-laden fashion items—all design. Graphic design is particularly bad, though paper materials, at least, have a huge potential to fix this problem."[29]

The Hannover Principles led to the development of sustainable design which is now embedded in architecture and other areas of design such as landscape architecture, interior design, urban planning, and industrial design. Sustainable design can be described as an approach that recognizes that products and processes are interdependent with the environmental, economic, and social systems surrounding them and implements measures to prevent an unsustainable compromise to these systems.[30] It is a design approach that is often described as holistic, systems-based, and synergistic. The present day green building movement embraces sustainable design as central to the production of buildings, cities, and infrastructure that lower the impacts of construction and the consumption of resources associated with human-made structures.

The Three Legged Stool Interpretation

While not the formal name for this sustainability framework, the *three-legged stool* interpretation is likely the most common understanding of sustainability and how it is most commonly applied. In this model sustainability is comprised of three systems: ecological, economic, and social. For sustainability to be the outcome, these three systems must be balanced. Hence the metaphor of the three-legged stool: to serve its function best, its legs must be of equal length. A strong and healthy society is the primary desired outcome of sustainability. The needs of its population are met and society's ethical obligations to future generations are met though a careful examination of the society's consumption of resources, its populations growth, its generation of waste, the role of technology in the society, the behavior of the economic system, and the protection of environmental services and amenity. Clearly a strong economy is a fundamental need of any nation and meeting the needs of its citizens includes having institutions and regulations in place that provide incentives and controls for its economic and financial systems. The financial crisis of 2008-2009 in which many banks, insurance companies, brokerage houses, and other components of the economic system failed, is a warning for the future about the need to make the economic system a servant of the people instead of the reverse. That being said, a strong economy that provides jobs with a living wage and adequate healthcare, life insurance, pension and other benefits is highly desirable for a healthy society. And both society and its economic system must respect the central role of the Earth's ecological systems in the health of both society and the economy. Indeed both are utterly dependent on healthy ecosystems for their existence.

In spite of its attraction as a simple device for understanding sustainability, the three-legged stool does have some inherent conflicts and contradictions. Due to the structure of the stool, humanity is placed outside of the environment instead of being embedded in the environment. It could be said that the three-legged stool interpretation of sustainability is no different than the neoclassical economic model, the fundamental obstacle to the adoption of sustainability as an international framework for decision making. Thus humanity is embedded in the ecological system as is the economy. The destruction of the ecological system through growth, consumption, and waste can only result in serious problems for human quality of life and for the economic system which supports it.[31]

Additionally the developed world continues to consume resources and generate waste at ever-increasing rates. Except for a downturn caused by the financial meltdown of 2008-2009, there is no trend to reverse the pattern of growth. The failure of the U.S. and Russia to sign the Kyoto Protocol on climate change, which addressed just one of the many serious environmental issues confronting humanity, is a case in point.[32] It is likely that in spite of its efforts to reduce carbon emissions, the vast majority of the power plants planned for the next 20 years, each with a 50 year lifetime, will be coal-fired systems. Changing the behavior of the big emitters of carbon is one of the keys to success in addressing climate change because fewer than 20 countries are responsible for 8o% of the world's carbon emissions. Changing the behavior of the big emitters has been fraught with problems. President Bill Clinton's attempt to introduce a 4.3 cent per gallon carbon tax on gasoline in 1993 to finance a transition to alternative and renewable energy technologies was soundly rejected by Congress under intense pressure from the oil lobby. The Waxman-Markey "American Clean Energy and Security Act of 2009" is the first serious effort on the part of the U.S. to cut carbon emissions, calling for a 17% reduction in 2005 emission levels by 2020, and a 83% cut by 2050. At the Copenhagen Climate Change summit in December 2009, the Obama administration agreed to reduce U.S. carbon emissions by 17% by 2020. At this meeting the Chinese also agreed to reduce the carbon intensity of their economy 40% by 2050. Both commitments, while reducing the rate of growth of carbon emissions, will not reverse the concentration of carbon in the atmosphere and only delay the inevitable impacts of climate change.

The three-legged stool has emerged as the most common interpretation of sustainability and the basis for implementation. Corporate Social Responsibility, covered in the following section is an example of its application. Simply put, for business sustainability can be interpreted as expanding the measures of success for a commercial endeavor from the financial bottom line to the enterprise's social and environmental performance. This is a significant step forward in the struggle to have sustainability become the framework for all sectors of society and proves the utility of the three-legged stool interpretation for at least some stakeholders.

Corporate Social Responsibility

A present there is aa growing movement in the world of business to engage in the international dialogue about sustainability. The Exxon Valdez oil spill, the Bhopal disaster, the fraudulent financial reporting and subsequent collapse of Enron, Tyco, and Worldcom, and the 2008-2009 collapse of financial industries destroyed public trust and confidence in the corporate world, and affected the bottom-line performance of numerous companies because their behavior and financial reporting could not be trusted.

Driven by this plague of environmental mishaps, fraud, and corporate scandals over the past three decades, the business world has embraced the notion of responsibility beyond mere financial performance. The corporate sustainability movement is now termed Corporate Social Responsibility (CSR) and it attempts to apply sustainability to guide the behavior of business with respect to both society and the environment as well as its responsibility to stockholders. In this new model corporations value their success not

solely based on its financial bottom-line, but also on their environmental and social performance.

This shift in corporate attitudes from purely profit-making operations to sustainable organizations is nothing short of startling. The economist, Milton Friedman, famously said in 1962, "Few trends could so thoroughly undermine the foundations of our free enterprise society as the acceptance of a social responsibility other than to make as much money for their stockholders as possible."[33]

In 2000, Intel dramatically stepped up its support for education programs and now values its annual support for education programs supporting math, science and technology at $100 million, a combination of cash grants, equipment and services. Standard Chartered, a U.K.-based international bank with 75,000 employees operating in 70 countries recently announced a $20 million global initiative, *Seeing Is Believing*, which aims to provide eye care to poor urban areas around the globe. Standard Chartered also has committed to making $500 million available for microfinance loans in developing countries; to educate a million people about HIV/AIDS over three years; and to operate a program called *Nets for Life* in Africa, which is working to curb the spread of malaria. Xerox uses paper in a way that is environmentally responsible and has partnered with the Nature Conservancy, giving the conservation organization $1 million and the help of their researchers to create better forest management practices. Drug-maker Wyeth is making efforts to make life-saving vaccines more accessible to the world's poor.

Starbucks Corporation provides a good example of an organization that has embraced CSR. In their 2009 CSR Report they state:[34]

> Our commitment to being a deeply responsible company contributing positively to our communities and environment is so important to Starbucks that it's one of the six guiding principles of our mission statement. We work together on a daily basis with partners (employees), suppliers, farmers and others to help create a more sustainable approach to high-quality coffee production, to help build stronger local communities, to minimize our environmental footprint, to create a great workplace, to promote diversity and to be responsive to our customers' health and wellness needs.

This statement is indicative of the comprehensive approach that companies applying the CSR framework take when approaching their responsibilities beyond financial performance. They have thoroughly examined their supply chain to ensure that throughout the entire process, the farmers, workers, and communities with whom they deal are treated fairly and justly and that the environmental responsibility is a key aspect of their approach. Companies engaged in the CSR framework accrue significant benefits such as a better brand identity, lower levels of regulatory scrutiny, reduced liability, a better reputation among prospective employees, and a far greater probability of gaining a 'license to operate' in communities where they propose to establish operations.

All of these social and environmental efforts by major corporations mark a significant departure from the traditional model of doing business and point to a trend toward incorporating sustainability thinking in business. The result of this new approach to measuring success it sometimes referred to as triple bottom line performance. Common CSR policies include:

- Adoption of internal controls reform in the wake of Enron and other accounting scandals;
- Commitment to diversity in hiring employees and barring discrimination;
- Management teams that view employees as assets rather than costs;
- High performance workplaces that integrate the views of line employees into decision-making processes;
- Adoption of operating policies that exceed compliance with social and environmental laws;
- Advanced resource productivity, focused on the use of natural resources in a more productive, efficient and profitable fashion (such as recycled content and product recycling); and
- Taking responsibility for conditions under which goods are produced directly or by contract employees domestically or abroad.

When analyzing companies, the United Nations Environment Program Financial Initiative asked one of the world's largest law firms to research whether institutional investors such as pension funds and insurance companies are legally permitted to integrate environmental, social and governance issues into their investment decision-making and ownership practices. The resulting report, released in October 2005, concluded that investors were not only permitted to but also sometimes required to take such factors into account. The report concluded that, "Integrating environment, social and governance considerations into an investment analysis so as to more reliably predict financial performance is clearly permissible and is arguably required in all jurisdictions."[35]

One of the outcomes of the CSR movement has been new approaches to how companies report on their triple bottom line performance. Most prominent among the various reporting formats is the *Global Reporting Initiative* which provides guidelines for CSR reporting by a wide variety of public and private sector organizations. Sustainability reports based on the GRI framework can be used to benchmark organizational performance with respect to laws, norms, codes, performance standards and voluntary initiatives; demonstrate organizational commitment to sustainable development; and compare organizational performance over time. GRI promotes and develops this standardized approach to reporting to stimulate demand for sustainability information – which will benefit reporting organizations and those who use report information alike. Over 1,500 organizations from 60 countries use the GRI framework to report on their triple bottom line performance. Companies as diverse as Volkswagen and Dell Computer use the GRI for their sustainability using sector specific adaptations of the GRI.[36]

CSR has been criticized by some as a form of 'greenwash' whereby companies adopt this framework as a strategy primarily to improve their public relations. The operations and products of some companies, for example, chemical companies, oil companies, weapons manufacturers, and tobacco companies, to name but a few, seem to be incongruent with CSR and sustainability. Some critics argue that CSR is simply a means of allowing companies to reduce their social and environmental impacts voluntarily when what is truly needed are strong government intervention and regulation. The financial collapses of 2008-9 are perhaps indicative of what can occur when the hand of government is removed and the interests of society at large are not addressed. On the other hand, some CSR proponents are optimistic that the widespread adoption of this framework will generally improve the well-being of society and instill a culture of responsibility in corporate boardrooms.

THE ETHICAL CONTEXT OF SUSTAINABILITY

As noted earlier, the classic, Brundtland Report definition of sustainable development is "[development] that meets the needs of the present without compromising the ability of future generations to meet their own needs." Indeed this definition proposes a novel ethical concept that frames the rights of both present and future peoples, juxtaposes the rights of future versus present generations, and suggest that everyone's needs should be fulfilled before the wants of some are addressed. Even as issues of both intergenerational and intragenerational justice are raised by this definition, some clear quandaries arise. For example, how is it possible to address the needs of future peoples when the needs of the vast majority of the world's present population are not being met? What exactly are the 'needs' that must be met? Chapters 5 and 6 further develop this theme.

There is also the question of whether future generations can be said to have rights. M.P. Golding addressed this problem in1972 when he suggested that a moral community can be organized only in one of two ways, by an explicit contract between its members or by a social arrangement in which each member benefits from the efforts of other members. With respect to future generations neither an explicit contract nor social arrangement is possible and thus rights cannot be attributed to future generations as a result of a contract or social arrangement.[37] Alternatively, if future generations shared the same interests or social ideals as present peoples, then it could be argued that they have rights equal to ours. Golding argued that, due to technological changes and other factors it is not possible to know the condition of future generations and their conception of life and values. Around the same time frame as Golding's musings about rights of future generations, Walter Wagner (1971) suggested that if we recognized the rights of future generations, then we would experience a greater degree of self-actualization and well-being.[38]

Another lens through which to view the issue of future generations is that our ancestors have greatly benefited us and that we have a similar obligation to the future. The Japanese concept of *On* is close to that of obligation. *On* requires that one make past payment to one's ancestors by giving equally good or better conditions or things to posterity. Future persons may be thought of proxies for past generations to whom present

people owe debts. These debts are repaid by providing as much or more to future generations as our ancestors did for us.[39]

In addition to the positive benefits that must be passed on to future generations, harmful consequences must not be passed on. Many of the present day's technologies are likely pose ominous threats to future generations: genetic engineering, nanotechnology, chemicals, antibiotics, pesticides, nuclear reactors and their fuel cycles, to name but a few. The resources we take, the products we make, and the resulting waste streams pose enormous challenges for future generations. Consequently if sustainability suggests an obligation to the well-being of future generations, how to deal with technology development and application must be issues of great concern.

SUMMARY AND CONCLUSIONS

Sustainability is a meta-concept that has been applied in the creation of frameworks, such as the Natural Step, that are designed to be applied to real situations to guide citizens, organizations, government, and corporations onto a path where both present and future generations can have the potential for a good quality of life. Although it could have been merely a passing fad, sustainability has proven its staying power over the past two decades by becoming a part of the common vernacular rather than the vocabulary of specialists. National sustainability policy is not uncommon and commercial enterprises are adopting the Corporate Social Responsibility framework at an accelerating pace. At its core, sustainability is about ethics because it calls on present people to not only consider the condition of the current impoverished population, but also the potential condition of future populations who are the mercy of our production and consumption patterns. Clearly we are at a significant fork in the road, with the consequences of climate change and resource depletion on the horizon. The question of our responsibility to the future looms large and it is an ethical responsibility that should be addressed and better understood. In effect sustainability forces us to face the consequences of our behavior in a manner unlike any other concept. And as a result, developing an understanding of the ethical underpinnings of sustainability is fundamental to applying it as a solution for the many problems that are being faced or will be faced, by present and future peoples.

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END NOTES

[1] *Securing the Future* is the March 2005 update to the UK's sustainable development strategy originally formulated in 1999. The UK's strategy is based on four priorities: sustainable production and consumption, climate change, natural resource protection and sustainable communities with a focus on addressing environmental inequalities. The strategy also provides a set of indicators to be used in measuring progress toward achieving the commitments laid out in the strategy.

[2] The EUs sustainable development strategy was first formulated in 2001. In 2005 this policy was revised and is now referred to as the *Renewed EU Sustainable Development Strategy*. An overview of this strategy can be found in the 2007 publication, *A Sustainable Future in Our Hands - A Guide to the EU's Sustainable Development Strategy*. The seven challenges to sustainability described in the EU Sustainable Development Strategy include climate change, sustainable transport, consumption and production, natural resources, public health, social inclusion, and global poverty.

[3] The main actor in the US green building movement is the US Green Building Council which developed a building rating system know as LEED (Leadership in Energy and Environmental Design) which is now being used to assess the design and construction of several thousand buildings in the US. LEED is also being adapted for use in other countries and variants of it are appearing in countries around the world. See www.usgbc.org for information about the USGBC and www.thegbi.org for information about a second building assessment system, Green Globes, developed by The Green Building Initiative.

[4] The Brundtland Report (1987) was published by the World Council on Economic Development (WCED) under the title *Our Common Future*. The report is named after Gro Harlem Brundtland, then Prime Minister of Norway and chair of the Brundtland Commission which four years after its establishment produced the final report that provided the classic definition of sustainable development.

[5] Carrying capacity is a term used to describe the maximum population that a given area of land, or the Earth as a whole, can support. Visit the Carrying Capacity Network at www.carryingcapacity.org for more insights into this concept .

[6] David Pearce's gallery of definitions for sustainable development can be found in *Blueprint for a Green Economy* (1989) which he co-edited with Anil Markandya and Edward Barbier.

[7] This list of definitions for sustainability was compiled by the National Park Service and can be found at www.nps.gov/sustain/spop/def.html

[8] From Sharachchandra Lélé 1991.

[9] Information about population and consumption is from the World Watch Institute's State of the World reports and the Sierra Club.

[10] From the American Association for the Advancement of Science (AAAS) online Atlas of Population and Environment at atlas.aaas.org/index.php?part=2

[11] Information on consumption levels is from the American Association for the Advancement of Science

(AAAS) and can be found at atlas.aaas.org/index.php?part=2

[12] The Fourth Assessment Report of the IPCC (2007) can be found at www.ipcc.ch

[13] From R.B. Gordon, M. Bertram, and T.E. Graedel 2006.

[14]From "Materials Prices Dictate Creative Engineering," in the 26 May 2006 edition of *Engineeringtalk*, an online publication at www.engineeringtalk.com/news/lag/lag102.html

[15]See "Global Environmental Problems: Implications for U.S. Policy," Watson Institute for International Studies, Brown University (January 2003), available at www.choices.edu

[16]Excerpted from "The Loss of Biodiversity and Its Negative Effects on Human Health," on the website of the Students for Environmental Awareness in Medicine, seamglobal.com/lossofbiodiversity.html

[17] From the "State of the World Fisheries and Aquaculture Report 2006," Food & Agriculture Organization of the United Nations. Available at www.fao.org/docrep/009/A0699e/A0699e00.htm

[18]The website of the United Nations Convention to Combat Desertification is at www.unccd.int

[19]A group of Swedish nongovernmental organizations maintain a website promoting knowledge about the effects of acid rain at www.acidrain.org

[20] From Costanza, R., et al 1997

[21] From Vitousek, P.M., et al 1997

[22] As cited in "Tropical habitats disappearing fast, ScienceAlert Australia & New Zealand, June 26, 2008. Available at www.sciencealert.com.au/news/20082606-17560-2.html

[23] From the U.S. Census Bureau at www.census.gov/hhes/www/poverty/threshld/thresh07.html

[24] From Gordon, David 2005

[25] From the World Bank website at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTPOVERTY/0,,contentMDK:20153855~menuPK:373757~pagePK:148956~piPK:216618~theSitePK:336992,00.html

[26] The Natural Step organization's U.S. branch has a website at www.naturalstep.org

[27] From Upham (2000)

[28] *The Hannover Principles: Design for Sustainability*, is available at the McDonough and Partners website, www.mcdonough.com/principles.pdf

[29] The ICSID/IDSA Conference was held in San Francisco October 17-20, 2007. A link to the events of the conference can be found at www.idsa.org/ICSID-IDSA07/congress/index.asp

[30] As described at the US Department of Energy website at www.pnl.gov/doesustainabledesign/

[31] The shortcomings of the three-legged stool model are addressed in a paper by Neil K. Dawe and Kenneth L. Ryan (2003) in *Conservation Biology*.

[32] The failure of the Kyoto Protocols is covered by Gwyn Prins and Steve Rayner (2007) in an article in *Nature*.

[33] As stated in Friedman (1962).

[34] The Starbuck Corporation CSR website with links to their 2007 CSR Report is www.starbucks.com/aboutus/csr.asp

[35] The UNEP report can be found at www.unepfi.org/fileadmin/documents/freshfields_legal_resp_20051123.pdf

[36] Information about the CSR reporting requirements established by the Global Reporting Initiative can be found at www.globalreporting.org

[37] From Golding (1972)

[38] From Wagner (1971)

[39] From Shrader-Frechette (1981)

CHAPTER 2
THE TECHNOLOGY CHALLENGE

Sustainability is in part tied to the notion that humans need to live within the carrying capacity of the planet, which ultimately means a slowing of population growth and reducing per capita consumption of resources The ability of the human population to both grow and increase its per capita consumption is tied directly to technology, because without agricultural, energy, and medical technologies, it would not be possible for humans to exceed the planet's carrying capacity. Thus, technology can be considered to be one of the core issues faced by organizations and individuals intent on applying sustainability to the resolution of many of the world's most difficult and persistent problems. And any effort to analyze technology for the suitability of its deployment inevitably encounters ethical dilemmas, many of the linked to sustainability. As noted in a report on ethical issues of nanotechnology, "Because technology structures our experiences and shapes how we live, it has enormous ethical significance."[1]

While technology is certainly one of the challenges faced by sustainability, it may provide at least some partial remedies to solving resource and environmental problems by finding ways to reduce resource consumption, emissions, and waste; developing chemicals, materials, and processes that are environmentally benign; linking nature's processes to human needs and development; and making possible the shift from non-renewable to renewable resources as the basis for the economy. Consequently technology also provides its own twin-horned dilemma or paradox, being both a significant concern as well as a potential source of solutions for many of the problems being addressed by sustainability.

An excellent example of technology that fits very well into the sustainability framework is *biomimicry*. Defined by its originator, Janine Benyus, as "the conscious emulation of nature's genius," biomimicry provides an approach to creating an enormous range of materials and processes from nature that can be adopted in the human sphere and which have the attributes of being biodegradable, originating from local resources, and being less harmful to the environment.[2] The powerful adhesives secreted by mussels, the hard ceramic coatings of seashells, and the ability of plants to convert sunlight to other energy forms via photosynthesis are examples of natural system materials and processes that are effective and benign and which have application in the human sphere. The development new generation of adhesives b Biomimicry is nothing more than understanding and adopting the results of 4.5 billion years of trial and error by nature that has resulted in materials and processes that run off the sun, are made from local resources, and that biodegrade into valuable nutrients for nature.

Sustainability, ethics, and technology are tightly connected because humans have choices as to which technologies to develop and implement. A wide range of ethical issues, many of them connected to sustainability, have emerged due to the development of a vast array of chemicals; the alteration of the earth's surface, waters, and atmosphere by human activities; and of course, the development of newer, 'high' technologies such as genetically modified organisms, robotics, nanotechnology, antibiotics, and nuclear

energy, to name but a few. Sustainability provides developers of technology numerous challenges, from evaluating their inventions for their impacts on present and future humans and non-humans, to the redirection of technology to ends consistent with the sustainability framework. In the former, the fundamental questions posed by sustainability might be of the form: Do the benefits far outweigh any impacts on humans, other species, and the environment, both immediately and over the long term? In the latter, the questions posed might be: Does the technology have a precedent in nature? Is it harmless?[3] Does it support life and natural systems?

In this chapter the issues of technology and their relationship to sustainability will be addressed, and the ethical issues of technology will be explored in light of their connection to sustainability. It is clear from recent history that new technologies often give rise to new, previously unknown ethical dilemmas. Cloning, in which an exact copy of a biological organism can be made through the manipulation of DNA fragments, is a case in point. Glenn McGee of the Bioethics Center of the University of Pennsylvania noted that, before cloning is considered permissible medicine for human infertility, society needs to resolve many questions, including:[4]

1. Is cloning unnatural self-engineering?
2. Will failures, such as deformed offspring, be acceptable?
3. Will cloning lead to designer babies who are denied an open future?
4. Who is socially responsible for cloned humans?
5. Do clones have rights and legal protection?

These are of course the new, general ethical issues that have emerged as a consequence of the development of cloning. It is arguable whether or not all of these ethical issues can also be considered to fall under the umbrella of sustainability. The possible loss of genetic diversity caused in part by cloning, would be of interest in an ethics of sustainability. Cloning does have the potential to impact the quality of life of humans and non-humans and in this sense all of these questions are appropriately addressed by ethics centered on sustainability. On the other hand, questions of absolute moral right or wrong, perhaps based on the Bible or Qu'ran, may fall outside the realm of an ethics of sustainability. For example, some would argue that cloning is immoral on religious grounds because God, not man, is the author of all life, and that life begins in the womb at conception, not in a petri dish. In general the new ethical questions posed by the most significant new technologies will be posed with the aim of addressing them in later chapters using sustainability based ethical arguments.

OVERVIEW OF TECHNOLOGY

Although technology, science, and engineering are related and often used interchangeably, there are distinct and important differences worth noting before focusing on technology itself. *Science* can be defined as the investigation of phenomena that humans observe in the natural world by using a formal approach known as the *scientific method*, to elaborate laws and principles that are universally applicable. Kepler's observations of planetary motion and his discovery of the laws of this motion are an example of what would classically be described as science. *Engineering* is the

application of these laws and principles, discovered through scientific methods, to produce processes and tools, thus exploiting science for human needs. The development of the airplane wing was based in part on the application of Bernoulli's principle which described how lift could be generated by air passing over surfaces where the air velocity under the surface could be induced to be greater than that on top of the surface, thus creating a pressure difference. *Technology* is the combination of science and engineering to produce the artifacts of human society, the computers, automobiles, airplanes, stainless steel, and polymers that are the markers of human society. In short, technology is the ultimate outcome of science and engineering. Interlaced with science and engineering, technology can be considered a problem-solving process in which the designer applies science and engineering to move from problem to solution. The iPhone and iPod are examples where designers applied science and engineering to solve the problem of how to create small devices to store, communicate, and display information, a wedding of physics and creative design.

And as is the case with sustainability itself, technology has many definitions which are worth reviewing to get a sense of what exactly is being addressed when technology is being mentioned. The following are a sampling of definitions of technology:

The process by which humans modify nature to meet their needs and wants.
-*National Research Council*[5]

The range of practical, utilitarian endeavors undertaken by society to provide its members with those things perceived to be necessary
-*Robert Thayer*[6]

The practical application of knowledge, especially in a particular area (automobile fuel-saving technology); a manner of accomplishing a task especially using technical processes, methods, or knowledge (information storage technology); the specialized aspects of a particular field of endeavor (educational technology).
- *Merriam-Webster Online Dictionary*[7]

An often asked question is: what counts as technology? It turns out that on closer examination, there are a wide range of possible 'classes' of technology:

1. Technology as objects: the physical artifacts such as cell phones and refrigerators
2. Technology as knowledge: the know-how of scientists, engineers, and designers
3. Technology as activities: the skills of people such as machinists and computer programmers
4. Technology as process: finding solutions based on a problem
5. Technology as a social-technical system: the interaction of people and artifacts in manufacture and use.[8]

Much of the technology that does and will underpin sustainability is based on science that is still evolving. A new field, sustainability science, is preparing the foundations for technological developments that parallel the general intent of sustainability. Some of these endeavors include work on: (1) ecosystem resilience, (2) industrial ecology, (3)

earth system complexity, (4) yield-enhancing, land-saving agriculture, (5) nature-society interactions, (6) renewable energy systems and (7) biomimicry, to name but a few.[9]

Brief history of technology

The technology people observe seems to be of rather recent origin and indeed much of the technology we do notice evolved in the last century. Examples are computers, airplanes, electronic communications of every type (television, radio, cellphones), nuclear power, plastics, electric power grids, superhighways, nanotechnology, biotechnology, genetically modified organisms, robotics, and information technology. However, each of these technologies is based on other prior technologies that provided the foundation for the contemporary technologies that continually evolve to support our contemporary life styles. Technology can be said to date back over 2.5 million years when the first evidence of toolmaking, the Olduwan tools of the late-Paleolithic period, appeared to aid in butchering dead animals. In the 9th millennium B.C. the ability to extract copper and use it emerged. It was also in this millennium that agriculture emerged as a technology that enabled humans to subsist as other than hunter-gatherers. The wheel appeared for the first time in the 5th millennium B.C., bronze around 3300 B.C., and iron around 1500 B.C. The Egyptians invented the ramp which enabled the construction of the pyramids and the sail which allowed the age of exploration to begin. At the same time, the ancient Chinese were inventing the pump, gunpowder, matches, the magnetic compass and the iron plough. The Romans, considered the greatest engineers of the time, developed roads, aqueducts, domes, harbors and reservoirs, the book, glass blowing, and concrete.

In Medieval Europe (500 AD to 1450 AD), the windmill, clock, pointed arch and cannon were invented. The Renaissance (starting in about 1450 AD) experienced the many inventions of Leonardo DaVinci, Johann Gutenberg's moveable type presses, improved navigation tools and ships, the pocket watch, and flush toilets. During the same time frame the Incas and Mayans developed potatoes, corn, the calendar and reshaped the landscape. Technological developments accelerated in the 17th century with Isaac Newton's discovery of calculus and the invention of the submarine, telescope, steam turbine, adding machine, and air pump. The 18th century saw the replacement of human labor by machines and the steam engine which revolutionized manufacturing and transportation was invented by Thomas Newcomen. The 19th century experienced the invention of useable electricity, steel, and petroleum products, the growth of railways and steam ships, and the development of faster and wider means of communication. During this century, the steam locomotive, reaper, sewing machine, refrigerator, telegraph, photography, bicycle, plastics, typewriter, phonograph, automobile, diesel engine, vacuum cleaner, and revolver all made their appearances.

As enormous as the advances of the 19th century were, the pace of technology really exploded in the 20th century as automobiles, airplanes, computers, cell phones, wireless technology, genetic engineering, the internet, nuclear technology, biotechnology, nanotechnology, space travel, and a host of other technologies appeared. The development of biological, chemical, and nuclear weapons of mass destruction also occurred along with aircraft and missiles. Based on the pattern of the past it is probable

that the pace of technology will continue to accelerate even more. In the 21st century we have already seen the emergence of the iPod and iPhone and a wide range of other compact information display, storage and communication devices. The hybrid automobile, translucent concrete, the Wii, YouTube, and countless other products and processes have already emerged in this decade.

In short, the pattern is that, over human history, the pace of technological development has accelerated. It is probable that this pace will continue to increase, the result being even more products, processes, and services, some designed to improve quality of life, others that may support national policy and military operations. At present society is faced with numerous ethical issues connected to technology, from designer babies that can be produced by DNA manipulation, to autonomous robots that can cause harm if control of them is lost. Resolving these ethical dilemmas is important to society and also to the application of the sustainability framework.

Patterns of Technology Diffusion

The diffusion of technology is often described as following an S-curve pattern in which initial progress in the development of the technology is slow and then once a critical mass is reached, the technology flourishes until it is matures and has saturated the market, eventually to be replaced by an even newer and better approach. This pattern, if plotted in a graph of time versus market penetration, would look like the letter "S". The S-curve was first proposed by Everett Rogers 1962 in his book, "The Diffusion of Innovation."[10] In 1986 Richard Foster, at the time a business consultant with McKinsey and Company in New York City, applied the S-curve to research and development (R&D).[11] Foster used the S-curve as a device for helping R&D managers understand the point in time when it was critical to develop new technologies and invest in more R&D because the old technology would soon be producing diminishing returns. By plotting the S-curves for a family of technologies, it is possible to see the general pattern and timing of technology change. For example, the S-curves for removable computer storage devices would indicate the shift from the large 5 ¼ inch floppy disks to 3 ½ inch disks, then to CDs, DVDs and now jump drives.[12] The S-curve can also help managers understand the slow pace of technology development and the relatively long lag time between scientific discovery and the appearance of applications for that technology. Light emitting diodes (LED) which are one of the latest lighting technologies are rapidly replacing compact fluorescent lights, which in turn have been replacing incandescent lights. The red and green LED's which are familiar from computers and other electronic devices were invented in 1962 by Nick Holonyak and the white version was developed in 1993. Consequently it took almost 50 years from the invention of the LED to the development of lighting technology that could exploit this long lasting, low energy device at an acceptable cost. The length of this cycle is instructive, especially in this case to the lighting industry, because it indicates the long gestation period for emerging technologies and the time required to move a technology from laboratory to factory. The S-curves for removable computer storage devices indicate a much more rapid pace of development and consequently companies need to create new technologies at a far faster pace than, for example, the lighting industry.

Jumping from one technology or one S-curve to another is the major problem facing many industries. Get it right and the company sustains its competitive advantage. Get it wrong and the company can end up in bankruptcy. The U.S. automobile industry clearly had it wrong in deciding to move to ever larger vans, SUV's and Humvee's in the 1990's and first decade of the 21st century. Japanese automakers were better able to read and understand the situation and jump the S-curve from conventional automobiles to new technologies such as hybrid automobiles. The problem with making this jump can be simply the way that companies do business. Human and financial resources often flow to the division of the company selling the most products and not to the divisions developing new products, clearly a short-sighted approach. As is the case with much of American industry, optimizing current profits takes precedent over optimizing long-term performance.

With respect to sustainability, the S-curve is pertinent in that new technologies supporting sustainability will have to be developed to replace technologies that run counter to the core values of sustainability. In particular, inherently safe technologies based on renewable resources, reuse and recycling, closing materials loops, mimicking nature, restoration of natural systems, low energy consumption, preservation of biodiversity, and reversing climate change have to be introduced into the technology development cycles. Not all technologies will possess these attributes and consequently humankind must also decide on the levels of risk that are appropriate and perhaps even ethical. In this latter category are decisions to use nuclear power instead of coal power. There is a distinct advantage in mitigating climate change by making this shift but there may be consequences for far future generations who must deal with the impacts of current consumption in the form of highly radioactive nuclear waste.

The Technology Paradox: Quality of Life for Present vs. Future Generations

Technology is clearly a two-edged sword, providing opportunities to shift on a more sustainable path, while at the same time presenting serious challenges to the entire concept of sustainability. As a result technology presents several paradoxes for sustainability:

1. Technology is both at the root cause of the problems which the sustainability framework was designed to address and also the potential source of solutions. An example of a major technology challenge is that, of the 700 new chemicals introduced each year in the U.S., few are tested for their toxicity and the burden is on the government and society to prove any of them are harmful. In the European Union the reverse is true and companies developing new chemicals are obligated to prove they are safe prior to their deployment. On the positive side of technology, the development of wind turbines, photovoltaics, and plant-based ethanol are providing the ability to shift from non-renewable energy sources such as coal, petroleum, and natural gas to energy systems based on the sun.

2. It can enable a good quality of life for present generations while at the same time threaten the quality of life for future generations. As humans have evolved, each generation has sought to maximize its quality of life without regard for its decisions on

future generations.[13] Indeed the impacts of technological developments have often been unknown and the default behavior has been to assume the risk without a full understanding of the consequences. The contemporary controversy over genetically modified organisms (GMOs) is a case in point. Corn that can produce its own insecticide, BT corn, provides farmers with a simple fix in dealing with pests. Farmers often suffer devastating crop losses, especially in developing countries where insecticides are expensive. However the long term consequence of BT-resistant insects that can cause even more damage for future generations is ignored. Similar examples can be found in the development of chemicals, nuclear energy, nanotechnology, cloning, and others.

Determining how to cope with technological development and its deployment is not an easy matter. Charles Lindbergh had perhaps as sound a view of the role of technology in society as anybody. He had a fascination with technology and his association with the development of the airplane has made him a metaphor for technology growth in the 20th century. His euphoria at being able to be able to fly solo across the Atlantic in 1927 in the most technologically advanced aircraft ever developed was tempered by the death and destruction of World War II, largely a result of the continued evolution of the *Spirit of St. Louis*. His profession and its associated technology had made vulnerable many more population centers and permitted the delivery of nuclear weapons to end the war. Rather than despairing over the perverse twists that had turned the technology he admired into a major vector for destruction and rejecting it, he came to the conclusion that technology was a question of balance. Although a technologist at heart, Lindbergh also loved nature and he recognized that a balance was needed between spirit and nature and the world of technology. As Lindbergh himself stated it: "I loved the farm, with its wooded river and creek banks, its tillage and horses. I was fascinated by the laboratory's magic: the intangible power found in electrified wires, through which one could see the unseeable. Instinctively I was drawn to the farm, intellectually to the laboratory."[14] In the end he concluded that science was a means to reveal the workings of the divine, revealing both the cosmic and microscopic rules governing the workings of the universe.

Technological Optimism versus Technological Pessimism

People generally have one of two opposing views when thinking about technology, and their perception of technology dictates the levels of risk they are willing to accept. So-called technological optimists have the point of view that any problem has a technical solution, that given the resources and with minimal government regulation, scientists and engineers will find a solution. They suggest that in key areas such as food production, environmental quality, and energy, technology will sustain quality of life even as human population increases unabated. In this school of thought, running out of oil is not a cause for concern because a yet as unidentified source of energy will be found. Indeed climate change, caused in part by the depletion of oil, can also be resolved by technological fixes, for example the carbon dioxide can be extracted from the atmosphere and stored in caverns or dikes can be built that will prevent widespread flooding due to rising sea levels. Alvin Toffler, author of *The Third Wave* and *Future Shock* and a poster child for technological optimism, posited the notion that technological developments have led to a sequence of so-called 'waves' over the centuries.[15] The First Wave was agrarian society

in which farming replaced hunter-gather. The Second Wave was industrial society, from the start of the Industrial Evolution in the 17th century through the mid-20th century. Toffler referred to the Third Wave as the post-industrial era or Information Age. He was confident that technology would increase wealth with a better life for all being the result. Another technological optimist was Alvin Weinberg who invented the phrase, technological fix.[16] He proposed nuclear energy as the substitute for rapidly depleting fossil fuels and as a source of cheap energy for developing countries, to include using it to convert seawater into potable water. In general, technological optimists favor the status quo, they do not support change that would reduce consumption, just more technology to mitigate the impacts of consumption. They are likely to favor end of pipeline solutions rather than changing the fundamental processes. For example, their focus would be on converting the waste from manufacturing into useful products instead of changing the manufacturing process to eliminate waste.
According to University of Michigan Law professor James Krier, technological optimists tend to delude humanity by predicting the continual emergence of technological breakthroughs at ever-increasing rates. As a result technology can increase pollution and permit the human population, at least for the short term, to exceed planetary carrying capacity.

Technological pessimists include such notables as the population biologist Paul Ehrlich who wrote *The Population Bomb* in 1968 in which he predicted the world would experience widespread famine in the 1970s. His remedy for countering this then looming catastrophic situation was population control. Ehrlich also gained notoriety for a bet he made with Julian Simon, a technological optimist, in 1980. Simon suggested that if Ehrlich's population predictions were correct, the price of commodities would rise over time due to enormous demand for increasingly scarce resources. Simon believed in human ingenuity and technology, and he bet Ehrlich that for any basket of five commodities selected by Ehrlich, the total price would fall by 1990. Ehrlich took the bet and selected tin, tungsten, copper, nickel and chrome as the commodities and purchased $200 worth of each, a total of $1,000. If the price rose, Simon would owe Ehrlich the increased value of the commodities. If the price fell, Ehrlich would owe Simon the decrease in value. In 1990 Ehrlich wrote Simon a check for $576, the price of all five metals had fallen. Ehrlich did underestimate human ingenuity and not only did commodity prices fall, the number of famines and their death toll fell steadily during the 25 year period after the book was written, and with a 50% increase in world population.

At about the same time as the publication of *The Population Bomb*, the Club or Rome report, *Limits to Growth* was published in 1972 as an exploration of the consequences of exponential growth among five variables: world population, industrialization, pollution, food production and resource depletion.[17] Although not intended to predict future resource scenarios, it did provide ammunition for its critics by indicating scenarios for oil depletion, among other resource issues. For oil it could be interpreted that depletion would occur between 31 and 50 years from the time of the report, that is, as early as 1992. The wild card that was ignored by the book was technology and how it could be used to both extend existing resources as well as develop alternative resources.

It would seem that both technological optimists and their pessimistic counterparts have it wrong, that the truth lies somewhere between these extremes. Ehrlich lost the bet with Simon, indicating that at least for the short term, human ingenuity could trump resource problems. However, the long term future is impossible to predict, but it is clear the Earth is a finite planet with finite resources and at some point in time, if population and consumption continue to grow, collapse will occur. By using a *reductio ad absurdum* argument, if one were to assume the current annual population growth rate of about 1.7% were to continue indefinitely, there would be a human standing in every square meter of the Earth within five centuries. Clearly this is impossible, population cannot grow to this extent. Similarly consumption per capita is also growing at about 1.7% annually and the combination of population growth and consumption would consume the entire planet in the same six century time frame. Either population or consumption but probably both need to be limited to permit the sustainability framework, which seeks to meet the needs of both present and future generations, to achieve the ends for which it was designed. Deploying harmful, consumptive, wasteful technologies pose ethical challenges that need to be addressed with sustainability oriented ethical principles that ensure the results of technology development are not deployed should they violate the intent of the sustainability concept.

TECHOLOGY AND SUSTAINABILITY

Sustainability is inextricably linked to technology because the sustainability framework is frequently applied to situations that involve technology. Climate change has been defined as being due to anthropogenic effects, that is, it can be traced to human behavior, and more specifically, to human behavior permitted by the technologies we have developed. Power plants and automobiles are technologies that contribute directly to climate change by burning oil-derived fuels and coal which produce carbon dioxide as by-products. These technologies combined with technologies that enhance the extraction of petroleum and coal have resulted in humans contributing enormous quantities of carbon dioxide into the atmosphere. The human population of 6.5 billion annually produces about 2.7 billion tons of carbon dioxide via respiration but produces almost a factor of 10 more carbon dioxide (21.3 billion tons) annually by burning coal and oil. At the same time that technology is being identified as a root cause of climate change, there is the prospect that renewable energy technologies and carbon storage or sequestration. Examples are solar photovoltaics and biofuels that generate energy in a carbon neutral manner. Another set of technologies under development are aimed at sequestration by separating the carbon dioxide from fossil fuel and storing it in geological formations such as oil and gas reservoirs and unmineable coal seams. Even more novel technologies such as genetic manipulation of trees to allow them to uptake more carbon dioxide and advanced membranes to assist in carbon dioxide separation are being proposed. The problem is that these are so-called “end-of-pipeline” approaches that rather than changing society’s approach to energy generation, simply attempt to dispose of the consequences in the least objectionable and least costly manner. The interplay of technology and sustainability is basically axiomatic, they are inextricably coupled. Humans characteristically have a difficult time anticipating the outcomes of developing specific technologies and addressing the consequences of technology. Technology can be quite complex and the ecological and human systems with which it interacts are even more

complex. In addition to the issue of both positive and negative interactions of sustainability and technology, human behavior plays a role, with technological optimism vying with technological pessimism as the dominant force in moving forward.

Consequences of Technology

New technologies have consequences, some of them known, others that are suspected, and many that are unknown or unanticipated. In general technological consequences can be categorized as *Anticipated* or *Unanticipated*. Anticipated consequences can be (1) intended and desired; (2) not desired but common or probable; or (3) not desired and improbable. Similarly unanticipated consequences can be (1) desirable; or (2) undesirable. The development of hybrid automobiles brings with it the anticipated, intended and desirable outcomes of reducing the need for petroleum, reducing air pollution and reducing carbon emissions into the atmosphere. An anticipated, undesired but probable outcome could be more automobiles on the road and more accidents because hybrid cars will allow more miles to be driven. An anticipated, undesirable and improbable outcome would be significant issues connected with disposal of vast quantities of batteries needed by hybrid cars. The unanticipated consequences of technology are of course the wild card, by definition they occur unexpectedly. It is true that unanticipated but desirable consequences can occur. There have been several pleasant outcomes from the DNA sequencing of the human genome, for example, a richer understanding of how we are all related to one another. It has also opened the doors to relatively easy genetic testing for predisposition to breast cancer, liver disorders, and many other diseases. In contrast this same technology can result in unanticipated and undesirable outcomes, for example, cherry picking of patients by health insurance companies as they reduce their risk by rejecting people with a propensity to certain health conditions.

The reason that the consequences of technology, both good and bad, are often not well understood is that technologies have features that make it difficult to comprehend their full effects. Dietrich Dorner suggested that there are four classes of these features that contribute to the problem of grasping the consequences of technology: (1) complexity, (2) dynamics, (3) intransparence, and (4) ignorance and mistaken hypotheses.[18]

Complexity addresses the many parts of a system and the wide range of interconnections, many of which are not obvious and may be unknown. For example, ecosystems are extremely complex and only a small fraction of the enormous number of ecosystem relationships are known. Consequently, when ecosystems are disturbed by human activities, the extent of the damage may be unknown because the interconnections are not known. Robert Ulanowicz, the theoretical ecologist and philosopher, upon realizing the complexity of ecosystems, abandoned a reductionist approach and instead developed approaches, such as *ascendancy*, that tried to understand ecosystems as a whole. Ascendency is a quantitative attribute of an ecosystem, defined as a function of the ecosystem's food network and is intended to capture in a single index the resilience of an ecosystem to disturbance by virtue of its combined organization and size. Similar complexity can be found in virtually every technology and it presents a serious challenge to society in assessing the deployment of technology. Complexity has evolved into a

theory of its own backed up by new mathematical and computer modeling techniques designed to assist scientists in understanding highly complex phenomena such as weather systems.

Dynamics describes the property of continuous and sometimes spontaneous change that takes place in systems that often cannot be fully described and comprehended. The movement of information across the internet, the flow of electricity through the grid, and the behavior of high-definition televisions all exhibit dynamic behavior. The dynamics of a system increase, often exponentially, as the number of actors in the system increases. For example, the dynamics of traffic on an interstate highway increases as the number of drivers increases, each driver with their own driving style, behavior, attitudes, and state of mind.

The fact that many of the components of a system cannot be seen is the property called *intransparence*. The more complex a system is, the greater its degree of intransparence. Ecosystems, the economic system, and the internet are systems that exhibit a high level of intransparence.

Sometimes humans simply get it wrong and the resulting model is badly flawed due to *ignorance and mistaken hypotheses*. The economic collapse of 2008-2009 can be at least in part attributed to the belief that the economy and the demand for housing would continue to grow unabated and that highly speculative hedge funds and financial instruments based on the growth in demand for housing would provide huge returns to the financial institutions that created them. The hypothesis that the risk of these instruments was manageable turned out to be false and the collapse of banks, insurance companies, stock brokerages, and other financial institutions ensued.

When judging technologies, society is faced with difficult choices. The technology developer is not the best person to ask whether or not there is a reasonable level of risk associated with the technology because their judgment, as the inventor, may be clouded. Yet because inventor best understand technology, society must often turn to them to determine the likely outcomes. Remedying this situation so that the consequences of technology are better understood is crucial. Frank Knight addressed this issue by suggesting four ways that society could decrease the uncertainty and unintended consequence of technology: (1) increasing knowledge, (2) combining uncertainties through large-scale organization, (3) increasing control of the situation, and (4) slowing the march of progress.[19]

Increasing knowledge by additional research, studies, and independent evaluations should provide a better understanding of consequences. However there is no perfect knowledge and any effort to gain additional insights will inevitably run into time and cost constraints. Combining uncertainties through large-scale organization refers to the potential for providing some type of insurance that will help protect society due to catastrophic consequences. This is plausible to some degree because if there are potentially high risks, the cost of deploying the technology could be prohibitive and effectively block its implementation. Government can increase its control of technologies by factoring in probable costs to society by imposing taxes that shift the burden to the producers and effectively reducing the rate of uptake. Finally the rate of

change can be slowed to allow more time to effectively study and understand the situation. In its extreme form this could take the form of a moratorium that would freeze development until the risk could be adequately studied or understood. Immediately after the cloning of the sheep Dolly was announced in 1996, President Clinton announced a moratorium on cloning until more was understood about the implications of this technology.

Technology Risk Assessment, Acceptance and Management

Virtually every technology is accompanied by some form of risk and the assessment of the risk is essential for government and society to determine if the technology is suitable for deployment. The transformations of matter and energy that occur as a result of the application of science and engineering, although intended to benefit humans beings, can have a wide range of consequences with negative impacts, some of which in fact damage what humans in fact value, for example their health. Occasionally a technology will have clearly undesirable consequences, for example pesticides such as DDT that had profound impacts on natural systems and human health - these should be clearly avoided. Even though DDT is a problematic chemical, it did result in wiping out malaria in the U.S. and banning it could result in decimated populations in less developed countries. Most often technology is a tradeoff between benefits and costs each of which may be technical, social, economic, and/or environmental. Risk assessment and the resulting decision to implement or shelve a technology represent the intersection of an ethics of sustainability with technology. Weighing short-term, contemporary benefit against the welfare of future people is characteristic of this type of ethical decision as would be decisions that benefit wealthier people at the expense of vulnerable populations. Certainly the assessment of risk must be based in science and research, but much of the assessment will be statistical and the interpretation of the probability and intensity of impact makes it extremely difficult to judge the risk. For example, pressurized water reactors (PWRs), the most common variety of nuclear power plant in the U.S., have a very low probability of a serious accident. A 1975 report by the U.S. Nuclear Regulatory Commission (NRC) put the probability of a worst case accident with core meltdown and the failure of containment at 1 chance in billion or about 1 in 10 million for 100 operating nuclear reactors.[20] Four years after the NRC report, the Three Mile Island PWR in Pennsylvania suffered a core meltdown, calling into question the low probabilities cited in the report. The Chernobyl disaster of 1986 resulted in a plume of radiation that spread around the world and there is still a 17 mile radius exclusion zone around the reactor site. Greenpeace maintains that over 200,000 deaths resulted from the accident and over 4,000 cases of thyroid cancer have been attributed to the accident in the Ukraine, Belarus, and Russia. The RMBK reactors at Chernobyl did have serious design flaws that are not present in contemporary PWRs. Yet government, and by extension, society, have opted for the benefits of nuclear power in spite of the risk. Still largely ignored is the ever growing volume of waste from the nuclear fission process which is stored on site at nuclear power plants because the government, after over 50 years of futile attempts, has yet to make a decision as to the long term storage strategy for this waste.

Presuming the consequences of a technology have been assessed, the result will be a range of known outcomes from its deployment, some desirable and some undesirable. The probability is that there are also a number of unknown consequences, some of which

may also be undesirable. The undesirable outcomes are those that are of concern to society and despite the potential for negative results of a technology, the majority of stakeholders may decide to permit its adoption. Risk is the probability of a negative consequence causing widespread damage or turning into a disaster. When society gambles that a technology will have a favorable outcome, it is deciding the risk is acceptable. Technology is of course not the only source of risk. Where people live, their lifestyles, where they work, how they travel, what they consume, and the waste they generate all have risk associated with them. Natural disasters, terrorism, and the weather all have risks associated with them. But risk associated with technology is a special class of risk because, unlike the risk from natural disasters, risk from technology is avoidable if society decides the risk is too great. Additionally the potential widespread impacts of technology can be widespread, even global, and there can be a significant amount of uncertainty. Genetically modified corn seeds can benefit developing countries because of the possibility of reduced reliance on pesticides and herbicides, and reduced water and energy requirements. However the potential risk is enormous because fewer strains of corn are being planted, pests and weeds are likely to adapt to the genetically engineering strategy, resulting in 'superpests' and 'superweeds,' and the farmer becomes dependent on fewer sources of seed, all of which are patented. Additionally genetically modified crops cross-pollinate with natural crops, with the result that the natural crops may effectively disappear. The impacts on the larger planetary ecosystem are totally unknown. A possible unknown negative risk that has been speculated but not proven is the effect of genetically modified corn on beneficial insects, for example, butterflies. A study by Cornell University showed that a gene for a bacterial toxin inserted into corn proved poisonous to monarch butterfly larvae that ate the leaves of those plants. Similarly soybeans that had been modified with a gene from the Brazil nut triggered allergic reactions in people who were allergic to nuts. In spite of these risks, the benefits of more robust crops with higher yield are resulting in increased sales of genetically modified seeds each year. Stakeholders may differ on their perception of risk. Acceptance of genetically modified organisms (GMOs) is more widely accepted in the U.S. than in Europe, Korea, and Japan with 75% of U.S. corn now being genetically modified versions.

The process of moving from recognizing risk to accepting it is a complex path because it involves a process of making and justifying a judgment about the tolerability or acceptability of a given risk. *Tolerable* means that the technology is worth pursuing due to its benefits while *acceptable* implies that the risks have been reduced to the lowest possible level. The acceptance of risk is the most difficult and controversial step in deploying technologies. Risk associated with GMOs for many countries is considered to be tolerable because for them, the benefits far outweigh the costs as they perceive them. Nuclear power is certainly risky to present and future generations due to potential accidents and the need for long-term storage of waste from spent uranium fuel rods. The risk of an accident has certainly been minimized and therefore as a technology its deployment is almost universally permitted.

Once the risk has been assessed and accepted, risk management is needed to ensure that the risk of harm does not increase and that unintended negative consequences are

detected and handled. Climate change is an unanticipated negative consequence of fossil fuel driven power generation and the international community is struggling to manage a wide variety of options proposed to deal with this very serious global problem. Seed banks have been established to preserve the genetic material of food crops and other species in the event of catastrophic events such as natural disasters and war, as well as to have them available should the now prevalent genetically modified seeds prove to be failures.

Alternative, Appropriate and Sustainable Technology

One approach to managing technology risk is to allow those that are inherently people and environmentally friendly to have an advantage in their deployment. Through the use of regulation, fees, taxes, or incentives, society can exercise control over which technologies are permitted to enter the marketplace, permitting only those that are very low risk to be implemented. Two categories of technologies that are often described as having these attributes are *alternative technology* and *appropriate technology*.

Alternative technology refers to those types of technologies that are inherently friendly to the environment. Technologies that mimic nature or that rely on natural processes are often labeled as alternative technologies. Technologies that use resources sparingly, foster recycling, use renewable and local resources, and limit the use of fossil fuels are examples of alternative technologies. Composting, solar hot water heating, anaerobic digestions, biofuels, and wind energy generators are examples of technologies that would fit this description. The term was first used by Peter Harper from the Centre for Alternative Technology in Wales in the 1970s and is still commonly used as label to describe technologies that are relatively benign.

Appropriate technology includes the concept of alternative technology but in addition to considering the environmental attributes of a technology, also considers its ethical, cultural, social, and economic aspects. It can refer to technologies that are either the most effective for addressing problems in developing countries or that are socially and environmentally responsible in industrial countries. In the context of developing countries, it often refers to the simplest type of technology that can be used to accomplish a given end, with low capital cost being an objective. This is in contrast to the complex and often capital intensive technologies prevalent in the industrial world. Appropriate technology should not be confused with low technology. Solar photovoltaic panels that are used to power nighttime lighting systems in rural India in support of microeconomic ventures would be considered appropriate. Compact fluorescent bulbs and LED lights can also be considered to be appropriate technology because they use minimal energy, are durable, and provide a substitute for otherwise dangerous and unhealthy lighting systems. Food production systems that involve intensive gardening, hydroponics, no-till farming, permaculture, and drip irrigation and that rely on simple tools such as scythes would fit the description of appropriate technology. Amory Lovins, E.F. Schumacher, and Buckminster Fuller are considered to be among the originators of this concept, along with others from around the world, particularly in India where the convergence of microbanking and appropriate technology is improving the quality of life of otherwise destitute villages. Mahatma Gandhi is often associated with the emergence of the

appropriate technology movement.

MAJOR CONTEMPORARY TECHNOLOGICAL DILEMMAS

Each new technology brings with it new and often surprising dilemmas, even the possibility of humans eliminating themselves due to a less than full comprehension of the potential impacts of technology. New technologies are emerging at an accelerated pace, compounding the problem of trying to cope with the effects of more mature technologies. Bill Joy noted this problem in 2000 in a well-know article in *Wired* magazine in which he addressed some of the potentially enormous problems facing humankind as the result of robotics, nanotechnology, and genetic engineering.[21] In the end he suggested that the only answer to the dangers posed by technology was not to develop them at all, that the only answer is to limit the pursuit of certain types of knowledge. He referred to this as *relinquishment*, and noted that it would require a sort of Hippocratic Oath for scientists and engineers in which they swear allegiance to a strong code of ethics whose core value is to do no harm. The ethical dilemmas posed by so-called GNR (genetics, nano and robotics) technologies, along with several newer issues are discussed in the following paragraphs.

Biotechnology and Genetic Engineering

Biotechnology is a term that covers a complex array of technologies such as cloning and genetic engineering. In general, biotechnology is technology based on biology, especially when used in agriculture, food science, and medicine. It is the use of living organisms or their products to make or modify a substance and biotech processes range from simple to hyper-complex technologies. An example of simple biotechnology in action is a beer brewery where hops and malts are heated and then combined with yeast that transforms the ingredients into an alcoholic beverage. The other end of the biotechnology spectrum is genetic engineering, a laboratory technique used by scientists to change the DNA of living organism, also referred to as recombinant DNA techniques. And although genetic engineering is just one of several biotechnologies, because of the enormous potential for new crops and enhanced species, not to mention the future possibility of so-called 'designer children,' genetic engineering is quickly dominating the biotechnology sphere.

Biotechnology is laced with such a wide variety of ethical issues that a separate branch of ethics known as *bioethics* has evolved to focus specifically on the myriad issues that have emerged as human understanding of genetics, biology, and chemistry have increased over time. The power to read and modify genetic structures alone brings myriad potential problems to light. It is likely, for example, that parents of the not too distant future will be able to create designer babies whose traits are selected from a menu. In addition to the fundamental moral problem of humans playing with the code of life, there are the problems of future generations comprised of individuals who, rather than evolving and emerging as a consequence of random events, are instead the result of deliberate manipulation. The result can be that human diversity will suffer. This has already occurred in agriculture where corn varieties dwindled from several thousand natural species to under 10 major genetically engineered species. The design of corn seeds by agro-business giants such as Monsanto ultimately results in a loss of both crop diversity

and biodiversity, and results in a weakening of the resistance of the food supply to pests and weather. The same thinking can be extended to the design of human babies – interference with genetic codes may have short term benefit to the parents who obtain exactly the baby they wanted but over time results in a less diverse human race.

Genetic engineering is a major biotechnology endeavor which takes genes and segments of DNA from one species and puts them into other species. Genetic engineering provides the techniques needed to remove, modify, or add genes to a DNA molecule in order to change the information it contains. The result is the alteration of the genetic material of cells or organisms in order to make them capable of making new substances or performing new functions. Supporters of this technology claim it can lead to more abundant food supplies, inexpensive medicines, and cures for currently untreatable diseases. Its detractors suggest that it would lead to plagues and diseases which may be catastrophic or other environmental disasters. The potential downside is especially daunting because new life forms whose behavior and consequences would be largely unknown may have been introduced either accidentally or deliberately into the biosphere. Genetic engineering of agricultural products, to produce genetically modified (GM) crops brings with it several ethical challenges. First, is the possibility of creating so-called 'Franken-foods' that will threaten the environment. They may also be harmful to human health, for example, allergic reactions. For example, splicing peanut genes into other plant DNA to produce an enhanced species has already been shown to affect people with peanut allergies. The modified bacterial genes of GM crops allow them to make their own pesticides which may result in the death of harmless insects such as monarch butterflies. Amory and L. Hunter Lovins articulated the problem with GM organisms in an article published in 2000:[22]

> "Traditional agronomy transfers genes between plants whose kinship lets them interbreed. The new botany mechanically transfers genes between organisms that can never mate naturally: An antifreeze gene from a fish becomes part of a strawberry. Such patchwork, done by people who've seldom studied evolutionary biology and ecology, uses so-called "genetic engineering" - a double misnomer. It moves genes but is not about genetics. "Engineering" implies understanding of the causal mechanisms that link actions to effects, but nobody understands the mechanisms by which genes, interacting with each other and the environment, express traits. Transgenic manipulation inserts foreign genes into random locations in a plant's DNA to see what happens. That's not engineering; it's the industrialization of life by people with a narrow understanding of it. The results, too, are more worrisome than those of mere mechanical tinkering, because unlike mechanical contrivances, genetically modified organisms reproduce, genes spread, and mistakes literally take on a life of their own. Herbicide-resistance genes may escape to make "superweeds." Insecticide-making genes may kill beyond their intended targets. Both these problems have already occurred; their ecological effects are not yet known. Among other recent unpleasant surprises, spliced genes seem unusually likely to spread to other organisms. Canola pollen can waft spliced genes more than a mile, and common crops can hybridize with completely unrelated weeds. Gene-spliced Bt insecticide in corn pollen kills

> monarch butterflies; that insecticide, unlike its natural forebear, can build up in soil; and corn borers' resistance to it is apparently a dominant trait, so planned anti-resistance procedures won't work.
>
> It could get worse. Division into species seems to be nature's way of keeping pathogens in a box where they behave properly (they learn that it's a bad strategy to kill your host). Transgenics may let pathogens vault the species barrier and enter new realms where they have no idea how to behave. It's so hard to eradicate an unwanted wild gene that we've intentionally done it only once - with the smallpox virus."

On the other side of the debate, proponents of GM crops say they do not need to be labeled because they are not different in any important way from their natural counterparts. If the Lovins' are correct, the claims of the proponents cannot be believed. And although the risk to society may be great, this technology is already being deployed and probably causing negative impacts. Herein lies one of the great ethical quandaries that an ethics of sustainability must help resolve.

A second ethical issue from GM crops concerns attempts to encourage poor farmers in developing countries to grow GM crops. Corporations such as Monsanto and Novartis own patents on these altered plants and the farmers using them must buy new seeds each year at premium prices rather than reusing seeds from the previous year's crop as they have traditionally done. Marketing GM seeds to developing countries increases the profits for multinational companies while not addressing the poverty and inequality that are the real roots of world hunger. Biotechnology proponents claim that GM crops offer the world's best chance to end or greatly reduce hunger and malnutrition, pointing to, for example, "golden rice," a genetically engineered variety designed to provide extra vitamin A, thus preventing blindness caused by a deficiency of this vitamin, that is widespread among the poor in developing countries.[23]

An additional problem with genetic engineering may be unequal access to some beneficial therapies, with the rich able to benefit from gene treatments for diseases while the poor languish without such treatments, much less conventional drugs. Gene therapy in which manufactured viruses can deliver repairs to somatic cells with genetic defects, is making progress in correcting genetic diseases in fully grown humans, a remarkable feat.[24] Based on past history it seems doubtful that everyone will have access to the benefits of this technology.

Xenotransplantation is another biotechnology that allows animal organs to be transplanted into humans to help the medical community deal with the shortage of human organs available for transplant. In addition to the immunological issues, there are safety concerns for whole populations, due to the possibility of infection of an organ recipient by an animal virus, and animal rights issues, that result in ethical debate over the topic of xenotransplantation. As a result, there are also many regulatory hurdles to overcome, before xenotransplantation becomes everyday practice. The H1N1 swine flu outbreak of

2009 is a grim reminder that when genes cross species boundaries, the result can be dangerous and the consequences severe.

Nanotechnology

The American physicist Richard Feynman is credited with the notion of manipulating individual atoms and molecules to make designer molecules in a speech he made at a meeting of the American Physical Society at Caltech on December 29, 1959. He described a process of creating tools that could manufacture ever smaller versions of themselves, ultimately reaching the size of individual molecules and atoms that could be rearranged by the smallest set of tools. The term *nanotechnology* was first used by Professor Norio Taniguchi in 1974 in which he defined it as processing single atoms or molecules for some end purpose such as creating new materials. Eric Drexler contributed the first popular volume on nanotechnology in 1986 with his writing of *Engine of Creation: The Coming Era of Nanotechnology*. The theoretical became the practical in the mid-1980's with the development of tools such as the Scanning Tunneling Microscope (STM) which contributed to the observation and actual manipulation of matter at the atomic scale.

Like biotechnology, nanotechnology encompasses a wide range of technologies and processes. It can be defined as the branch of engineering that deals with things smaller than 100 nanometers, about 1/100,000th the thickness of a human hair. At this scale the materials being manipulated are individual molecules, the basic building blocks of the material world. The materials and devices being created are also at this tiny scale. Fundamentally new compounds can be created. For example, carbon in its pure state exists in two forms: diamonds and graphite, the latter being the stuff of pencil lead. By rearranging the carbon atoms into a novel structure, a new materials, carbon nanotubes can be created that are thirty times stronger than steel but that have only one-sixth its weight. Carbon nanotubes were one of the first practical results of nanotechnology and they are ubiquitous in everyday products such as tennis racquets, aircraft wings, and bicycle frames. Materials at nanoscale demonstrate properties that do not exist at larger scale. One property is that materials at smaller scale are more reactive than at larger scale. Copper, an opaque material, becomes translucent at nanoscale. Similarly a solid material such as gold becomes a liquid and a stable material such as aluminum becomes combustible. The result is an enormous potential for truly new and improved products. New sunscreens made of restructured titanium dioxide provide UV protection without the pasty look of previous sunscreens. Moore's law which predicts that the speed of microprocessors will double every 24 months is now driven by nanotechnology which can shrink components to the scale needed to maintain this technological trajectory. The result is the appearance of nanotechnology in virtually every consumer electronic device, from MP3 players, to cell phones, digital cameras, video game consoles, and of course, computers. Nanotechnology can include the ability to devise self-replicating machines, robots, and computers that are molecular sized, nano-delivery systems for drugs, and quantum and molecular computing - the next generation of computation. According to Professor Mark Welland of the Cambridge Nanoscale Science Laboratory the results of nanotechnology will extend much further. " In five years' time, batteries that only last three days will be laughable and in 10 years' time, the way medical testing is done now

will be considered crude. To say that in five years, an iPod will have 10 times its current storage capacity will be conservative. In the not-so-distant future, a terabit of data - equivalent to 10 hours of fine quality uncompressed video - will be stored on an area the size of a postage stamp."[25]

As is the case with other technologies, nanotechnology has positive and negative potential. It promises better materials, improved anti-cancer drugs, more powerful computers, better detectors for anthrax, and more efficient solar cells. However, in spite of the promise of contributing to a better quality of life, the risks of nanotechnology, although suspected to be non-trivial, are virtually unknown. Little effort has been expended on characterizing the risks of nanotechnology for humans or other species. The small size of nanoparticles means that when inhaled, they can penetrate into tissues, the bloodstream, and cells far more efficiently and quickly than for typical airborne particulates. There is the potential for them to end up in the environment, soil, food, and many other places that can affect health and life. A fundamental issue such as how to measure exposure to nanoparticles is still unknown. The process of determining the risk for chemicals is fairly well established and involves measuring the effects of exposure to a given chemical. Exposure to chemicals is based on the effects on organisms of a specific mass or 'dose' of the chemical for a given duration. Based on the dose-time scenario, the health effects of a given chemical can be determined. Typically cancer, mutagenic effects, and pulmonary effects are determined for chemicals thought to have hazardous potential. For nanoparticles it may be that surface area, not mass, is a better measurement of exposure and the effects of exposure. However at present, no accepted method of determining the health impacts of nanoparticles has been developed and accepted. Consequently there is no accepted methodology for assessing the impacts of nanoparticles on human health, as well as their impacts on other life forms. The nanometer size of these particles means that they can contribute to the mutation of DNA, directly impacting the evolution of living organisms. These are serious issues and problems that remain neglected in spite the rapid deployment of nanotech products. In the global market, manufactured goods that incorporate nanotechnology are expected to increase in value from $150 billion in 2008 to $2.6 trillion in 2014.[26]

Clearly the manufacturing of devices at molecular scale can be tedious and expensive so the notion of self-replicating molecular devices has been proposed in which the desired molecules make copies of themselves from local resources. Self-replication is not in and of itself novel – nature is full of examples of self-replication. Extending this to molecules as a general property is the novel aspect of this form of self-replication. There is ample concern over the potential consequences of self-replicating and nano-scale materials and devices. Several consequences of self-replicating devices have been proposed with catchy names like the 'grey goo' and the 'green goo' problems. Eric Drexler coined the term grey goo in his book, *Engines of Creation*, to describe how the self-replicating attribute could go awry and lead to potentially catastrophic consequences if the ability of nanostructures to make copies of themselves could not be turned off. The consequence would be the consumption of all matter on earth as the self-replicating nanorobots turn all matter into copies of themselves.

Taking the notion of out-of- control replication into the world of biology where new life forms are created via nanotechnology approaches, a hypothetical outcome could be the 'green goo' problem in which the new life forms dominate and destroy other forms of life. This is an ongoing synthesis of biotechnology and nanotechnology in which the techniques of nanotechnology are allowing the rearrangement of life associated molecules. The green goo problem becomes especially interesting when describing how human researchers can manipulate DNA . An excellent description of biological nanotechnology was produce by the ETC Group which they call "God for Dummies." In this short synopsis of progress in DNA manipulation, they noted that may scientists now believe that it is now possible to:[27]

- Craft synthetic DNA from the blueprint provided by a natural organism.
- Use the synthetic DNA to create unique living organisms.
- Construct new artificial amino acids that can be built into unique proteins.
- Add a fifth letter to DNA (there are now A, C, T, and G and "F" could be added.
- "Write" DNA code in much the same way programmers write softwarme.
- Use DNA to build nano-machines capable of exponential self-assembly.
- Design exponentially self-assembling nanomachines that can become motors, pistons, tweezers and so on, for manufacturing processes.

ETC reported that researchers at Stony Brook-New York synthesized the 7,500 letters of the poliovirus genome using published information and off the shelf, commercially available DNA material. Clearly there appears to be the potential to combine viruses with catalysts and protein molecules to allow the virus to be assembled. Thus the "God for Dummies" title as humans now have the apparent power to develop life forms.

In addition to the impacts nanotechnology is having on biotechnology, it is also having profound impacts elsewhere: information technology, computer science, robotics and cognitive science, to name but a few.

So dangerous are the possible outcomes from nanotechnology that the Project for Emerging Nanotechnologies (PEN) was formed as a result of a collaboration of the Woodrow Wilson International Center for Scholars and the Pew Charitable to identify gaps in knowledge about nanotechnologies and to close them. In A PEN report dated 2009, the social and ethical issues of nanotechnology were laid out to illuminate the full range of issues that society could face as a consequence of deploying nanotechnologies. The report organized the social and ethical issues into a typology consisting of (1) social context issues, (2) contested moral issues, (3) technocultural issues, (4) form of life issues, and (5) transformational issues. Under the category of technocultural issues, some that are appropriate to discussions of an ethical screen for nanotechnology are the following:

- A tendency to favor technological fixes over comprehensive solutions
- A tendency to treat problematic effects rather than address their underlying causes
- Techno-hubris, or over-estimation of our ability to predict and control technology (particularly in complex systems)

- Techno-determinism, or overstatement of the extent to which technology drives history
- Techno-optimism, or over-confidence in the inevitable goodness of technology and its capacity to solve social and environmental problems
- Alienation from nature, that is, detrimental technological mediation for interactions and relationships between people and nature

Robotics, Computers, and Information Technology

As technologies, robotics, computers, and information technology are all tightly interwoven. All three are dependent on microprocessors and programming and unlike biotechnology and nanotechnology, the outcomes of these technologies, with some exceptions, are tightly controlled by humans through the software they create. Several new fields of ethics have emerged to address the wide variety of ethical problems that have emerged as a consequence of these technologies, among them roboethics, computer ethics, and information ethics. Although these fields are under the control of humans through the programs they write, the potential for autonomous action by computers and robots puts the decision in the hands of the device. And in some cases the computers and robots are designed to learn and adapt, a process that can have unintended consequences because of programming complexity and the unpredictable outcomes when machines face unanticipated situations. This section will focus on robotics because they are a fusion of computers, machines, and information storage and manipulation.

The ethical issues of robotics were first raised by Isaac Asimov and John Campbell in 1940 when they formulated the Laws of Robotics. At the time of the formulation of these Laws, robots did not exist, and computers were also several years away from realization. Asimov had grown weary of the stories of Frankenstein and other similar monsters, a plot that always revolved the creation and destruction of the biological robot by its creator. As a young man in the 1920's he wrote stories about machine robots created by engineers, not as he put it, 'blasphemers.' The Laws of Robotics were created to address the potential for robots to harm people and first appeared in his fourth short story about robots, "Runaround."[28] Interestingly, the absence of computer technology did not deter Asimov, he referred to the intelligent architecture of the robot as "platinum iridium positronic brains." He modified the Laws in 1985 by adding the Zeroth Law which ensured that humanity had higher priority for protection than individual humans. The complete 1985 version of the Laws of Robotics are as follows:[29]

Zeroth Law: A robot may not injure humanity, or, through inaction, allow humanity to come to harm.

First Law: A robot may not injure a human being, or, through inaction, allow a human being to come to harm.

Second Law: A robot must obey orders given it by human beings, except where such orders would conflict with the First Law.

Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Cyborgs, also found in science fiction stories, are potential future variants of robots, either machine-enhanced humans or biologically enhanced machines. The increasing sophistication and use of artificial limbs, heart pacemakers, and other devices could potentially result in cyborgs. Indeed some science fiction writers speculate it is the fate of the human race to become cyborgs, particularly as it attempts to extend its lifetime, increase its speed and strength, and to increase its perceived quality of life. There is a long history of drug-use, enhancement, and surgery for these and other purposes and there appears to be no barrier for to the inclusion of machinery as part of the upgrade process.

It should be noted that the audience for roboethics should not be the robot and the artificial ethics represented by the Laws of Robotics, but the human ethics of the robots' designers, manufacturers and users. One of the stakeholders in the world of robotics is the military and there are concerns about the possible use of military robots against some populations and problems connected with biorobotics, implantations and human augmentation. It is absolutely clear that without a deep rooting of roboethics in society, the premises for the implementation of an artificial ethics in the robots' control systems will be missing. Some other ethical issues that are emerging out of the field of robotics, many of which are also common to computer and information technology, are:[30]

- Dual use technology (every technology can be used and misused);
- Anthropomorphization of the machines;
- Humanization of the human/machine relationship (cognitive and affective bonds toward machines);
- Technology addiction;
- Digital Divide, a socio-technological gap (per ages, social layer, per world areas);
- Fair access to technological resources;
- Effects of technology on the global distribution of wealth and power;
- Environmental impact of technology.

The development of military robots brings with it an even wider range of dilemmas, especially with the deployment of autonomous robots that are designed to make decisions and destroy the enemy. This becomes even more complicated in today's warfare environment with the close proximity of civilians to military units and often the lack of uniforms or other distinguishing markings that differentiate military forces from the civilian population. The use of Predator drones and smart bombs by American forces in Afghanistan has caused considerable controversy due to the large number of civilian casualties and collateral damage. It should be noted that neither of these two technologies are fully autonomous, they are both under direct human control. One of the ethical issues posed for future autonomous military robots is the potential that they may refuse orders based on their design. For example, a commander orders a robot to attack a house known to contain insurgents but the robot is equipped with advanced sensors that can see through the walls. If the robot detects children inside the building and refuses the order

because it is programmed with a Rule of Engagement that instructs it to minimize civilian casualties, what has priority, the direct order of the commander or the programmed instructions given to the robot? And if robots can refuse an order, does this mean that soldiers can also refuse a similar order? Dilemmas like this abound when it comes to addressing the deployment of autonomous military robots. What ratio of civilian to military casualties are permitted in an operation? What if a high value combatant is detected, what is the maximum number of civilian deaths that are permitted? Discriminating between active and wounded combatants could be another challenge for a robot roaming the battlefield. Can a robot's controls be overridden in the event a robot refuses an order based on its built-in rules? There is also the issue of proliferation. Once the U.S. deploys autonomous military robots that provide a competitive edge, other countries will design and deploy their own versions and the arms bazaar would have yet another product to sell. Finally there is the question of the inherent value of a robot. At what point does the robot have rights? The notion of so-called Kantian robots that are autonomous, moral agents with an ability to learn, dramatically increases the scope of problematic questions that have to be answered.

Roboethics, as it is emerging, addresses three distinct issues: (1) How humans might act act ethically through or with robots; (2) How to design robots to act ethically ad whether robots could actually be truly ethical agents; and (3) The ethical relationships between humans and robots. Regarding the third issue there are several questions: Is it ethical to create artificial moral agents? It is unethical not to provide sophisticated robots with ethical reasoning capability? Is it ethical to create robotic soliders, police, or nurses? How should robots treat people and how should people treat robots? Should robots have rights?[31]

The question of moral agency for robots is also another issue that must be considered. John Sullins (2006) stated that to determine the moral or ethical status of a robot, three questions should be posed: Is the robot significantly autonomous? Is the robot's behavior intentional? Is the robot in a position of responsibility? A robot nurse, for example, that is entrusted with the care of a human patient, can be programmed to be autonomous and to dispense drugs or take other actions consistent with its instructions. The robot nurse meets all three criteria for a moral agent: it is autonomous, acts intentionally, and is in a position of responsibility and can therefore be considered a human agent. According to the three criteria for moral agency, the robot nurse is a moral agent. However it is arguable that the robot nurse is a true moral agent, rather it is simulating moral behavior.

Robotic technology is evolving rapidly, with ever improving capabilities, and already providing humans with dilemmas on when and how and where to deploy them. An ethics of sustainability would also address the resources consumed to make robots, the resulting waste, the impacts of the processes used to manufacture the numerous high technology components such as computers, drives, and actuators that comprise the robot. Robots are replacing the human workforce in many factories – is this consistent with the sustainability framework? The broad impacts of robotics and the many serious implications they hold for a fair allocation of technology and resources make addressing

the implications of this particular technology particularly important because its deployment is ongoing, with few policy outcomes.

THE ETHICAL IMPLICATIONS OF TECHNOLOGY

Development and implementation of technology almost always results in ethical dilemmas. Some of the ethical issues are fairly straightforward and are simply a variant of age-old problems. The internet and email, for example, have opened up a Pandora's box of information security and confidentiality problems. Although serious, these are not actually new ethical issues, the technology simply multiplies the opportunity for problems. Other technology issues are strictly about right and wrong, classic ethical issues. For example, the decision of a Union Carbide subsidiary to build a pesticide plant in a densely populated area around Bhopal, India proved to be disastrous when the plant exploded in 1984, with 20,000 deaths, 100,000 injuries, and 5 million people affected directly or indirectly by this tragedy. The Union Carbide plant was conceived with the intent of supporting India's Green Revolution, a plan to dramatically increase India's agricultural output through the use of technologies such as pesticides.

The Bhopal disaster has many ethical dimensions and serves to illustrate the need for ethical principles that can cope with decision making about technology implementation. One ethical dimension is the question of producing chemicals whose toxicity is not fully understood. The Bhopal plant was producing carbaryl, a highly toxic and dangerous pesticide, with equally dangerous ingredients such as the highly reactive chemical methyl isocyanate (MIC). Carbaryl, for example, is listed by the U.S. EPA as a likely human carcinogen, and the full range of its toxicity has never been determined and it is illegal in the U.K. The full range of the toxicity of carbaryl is still unknown and it continues to be used in the U.S. and elsewhere. A second ethical dimension of this catastrophe was the location of the plant in a dense urban environment which meant that the explosion produced numerous immediate casualties – over 4,000 people died in their sleep the night of the explosion. Bhopal itself was a city of 900,000 people at the time of the incident. And in a classic case of environmental injustice, the people who died were from the nearby shantytowns of Jayaprakash Nagar, Kazi Camp, Chola Kenchi, and the Railway Colony so it was the poor who suffered the brunt of the event. A final ethical dimension of this disaster was the lack of information and transparency. It took at least two hours to sound the alarm after the workers detected the MIC leak, and by that time over 40 tons had leaked out and spread through the air in an 8 kilometer long plume that had formed and spread out over the city.

Of these three ethical dimensions, the location of the plant and the lack of notification are familiar and could be reasoned through by applying commonly accepted ethical principles. The question of producing chemicals whose impacts are unknown can be better answered by applying a range of ethical principles that are able to cope with the complexities of the sustainability framework which has social, economic, and environmental aspects. These ethical principles form the basis for an ethics of sustainability and include the Precautionary Principle, among others, that can assist in framing the issue and developing suitable solutions, and that can cope with risk and its ramifications. The Precautionary Principle will be discussed at length in Chapter 5.

Some of the ethical questions that must be considered when a technology has been developed and considered for deployment can be summarized as follows:

- Under what conditions is the deployment acceptable?
- At what point in the development of the technology is an increase in deployment acceptable?
- How does society weigh the associated risks against the possible benefits?
- Are there cases where a particular technology itself should be considered unacceptable even though it has potential for compensation as well as enhancement?

The development of general ethical principles that support the sustainability framework is vital to its utilization. The issue of obligation to present and future generations, and to other species, as well as issues of fair distribution of resources and technology, must all be answered for this framework to be successfully applied to solve many of our contemporary problems.

SUMMARY AND CONCLUSIONS

Technology provides the capability for humans to violate the carrying capacity of the planet while simultaneously increasing quality of life and decreasing poverty. It is probable, based on a finite planet with finite resources, that this is likely a short term phenomenon fraught with potentially disastrous consequences for future generations. At present the planet is headed, in a near out of control fashion to a future of higher global temperatures, rising sea levels, and alteration of rain patterns, food distribution and wholesale shifts in ecological systems. Layered on top of this are the technologies themselves and the range of their consequences, from the grey and green goo problems of nanotechnology to the destruction of species through genetic engineering. If indeed there is an obligation to future generations as well as to the present poor of Earth, then technology is a major actor that needs to be examined and used in a manner that will produce manifest benefits and minimize negative outcomes. Clearly ethics is central to the issues of technology development and deployment, and an ethics of sustainability that can help technology developers, policymakers, and technology consumers make sound decisions regarding technology would be of enormous benefit to the sustainability framework.

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ENDNOTES

[1] From *Nanotechnology: The Social and Ethical Issues* by Ronald Sandler (2009)

[2] In her book, *Bimomicry*, Janine Benyus (1996) described a whole range of technologies that could benefit by emulating of copying nature.

[3] The word "harmless"as used in this chapter means it is non-toxic to nature and is not a threat to health.

[4] From "Primer on Ethics and Bioengineering" by Glenn McGee online at http://www.actionbioscience.org/biotech/mcgee.html#primer

[5] From "Technically Speaking," a report by the National Research Council (NRC), the goal of which was to inform the general public about the issues of technology and how to differentiate science from technology. The report was edited by Greg Pearson and A. Thomas Young.

[6] As described by Robert Thayer in *Grey World, Green Heart* (1994).

[7] Excerpted and adapted from Merriam-Webster online at http:// www.merriam-webster.com/dictionary/technology

[8] From the website of Learning Alive website at http://atschool.eduweb.co.uk/trinity/watistec.html

[9] From "Sustainability Science: The Emerging Research Program" by William C. Clark and Nancy M. Dickson (2003)

[10] *Diffusion of Innovations* by Everett Rogers (1964).

[11] The S-curve was first described by Richard N. Foster (1970) in *The Attacker's Advantage*.

[12] From "Jumping the Technology S-Curve" by Praveen Asthana (1995).

[13] The Iroquois Indians and several other native peoples are an exception. The Great Law of the Iroquois states "In every deliberation, we must consider the impact on the seventh generation... even if it requires having skin as thick as the bark of a pine."

[14] From *The Control Revolution: Technological and Economic Origins of the Information Society* by James Beniger (1986) and as cited in an online paper by Tim Healy at http://www.scu.edu/ethics/publications/submitted/healy/consequences.html

[15] From *The Third Wave* by Alvin Toffler (1980).

[16] From "Can Technology Replace Social Engineering" by Alvin M. Weinberg (1960). Although a technological optimist, Weinberg did note that technology and social engineering should be used together., that technology that ignores social reality will not work.

[17] Limits to Growth (1972) was authored by Donella Meadows, Dennis Meadows, Jorgen Randers, and William W. Behrens III. A 20 year update with the same title and based on the original material was written by the authors in 1993. A follow-up with the title *Limits to Growth: The 30 Year Update*, was written by the authors (less Behrens) in 2004.

[18] From *The Logic of Failure: Why Things Go Wrong and How We Can Make Them Right* by Dietrich Dorner (1989). As described by Tim Healy as indicated in Note 9.

[19] From *Risk, Uncertainty, and Profit* by Frank Wright (1921) and as described by Tim Healy as indicated in Note 9.

[20] The Nuclear Regulatory Commission report on reactor safety is commonly referred to as the Rasmussen Report, after the chair of the committee, Norman Rasmussen, professor at Massachusetts Institute of Technology. The committee started its work in 1972 and issued its final report in 1975.

[21] Bill Joy wrote "Why the future doesn't need us" in the April 2000 issue of *Wired*.

[22] From "A Tale of Two Botanies" by Amory and Hunter Lovins (April 2000) in *Wired*.

[23] From "Ethics of Genetic Engineering" at www.enotes.com/ethics-genetic-article

[24] From "The Ethics of Genetic Engineering" by David Koepsell (2007).

[25] From BBC New online at news.bbc.co.uk/1/hi/sci/tech/3920685.stm

[26] From the website of The Project on Emerging Nanotechnologies at www.nanotechproject.org

[27] From "Nanotech Un-Gooed! Is the Grey/Green Goo Brouhaha the Industry's Second Blunder? ETC Group Communique #80, 2003

[28] The short story "Runaround" can be found in *I, Robot*, a collection of short stories by Asimov (1960).

[29] An excellent examination of the Laws of Robotics by Roger Clarke can be found at www.rogerclarke.com/SOS/Asimov.html#Laws1940

[30] From "Ethics in Robotics" (2006) from the *International Review of Information Ethics*.

[31] From "What Should We Want from A Robot Ethic?" by Peter Asaro (2006) in the *International Review of Information Ethics*.

CHAPTER 3
MAKING ETHICAL DECISIONS

Ethics can be defined as reflection on the nature and definition of "the good." As a scholarly pursuit, philosophical and religious ethics examine the origins, priorities, emphases, and practical implications of various goods. The goods that orient and define ethical systems vary widely among different cultures, religions, and individuals. People value different qualities and things, most obviously, but they also value their goods in different ways, in different relations to each other, for different reasons, and to different ends. These differences are very relevant to sustainability, an undertaking which cannot be understood simply as a practical or technical one. Efforts to create more sustainable practices, organizations, and societies are rooted in an overarching set of values that can be identified and analyzed. Sustainability, in other words, cannot be understood or achieved without careful attention to its ethical dimensions. This is one of the main premises of this book, and it is a theme which this chapter elaborates with the resources and perspectives provided by philosophical and religious traditions of ethical thinking.

Ethical concerns are implicit in the term sustainability, as sustainability means taking into account not just utility, the usefulness of something, but also moral values and goals. The ethical aspects of sustainability often remain implicit, however, as most analyses focus on economic, social, environmental, and technical issues. This book makes the ethical dimensions of sustainability explicit, so that they – and the larger problem of achieving greater sustainability in scientific, technological, and social endeavors – can be understood, clarified, and evaluated more effectively and constructively. This chapter contributes to this goal by introducing and examining how different ways of thinking about ethics, both philosophical and religious, can help people sort through some of these complex issues and make more sustainable choices.

When questions of values are raised, a host of auxiliary issues follow, some of which are especially relevant for thinking about sustainability. First, and most generally, which specific ethical concerns (social, economic and environmental) enter into discussions of sustainability? Which ethical traditions and models have shaped contemporary thinking about the ethics of sustainability? How are ethical concerns incorporated into sustainable decision-making? What are the most important theoretical and philosophical dimensions of an ethic of sustainability? And last, how are the distinctive elements of sustainability – economic, environmental, and social – incorporated into an ethic of sustainability? These questions organize the discussion in this chapter, which has three overarching tasks. First, it discusses the ways that sustainability is related to and relies upon established philosophical and religious traditions of ethical thought. Second, it clarifies the ways that ethical decision-making must enter into thinking about sustainability. Third, it outlines some of the most important characteristics and principles of an ethic of sustainability. In other words, this chapter both explains how sustainability is an ethical enterprise and examines the most appropriate ways that enterprise might be understood and enacted. These discussions highlight and clarify questions that are important for professionals and

scientists, as well as policymakers, non-governmental organizations, and ordinary citizens who seek a more sustainable society.

ETHICAL TRADITIONS AND THE ETHICS OF SUSTAINABILITY

While ethics, in general, explores problems of good and evil, there exist countless ways to specify what this means, according to diverse interests and perspectives. For many philosophers, ethics is about individual conduct or character, and thus defined by questions such as "How shall I live?" or "What does it mean to be a good person?" For others, ethics refers to universal values and thus poses questions such as "What is the Good?" or "What rules can rightly apply to all moral actors or agents?" Still other ethicists focus on the process of moral decision-making, the characteristics of a good society, or the relationship between human goodness and the divine, among many other issues. These differing approaches depend in part on varying foundational assumptions about, for example, whether goodness stems from a transcendent power such as God or whether the source of value is nature, human conscience, or reason. A further source of divergence is the question of whether it is possible to identify a universal, absolute good or if, to the contrary, values are inevitably subjective or relative in nature. Differences in ethical frameworks also emerge from divergent attitudes toward rationality, emotion, and science, among other matters. What unites different schools of ethics is a conviction that it is both possible and worthwhile to identify good, or at least better, ways of acting and being in the world. (Ethics in this sense is identical to "morality," although some scholars distinguish between ethics as an academic area and morality as personal or cultural codes of conduct. The two terms are used interchangeably in this book.)

Religious Ethical Traditions

Probably the earliest, and still the most prevalent, way of thinking about values is religious. Religion involves ritual, symbol, community life, institutions, doctrines, and many other factors, but moral values are a central aspect of religious identity for both individuals and groups. Through religion, people think about what it means to be a good person and what a good society would entail; they find resources, support, and guidance in their efforts to live up to these values and to improve their communities. Many discussions of sustainability do not refer to religion explicitly but rather define the problems of sustainability only in relation to technical, economic, or otherwise secular concerns. This is an unfortunate omission, not because sustainability is inherently religious, but because so many people in the world think about values – including the social, economic, and environmental values that help define sustainability – in religious terms. In this chapter, therefore, both religious and secular ethical traditions are discussed in relation to the ethical dimensions of sustainability.

Religious values in the modern West are predominantly informed by biblical traditions. Hebrew and Christian scriptures are complex and varied: their component books were written over many centuries, by different people with different goals in vastly different cultural and historical settings. Biblical scholars emphasize the presence of diversity and the importance of context in any effort to understand the ethical (or other) dimensions of scriptures. Still, it is possible to identify some common concerns in Hebrew and Christian scriptures that have particular bearing on contemporary discussions of ethics

and sustainability. Most important is the biblical emphasis on social justice. Hebrew prophets such as Amos, Jeremiah, and Isaiah repeatedly and stridently call on their contemporaries to care for the least well off, symbolized by widows, orphans, and refugees – categories of people who were especially vulnerable in ancient Middle Eastern societies and are among those who remain vulnerable today. In relation to these groups, and in wider social interactions, some important ethical guidelines include hospitality, protection of the weak from the strong, forgiveness of debts, and prohibitions on usury. Christian scriptures (commonly referred to as the New Testament) continue these emphases, adding Jesus' particular concerns with social groups on the margins of mainstream society, such as lepers. For both Hebrew and Christian scriptures, individuals and societies are judged in large part based on how they treat the poor, the sick, and the outcast.

The biblical emphasis on social justice rests, in part, on a social view of human nature: people are related to and dependent upon one another and thus responsible for one another's well-being. To ignore those in need, to believe oneself apart from the webs of common life, is to court divine judgment (as the Jewish prophets insisted) and ultimately threaten one's own eternal fate (according to the Christian gospels). Both Jewish and Christian ethics insist on just distributions of social goods, especially to needy groups. For this tradition, a good society is one in which no one falls through the cracks, well-off people take care of those in need, and cries for help are answered promptly, generously, and without rampant self-interest.

Non-human nature does not play an especially important role in these scriptural ethics, at least in the dominant historical interpretations, although contemporary environmental ethicists and theologians highlight issues such as the importance of agriculture and "the land" for biblical societies and the inclusion of animals and other aspects of the natural world in visions of divine fulfillment (for example, the Jubilee Year). Perhaps the most important biblical principle with regard to non-human nature is the recurring injunction to be good stewards of the land and non-human animals. A **stewardship ethic** begins with the premise that God has created the natural world for the benefit of all people. Humans are not the owners of this world, but rather are caretakers who have both special responsibilities and some special privileges with regard to created goods. Stewardship is intended as both a social ethic, to ensure that all people have their just share of created goods, and an environmental ethic that helps to preserve God's creation.

The emphases on social justice and care for the least well off continue in some contemporary Western religious traditions, most notably Roman Catholic social thought. This is clear in the U.S. Catholic Bishops' 1986 pastoral letter on the economy.[1] In their pastoral letter, the bishops assert that economic decisions and institutions should be judged on whether they protect or undermine "the dignity of the human person." This dignity, they add, "can be realized and protected only in community." People are social beings, and their most important goods require collective support and enactment, which are the responsibility of all people, of all social groups and classes. This responsibility

can be fulfilled only with widespread participation in both the economic and political processes, which must be equitable and open. Finally, the bishops assert that all members of society, and especially the most powerful, have a special obligation to "the poor and miserable." This obligation can be understood, in part, as the demand to fulfill the basic human rights of all people to food, clothing, shelter, and other economic and material conditions for human dignity, as well as political and civil liberties. The economic values outlined in "Economic Justice for All" build on centuries of Catholic social thought and are reaffirmed in Catholic statements today, not only in the U.S. but globally.

Other Western religious traditions are not as centralized as the Catholic Church and thus do not issue the same sort of broadly authoritative statements on various issues. It is not as easy, therefore, to identify widely shared themes in social and economic ethics. However, broad trends are evident in the statements of more local institutions and associations from a wide range of religious groups. Both non-Catholic Christian denominations – Protestant, Eastern Orthodox, and other – and major Jewish and Muslim organizations emphasize social justice and care for the poor and vulnerable as the major ethical principles that guide their positions on concrete social problems. Serious differences exist, certainly, on issues such as the role of government, the responsibility of individuals and families, the moral status of capitalism and other economic systems, and a range of other matters, including sustainability. Still, major Western religious traditions largely agree on the centrality of justice, equality, fairness, and charity as the most important principles for evaluating specific social decisions, institutions, and processes.

Increasingly, contemporary religious thinkers and leaders are taking environmental concerns into account when discussing social and economic ethics. A wide range of religious groups have issued statements on the environment, some of them very general, such as Pope John Paul II's calls for "ecological conversion" and his naming of Francis of Assisi as the "Patron Saint of Ecology." Other religious statements address specific problems, such as climate change, a topic to which American Evangelical Protestants have recently given a great deal of attention. For many Christian, Muslim, and Jewish thinkers, the guiding principle behind environmental concern is the "integrity of creation," or the notion that because God created the natural world as well as humans, nature has its own intrinsic value and is not meant only to serve short-term human interests. This has a great impact on the way many religious persons and groups approach sustainability.

Of particular interest to many religious leaders is the impact of environmental problems on poor and minority populations; environmental concerns, in other words, are linked to traditional faith-based social and economic values. This effort at integration has entered into some secular discussions of sustainability, and particularly the effort to unite social, economic, and environmental concerns under the rubric of environmental justice. For religious thinkers, the emphasis on environmental justice, like approaches to other dimensions of social justice, rests upon a deeply social view of human nature. According to this view, people are connected to, dependent upon, and responsible to each other and to the larger society, in direct contrast to the highly individualistic approach to human

nature that dominates mainstream secular understandings. In contrast to religious approaches, contemporary thinking about sustainability rarely makes explicit its definition of human nature. One contribution that religious ethics might make to the ethics of sustainability, then, could come in the form of explicit reflection on the foundational assumptions that underlie moral, political, and economic claims.

Secular Philosophical Ethical Traditions

Not all ethical traditions, of course, are religious in nature. Contemporary Western culture, including its efforts to become more sustainable, is strongly influenced by philosophical ethics. The secular tradition in Western ethics begins with the classical Greek thinkers, especially Plato and Aristotle. Social ethics, and more specifically the characteristics of a good society, is the central moral problem for these thinkers. Plato and Aristotle asked explicitly what the good life is for humans and provided answers that continue to influence both scholarly and popular thinking about ethics. Their reflections began with the notion that humans are social beings whose good is only fulfilled in community. Their work does not display much interest in the issues that preoccupy many popular discussions of morality, but rather focuses on problems of public virtue, right relationships, and good leadership.

One of the most important classical philosophical themes for sustainability is justice -- one of the most important virtues discussed by Aristotle. Justice involves giving to each his or her due, which implies a careful weighing both of what is possible and what is deserved, as well as comparisons among different relevant cases. For Aristotle, justice is both procedural – concerned with fairness in decision-making and other social processes – and substantive – concerned with the proper distribution of actual goods. Both kinds of justice are central for sustainability today since a sustainable society requires both just political institutions and mechanisms, on the one hand, and distribution of necessary goods that avoids extremes of poverty and social inequality on the other.

The most influential thinker in the Western ethical tradition is Immanuel Kant (1724-1804), the father of **deontological ethics**, which defines good practices as those that identify and follow the correct rules or uphold correct duties (deontology comes from the Greek *deon*, meaning duty). For deontological ethics, the likely consequences of actions do not matter in moral decision-making, and the actual consequences do not affect evaluations of the moral worth of an action. Rather, ethical judgments are based on the moral actor's intentions and adherence to duties or rules.

Kant insisted that human reason was competent to determine ethics, and that ethics should be based and critiqued on rational grounds. Most famously, Kant articulated his ethical thesis in the form of several "categorical imperatives," moral statements that are objectively and universally true because of their intrinsic qualities (rather than because of their source or consequences). The most famous articulation of Kant's categorical imperative is to "Always act according to that maxim whose universality as a law you can at the same time will."[2] (To be ethical, in other words, an action must be able to be

made universal: if it is not good for all people to act in this way, it is not good for a single actor to act in this way. While there are countless critiques of Kant's approach, his emphases on rationality, consistency, and universality remain highly influential in Western philosophical ethics.

Perhaps most notably, Kant's deontological model has strongly shaped theories about rights, one of the most important concepts in modern political and social ethics. **Rights** are moral claims that certain categories of persons can make on other persons who are, in turn, duty bound to respect those claims. Theories of rights depend on Kant's insistence that morality requires treating other persons as ends in themselves and never simply as means to other ends. In other words, Kant argues that persons have intrinsic value that is independent of their instrumental use to others. The assertion of intrinsic value is necessary to declarations of human rights, which assert that simply by virtue of being human, persons have rights to such things as freedom from torture or access to clean water, for example. Other persons then have the duty to abstain from torturing or polluting water (and perhaps, in some models, to protect others from being tortured). There are also religious theories of rights, such as a Roman Catholic human rights approach that asserts that because God created humans with intrinsic dignity, all persons have the duty to respect and preserve this dignity through the fulfillment of rights claims.

Human rights models, both philosophical and religious, are often important for the social, economic, and also environmental dimensions of sustainability. Policies and projects aiming for sustainability can affect various rights, both those that are legally protected and those that are claimed on other bases. Thinking about rights becomes especially important for conservation and development projects conceived in one culture and applied in another since different societies understand and protect rights differently. For example, this is particularly important for Westerners working on "sustainable development" projects in Asia, Africa, Latin America, and North American indigenous communities. At the same time, it is important to remember that rights is a thoroughly Western philosophical concept, without parallels in many other cultures – so development specialists might face the dilemma of trying to protect the rights of particular groups while at the same time broadening their own understanding of ethics beyond a focus on individual rights. For example, the Buddhist concept of the interdependent self is centered on respect and ethics through relationality, not on a universal or preexisting ideal of rights (i.e. morality arises out of relationships)

Rights theories are also important in relation to the ethics of human relations to non-human animals. A number of philosophers and activists have asserted that non-human animals have certain rights, such as the minimum right to avoid unnecessary suffering and untimely death. These theories will be discussed in more detail in Chapter Seven.

In addition to deontological ethics, which includes rights theories, the other major model in Western philosophical ethics is **consequentialist or teleological ethics**. In consequentialist or teleological ethical systems, decisions about what to do and subsequent evaluations of the morality of an action are based on the expected or actual consequences of a behavior (from the Greek *telos*, meaning end). Whether or not a

person or action is good is based not on the intrinsic qualities of a person or on the rules he or she is following but rather on the outcome of particular actions. The most prominent consequentialist model is **Utilitarianism**, first articulated by English philosophers Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873). Bentham, who is regarded as the founder of utilitarianism, claimed that the ultimate goal of ethics should be to create the greatest good for the greatest number of people. For Bentham, the good is happiness (known as the "greatest happiness principle," which is focused on pleasure), and he devised a hedonistic or pleasure-based calculus to aid in determining if an action contributed positively or negatively to the overall good or happiness. Mill popularized and expanded upon Bentham's utilitarianism while diverging with his mentor. Bentham claimed that all pleasures were on a relatively level plane based on how well they contributed to one's happiness. Mill disagreed with this basic hedonistic form of happiness and claimed that there were higher pleasures (intellectual) and lower pleasures (sensual), and that the higher pleasures should be what are ultimately promoted over the lower pleasures. This led to Mill's effort to instill a moral education in the public sphere that would teach people how to value and promote the higher pleasures or good in society.

Classical utilitarianism generally claims that an action's utility is determined by whether it produces more benefit or harm to the overall good, including pain and pleasure (or negative and positive feelings). For utilitarianism, as for all consequentialist ethics, ends are more important than means, in contrast with deontological methods. As some rights theorists have pointed out, this means that a variety of questionable moral actions – especially involving minority groups – could be justified in relation to their positive outcome for majorities. As a result of this dilemma, some have promoted a form of rule utilitarianism or consequentialism, which uses the principles of utilitarianism to determine which rules should be followed in order to promote the greatest good. It is similar to deontology in determining rules, but is more focused on rules that create certain outcomes rather than focusing on the intrinsic value of the action itself. Various forms of utilitarianism have arisen in recent years, and each has its own conception of the good, pleasure, and happiness (which are all generally lumped under the category of "interests").

A final significant form of utilitarianism is preference utilitarianism, which claims that one's best interest is based in the satisfaction of individual-specific preferences and desires. This has most notably been championed by Peter Singer in relation to animals through the idea that rights cannot be conceptualized outside of the satisfaction of interests of all species, not just humans, which is mainly the minimization of suffering. Singer's work, building on Bentham's earlier interest in reducing animal suffering, has made utilitarianism an important resource for advocates of animal welfare.

Many approaches to sustainability implicitly, if not explicitly, follow a utilitarian ethical model. They aim to maximize selected goods – social, economic, and/or environmental – for the largest number of individuals or groups without the need to specify philosophical

foundations. Utilitarianism is especially appealing in culturally or religiously diverse settings where participants in environmental or social projects may have diverse founding principles while still agreeing on specific goals. Utilitarianism here may overlap with **pragmatism**, a school of philosophical ethics that originated with the work of American philosophers C. S. Peirce (1839-1914), William James (1842-1910), and John Dewey (1859-1952). Pragmatists assert that knowledge and meaning emerge from practical experience and that, in regards to ethics, value must be judged by practical consequences rather than intentions or relations to abstract goods: it is strongly empiricist, meaning that it asserts that knowledge, meaning, and values arise from practical actions and experience. For many social and environmental ethicists and thus for people concerned with sustainability, pragmatism is appealing because it represents an effort to achieve concrete, positive results without the need to find consensus about abstract philosophical issues in advance (or ever).

One of the most prominent philosophers of sustainability, Bryan Norton, writes from a pragmatist perspective and argues that people who seek a more sustainable society must join together to first establish, and then achieve, practical environmental and social improvements. Norton, like other pragmatists, finds many of the more abstract arguments in environmental philosophy insignificant and sometimes destructive to these larger goals insofar as they distract attention away from the urgent need for tangible results. He urges that diverse environmental groups look past their foundational differences toward practical goals that are based on the best environmental science and management available, and that well-reasoned action is the best course in enacting change and overcoming these differences.

While both pragmatism and Utilitarianism emphasize practical consequences as the measure of moral worth, they differ in their understanding of what defines the good and how people can know it. Pragmatism rejects efforts to uncover ultimate meaning, truth, or other philosophical foundations for ethics. It is thus more relativist than Utilitarianism since pragmatism requires no objective justifications for moral behavior, while Utilitarianism may insist that goods such as the reduction of pain and the maximization of pleasant feelings can be valued on objective bases. **Ethical relativism** asserts that moral value must always be defined in light of a particular context, which may include cultural, historical, or individual differences as well as the social, economic, and political relations that create an understanding of goodness in a particular situation. For example, a relativist could decide that something is right for *a* but wrong for *b*. In contrast, **objectivism** in ethics asserts that judgments of good and evil rest on absolute foundations, which may be religious, philosophical, or scientific in origin.

The debate between objectivism and relativism is important for scientists and others concerned with sustainability in several ways. Most scientists share a commitment to the pursuit of what they understand to be objectively verifiable truths, which may be modified when better evidence is uncovered but are still judged according to objective standards. In contrast, some contemporary humanistic scholars, including some philosophers and ethicists, have adopted **postmodernist** approaches. Postmodernism is an umbrella term used for a diverse array of scholarly approaches used predominantly in

the humanities and social sciences, although it has origins in late nineteenth century critiques of art and post-World War II critiques of architecture (both critical of modernist trends). In philosophy, postmodernists reject the conviction that people can, through the use of reason, attain objectively true knowledge or identify absolute values. Consequently, some heated debates have erupted over these questions between scientists and other scholars (especially in literary or cultural studies).

The debate between relativism and objectivism has implications for sustainability in both its social and environmental dimensions. If there is no objective standard by which to judge the health of a natural ecosystem, for example, environmentalists are not justified in rejecting some uses of natural resources and preferring others. Similarly, if social and political values such as equality, democracy, or human rights are always culturally relative, there are no solid grounds to identify some policies, institutions, or societies as more or less ethical. While these questions have been important in some related fields, such as environmental philosophy, they have not played a central role in scholarly discussions of sustainability, which – with their general focus on identifying and achieving practical goals – have tended more toward a preference for pragmatist or utilitarian ethical approaches.

While not every aspect of the history of Western ethics is relevant for sustainability, it is impossible to understand what an ethic of sustainability might look like without knowing how some of the most important ethical theories have emerged and which thinkers have defined them, as well as what theoretical and practical issues have divided the different approaches. That has been the aim of this section – to provide an overview of some of the philosophical terms, thinkers, and schools of thought that have helped make possible and continue to help define contemporary ethical discussions about sustainability. Building on this overview, we can now turn to issues that are more directly relevant for the ethics of sustainability.

SOCIAL, ECONOMIC, AND ENVIRONMENTAL ETHICS IN SUSTAINABILITY

In order to clarify some of the specific ethical fields and approaches that are most directly relevant for the ethics of sustainability, this discussion is organized in relation to the three "legs" of sustainability as often defined: the social, the economic, and the environmental. Social justice and economics are both addressed within the subfield of social ethics, which is concerned with the ways that a community or society (or even a nation) can be organized so as to achieve common goods that are not reducible to the sum of personal aims and interests. The other crucial dimension of an ethic of sustainability addresses not merely human welfare but also the good of non-human nature, including values such as clean air and water, biodiversity, ecological integrity, and the welfare of non-human animals. This chapter mainly addresses social ethics, including economic concerns, with some references as well to environmental ethics. Specific approaches in environmental ethics and related issues such as animal welfare and rights will be addressed in more detail in Chapter Seven.

In order to clarify contemporary thinking about the social and economic components of the ethics of sustainability, this chapter provides background information about ethical ideas, thinkers, and terms in major Western philosophical and religious traditions. Without attempting to survey all of ethics, it focuses on the information and ideas that will be most helpful for people who seek sustainability through ethical decisions in concrete settings.

Social ethics is a subfield in both philosophical and religious ethics that is primarily concerned with the ethical foundations, dimensions, and consequences of collective decisions, attitudes, and actions. It is social both because it looks primarily at decisions and actions that are collective rather than individual and personal, and because it is concerned with goods that are collectively defined and achieved. In contrast, more personal or individualistic ethical systems may be concerned with actions that do not directly affect larger groups of people, such as personal choices about sexual identity or behavior. Certainly even the most apparently personal of decisions have larger implications, if only for the people close to the individual concerned. Further, even intensely personal moral decisions are made in a larger social context and on the basis of values and attitudes that are the result of social learning, social experiences, and social relations. Thus the line between personal and social ethics is never hard and fast. Still, it is possible to distinguish between moral issues that are primarily personal and those that have immediate and unavoidable social implications. The latter is most relevant for sustainability, because it is a quality of groups, including local communities, institutions, and entire societies. An ethic of sustainability is, then, a particular sort of social ethic. While individual decisions and actions may have important ramifications for sustainability, they do so because they contribute to – or detract from – efforts to create and maintain more sustainable collectives. In other words, the goal of sustainability is a vision not simply of private benefit but rather of a common good.

Traditional topics of concern to social ethicists include the morality of war and peace, the benefits of different forms of governance, civil and human rights, and the proper role and treatment of vulnerable social groups, along with many other issues. Perhaps most important, social ethics has addressed the relations between individuals and larger groups, including the rights and responsibilities of the former and the beneficial as well as oppressive potential of the latter. This ethical analysis is conducted in light of social goods, which are defined differently in various times and places but which, in the modern West, often include justice and fairness, equity and equal opportunity, concern for vulnerable groups, stability and security, and protection of individual liberties.

Today, social ethicists continue to reflect on these longstanding questions while also expanding the discussion to important contemporary issues, including many related to science, medicine, and technology. These topics receive attention from many different perspectives, of course. What distinguishes their treatment by social ethicists is attention to the values that are explicitly or implicitly upheld in a given position or practice and to the moral consequences of collective decisions and actions. In relation to development projects, for example, social ethicists might ask about the moral assumptions underlying

various position regarding cloning, about ethical issues raised in the actual procedure itself, and about the moral consequences if cloning takes place. In each instance the discussion addresses not only individual values and issues, but also social costs and benefits. Social ethicists may also be concerned with what vision of a good society is implied in or supported by a particular stance on cloning, or which social groups might benefit or suffer the most, or which collectively-shared goods might be advanced or reduced. Similar analyses can be conducted on a wide range of other contemporary issues: How should the traditional just war requirement to minimize civilian casualties be modified in light of new weapons technologies that make it impossible, often, to avoid civilian deaths? Who will benefit and who will be harmed by agricultural innovations such as genetically modified crops or new pesticides? What moral duties does a society have in relation to new immigrant groups, and vice-versa? The examples are endless, and the important point is that social ethics raises and answers distinctive questions about distinctive concerns, sources, and criteria.

While the ethics of sustainability uses many of the same sources, approaches, and thinkers as other branches of social ethics, sustainability raises new moral questions. Perhaps the most important of these come in relation to the integration of social goods with economic and environmental values (the latter will be discussed in more detail in Chapter Seven.) We address **economic ethics** here, however, as a subfield of social ethics. Economics by definition involves collective decisions and processes. Even individual financial decisions are made only in relation to and subject to the influence of larger economic forces. Economic ethics is concerned with the moral foundations, characteristics, and consequences of economic activities and institutions. Economic ethics may look at specific business practices or industries or at broader issues such as the moral values, implicit or explicit, that undergird economic policies and practices. When considering the ethical dimensions of economic systems, institutions, and decisions, a number of significant questions related to sustainability must be taken into account. One question concerns the definition of economic goals such as productivity, efficiency, and security. Efficiency, for example, is usually defined as the maximization of output in relation to certain inputs, and is a primary goal of many economic practices, systems, and institutions. The inputs at stake can vary, and depending on which ones are selected – e.g., labor time, energy, or capital investment – judgments of economic efficiency will vary.

Contemporary North American agriculture provides an illuminating example of the way differing economic approaches entail particular ethical consequences. Agriculture, like sustainability more generally, is often assumed to be a practical, scientific, and technical undertaking rather than an ethical one. Any agricultural system, however, involves implicit or explicit efforts to live according to a particular definition of the good in the standards or rules that farmers and ranchers follow, the goals they seek, and the constraints by which they abide. Making explicit the values that underlie an agricultural system enables us to evaluate agriculture in relation to other values that are important for sustainability. This process is necessary in order to identify and transform unsustainable

practices. In other words, only if we know what social and scientific goods are being enacted can we judge their compatibility with the broader goals involved in sustainability.

A major value in Western agriculture, efficiency, is defined as a minimization of human labor – fewer "man-hours" – in order to produce ever larger harvests. The drive to reduce human labor has led to tremendous increases in the use of energy, mainly fossil fuels, and to the establishment of a particular type of farm. First, contemporary North American farms have become very large, often over 2000 acres. Such farms usually grow one or at most a few crops or raise only one species of animal. This reduction of diversity maximizes efficiency because you need fewer types of machines, but can create additional challenges, including the use of large amounts of artificial fertilizers and pesticides for plant production, and large amounts of waste in animal production. These farms employ very few people to work very large areas and thus rely heavily on large tractors and other machines. All these trends – stemming in large part from the drive for a particular kind of efficiency – have led to a number of secondary consequences. These include the depopulation of rural communities, the loss of topsoil and biological diversity, and the contamination of soil, water, and air. A number of observers have criticized the social, environmental, and economic consequences of the industrial model for modern agriculture while pointing out that this kind of farming, along with its effects, has arisen not accidentally, but because of a particular view of what values to prioritize and what goals to seek. It is possible to define efficiency in different terms, for example, in relation to the use of energy. Aiming for that sort of efficiency might lead to smaller, more diverse, more labor-intensive farms that have much smaller carbon footprints – farms, in short, that succeed according to economic values that are not dominant in Western agriculture today.

Another important and related value for modern agriculture (and many other economic undertakings) is productivity, which also entails implicit ethical priorities and generates consequences that are not always benevolent. From the perspective of social justice, the drive for productivity often leads to pressure for fewer workers to create more goods and services, which can lead to higher unemployment rates and inequities between different levels of workers, as well as stress for those doing the work. Further, environmentalists point out that the high volume goals of productivity demand ever-increasing levels of consumption, which consumes natural resources and produces more waste. However, productivity, like efficiency, can be defined in more than one way. Productivity might mean meeting people's basic needs with a minimal expenditure of energy and labor. Seeking this sort of efficiency would shift economic priorities away from continual increases in production and consumption and toward the fulfillment of other goals, such as equitable distribution of resources, greater community solidarity, and increased leisure time.

These examples show how economic and social goals are intertwined. Decisions about economic processes and institutions inevitably favor one social good or another, which can ultimately favor one social class over another. Sustainability involves social and economic values that are not priorities in contemporary U.S. society (or many other

societies). Agriculture, again, provides an illuminating example. Large-scale, fossil fuel-intensive industrial farms rarely promote the social, economic, or environmental values that are central to sustainability. Unless those values are made explicit, however, it is impossible to evaluate concrete practices and institutions or to develop alternatives. Simply establishing standards does not, of course, necessarily lead to real life changes. It may, however, constitute a necessary step in the movement toward more sustainable farms and ultimately toward more sustainable societies. In order to pursue these goals, professionals, scientists, policy makers, and citizens need accurate information and the analytical tools that can help them to clarify the ethical dimensions of sustainability and evaluate various decisions, projects, and in relation to those values.

The third kind of ethics is involved in sustainability, **environmental ethics**, can be defined as philosophical reflection on and arguments about the value of non-human nature. Environmental ethics may be concerned about entire ecosystems or regions or with smaller units such as species, individual non-human animals or plants, or landscape features such as mountains or forests. Questions about the value of non-human nature and its relations to other moral goods have predictably been important to philosophers, theologians, and naturalists for centuries. Environmental ethics in the West is shaped in particular by the work of Henry David Thoreau, who argued that human goods cannot be realized in isolation from nonhuman nature, and John Muir, who celebrated the intrinsic value of nature (especially wilderness). However, the usual starting point for environmental ethics is identified as the publication of Aldo Leopold's book *A Sand County Almanac*, including his essay "The Land Ethic," in 1949. Leopold argued that any ethic must rest upon the premise that "the individual is a member of a community of interdependent parts," and that an environmental or "land" ethic "simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land."[3] Today environmental ethics is a large and diverse field, with a number of subfields and approaches (including contemporary revisions of Leopold's land ethic)--these will be discussed in more detail in Chapter Seven of this book.

Here the most important point to make regards the relationship between environmental ethics and the ethics of sustainability. This relationship is often left ambiguous, and when it is specified, it takes several different forms. Sometimes "environmental" is treated as a synonym for sustainability, in which case an ethic of sustainability would be virtually identical to environmental ethics. This is the case for some environmental philosophers, including Bryan Norton, whose book *Searching for Sustainability* is subtitled "Interdisciplinary Essays in the Philosophy of Conservation Biology."[4] Norton's more recent book, called simply *Sustainability*, is subtitled "A Philosophy of Adaptive Ecosystem Management." For Norton, and for a number of other environmental philosophers, sustainability is first and foremost about conservation of and attitudes and practices toward non-human nature.

Another view would define sustainability as a subset of or specific approach within environmental ethics. In this approach, an ethic of sustainability would be identified with

environmental philosophies that emphasize social and economic issues, such as environmental justice and human health issues. Some of the more **anthropocentric** (human-centered) approaches in environmental ethics thus might be understood as "sustainability" ethics. One example of this is the work of Ben Minteer, who argues that environmental ethics should be identified as a kind of "civic philosophy" that emphasizes "long-term human interests, such as a concern with the well-being of future generations."[5] Minteer rejects **nonanthropocentric** (**ecocentric** or **biocentric**) ethics, which find intrinsic value in non-human nature apart from its usefulness to or appreciation by humans. While nonanthropocentric ethics often focus on wilderness and other aspects of nature apart from human goods, Minteer makes social, economic, and political concerns central to environmental ethics.

While both these approaches can be found in the literature on environmental (and sustainability) ethics, neither is adequate for the goals of this book. Here it is most accurate to understand environmental ethics as one part or subset of sustainability, corresponding to the environment as one of sustainability's three key dimensions. This approach is evident in the organization of this chapter, in which social, economic, and environmental ethics are discussed as distinctive subfields, all of which contribute to the integrative whole that constitutes an ethic of sustainability. This effort at integration is one of the most distinctive, and sometimes most difficult, aspects of sustainability. The attempt not only to include but to integrate social, economic, and environmental values makes the ethics of sustainability both especially challenging and especially promising. In its moral as well as practical dimensions, sustainability does not mean simply accumulating a list of divergent goals. Rather, it requires efforts to find common ground when possible and to adjudicate between different values and goals when necessary. Difference does not necessarily mean incompatibility or competition, however, and in fact sustainability rejects simplistic dualisms between social and environmental goods. Thus a sustainable ethic is holistic, in theory, insofar as it is guided by a vision in which social, economic, and environmental values not only coexist but, in many cases, reinforce each other.

In many concrete situations, however, different ethical concerns and goals cannot be integrated harmoniously, and choices must be made about which to prioritize. This is perhaps especially true for an ethic of sustainability, which explicitly takes into account distinctive and sometimes conflicting goals of social justice, economic efficiency, and environmental integrity. In order to address conflicts and ambiguities constructively, it is not enough simply to have ethical principles or rules. A clear and well-considered process of ethical decision-making is also required in order to understand the issues at stake, the options available, and the potential consequences of various decisions. In the final sections of this chapter some of the most important aspects of ethical decision-making are addressed in relation to problems of sustainability.

ETHICAL CONCERNS IN SUSTAINABLE DECISION-MAKING

Ethical traditions, both religious and secular, provide tools for thinking about difficult issues in a complicated world. They are thus a vital element of effective and successful decision-making processes. This is especially important for sustainability, which seeks to

integrate diverse and sometimes conflicting ethical and practical goals. Sustainable decision-making involves a number of factors, many of which are discussed in detail in the next chapter. In this chapter, we look at the distinctive contributions to that decision-making process that might come from ethics as a philosophical subfield.

Ethics can help people identify the values that are most important to them and analyze possible actions or outcomes in relation to these values. However, ethics is not simply about applying pre-established rules to clear-cut situations. First of all, multiple values are involved in many decisions, and certainly in those that aim toward sustainability. Thus the choice is never just between good or evil but rather among various goods. Further, the relationship among different goods is almost always complex. Rarely do genuine goods stand in such stark opposition to each other that the choice is a simple one between, for example, jobs or endangered species. Anyone who frames complicated decisions in such dualistic terms is usually obscuring or ignoring important pieces of the problem.

The issue of how to frame ethical problems in constructive and fruitful ways is vital but underappreciated – it is especially relevant for problems of sustainability, where popular discourse often defines problems as stark choices between economic or environmental goods. In such situations, one of the most important tasks of ethics is asking questions that help lead to good solutions. The philosopher Anthony Weston notes that "if we are to find the best solutions to our ethical problems, we first need to find the best *problems*."[6] Better framing of ethical issues makes it possible to avoid obstacles that frequently prevent people from arriving at solutions that maximize diverse goods. One of the most common obstacles, in both popular and scholarly ethics, is the tendency to conceive of decisions as dilemmas with only two mutually exclusive and opposed solutions. When people stop thinking in terms of dualistic choices, they may engage in creative searches for alternative solutions that do not require the sacrifice of important values. In searching for sustainability it may be possible both to preserve wildlife habitat and to increase economic security for local residents, for example, by thinking creatively about developing more sustainable kinds of jobs, adopting different farming methods, or protecting land through innovate means such as wildlife corridors. Such expansive solutions will not be possible, however, if decision makers understand economic and environmental goods as mutually exclusive and thus see their moral choices as between two diametrically opposed alternatives.

Another common obstacle to good ethical solutions is reactive thinking, or what Weston calls "freezing." In such cases, people simply try to cope with and adapt to a problem after it has developed. Instead of responding after the fact, Weston proposes that people think preventatively, asking whether ethical problems can be changed, made less serious, or even eliminated.[7] This call for proactive thinking is especially relevant for sustainable planning and design, endeavors which can help to maximize both environmental and social goods. Rather than cleaning up after people have made bad choices, in other

words, an ethic of sustainability can help make good choices more affordable, attractive, and convenient.

Maximizing goods is not always possible, of course. In real life situations, people often face decisions about what goods to prioritize, given multiple values and limited resources with which to pursue them. Ethical questions arise, in other words, not when there is an easy choice between a good solution and a bad one but rather when real values conflict and it is not possible to preserve them all to the extent desired. Such situations arise frequently in the context of sustainability, which strives to incorporate a range of social, economic, and environmental values in complex situations. Not infrequently, for example, environmental values such as the preservation of wildlife habitat conflict with social or economic goals such as the production of a larger food supply or low-cost housing. In such situations, the goal of ethics is to help resolve conflicts as constructively as possible. In such cases, the best decisions will be based on a number of factors, including good knowledge (scientific, economic, and cultural), an understanding of the history of the situation, accurate information about the likely outcomes of various decisions, a careful weighing of the different values involved, and efforts to frame the problem in a way most likely to maximize as many important values as possible. All these factors, in turn, will be facilitated by wide participation by the different individuals and groups affected by the decision. Democratic processes and open, fair political institutions are not only goods in themselves but also prerequisites for achieving a host of other goods.

While no ethic (or ethicist) is perfect, an adequate ethic of sustainability must strive to fulfill these conditions and principles. Understanding the history of ethical thinking and contemporary discussions of ethics can help decision makers understand the various options, the implications of each, and the ways to balance or maximize the diverse goods at stake. And even more basically, ethics can help us understand why sustainability is both important and feasible, for ordinary citizens as well as policy makers, scientists, and other professionals. These issues will be discussed in more detail in both Chapter Four, on the process of decision-making, and Chapter Nine, on turning ethical decisions into professional practices.

PRINCIPLES OF AN ETHICS OF SUSTAINABILITY

While an ethic of sustainability will rightly vary according to culture, context, and a host of other factors, it is possible to outline some of the key features that an adequate ethic of sustainability should possess to some degree.

First, it should be theoretically coherent. This means that the grounding assumptions, the form of argumentation, definitions of key terms, and goals should be consistent throughout, and the use of evidence persuasive. Related to this, an adequate ethic must be both clear and consistent with regard to its philosophical foundations about issues such as the definition of humanness, the source of value (transcendent, natural, or other), and the philosophical scope or aims of the ethic itself. Of particular interest here is the relation between knowledge and moral claims. Philosophical questions about knowledge are contained in the subfield of **epistemology**, which asks about the sources and nature of

particular kinds of knowledge. In relation to sustainability, scientific and social knowledge is especially important. An ethic of sustainability must also have clear and coherent interpretations of key foundational issues. Further, since the goal of sustainability is by definition oriented toward the future, an ethic of sustainability must take into account the relations between present and future generations (both human and non-human).

In addition, an ethic of sustainability, like any social ethic, should address the question of rights or interests. A deontological ethic is more likely to assert that people (and perhaps non-human animals, plants, or places) have rights, while a Utilitarian ethic speaks of the interests that people or animals have in, for example, avoiding pain or seeking pleasure. In both cases, individuals and groups may incur duties or responsibilities in relation to the rights and interests of others. A coherent ethic must be clear about the foundational grounds for asserting the existence of rights or interests, the reasons for speaking of one or the other, the particular ethical claims that will be met, and ways of adjudicating between conflicting rights or interests.

Finally, an ethic of sustainability should be feasible or practical. The purpose of an ethic of sustainability is to help guide people in their efforts to address real world problems and to build more socially, environmentally, and economically sustainable institutions, practices, and societies. An ethic of sustainability cannot succeed only in the realm of theory, because, as Kant famously declared, ought implies can.

Ethical Principles

In addition to these general characteristics, an ethic of sustainability must address a number of specific principles, which help fill out the most important values of sustainability in relation to social, economic, and environmental concerns. Obviously, not all ethics of sustainability will be identical in relation to these issues. They will develop divergent positions on these issues, rank them in different orders of priority, relate them to each other differently, and add additional points. However, an adequate and complete ethic of sustainable must deal, in some way, with the following principles.

From social ethics, the most important principles for sustainability concern justice and obligations to future generations. Justice is a longstanding theme in Western social ethics, perhaps its most distinctive and defining value. In the *Nichomachean Ethics*, Aristotle famously defined justice as a virtue, which, like all the virtues of classical Greek philosophy, constituted a mean between two undesirable extremes. Justice is the mean between two different kinds of injustice: the injustice that takes too much and that which takes too little. Building on Aristotle, classical Western ethics has come to define justice as ensuring that each receives his or her due – neither too much nor too little. Aristotle and subsequent philosophers have identified several specific types of justice: procedural (or formal) justice--which entails fair processes in governance--criminal justice, and other social practices and institutions, including the allocation of resources. **Procedural justice** establishes rules and standards by which these decisions are made, which is

necessary to ensure both political democracy and the rule of law. Standards of procedural justice are crucial for sustainability since a society cannot be sustainable, many argue, when it is characterized by unjust political systems, lack of openness and transparency, limited access to participation in decision-making, and individualistic rule – all evidence of failures of procedural justice.

The two other important kinds of justice for sustainability are distributive and substantive. **Distributive justice** is concerned with the fair or correct distribution of goods in a society. For an ethic of sustainability, attention would have to be paid not only to social and political goods such as housing, health care, food, and political power, but also to environmental goods such as clean air and water and perhaps access to recreational or wilderness land. Distributive justice, especially in relation to issues of international relations, is discussed more fully in Chapter Six.

While distributive justice is concerned primarily with the *relative* allocation of goods, **substantive justice** refers to absolute quantities. While distributive justice might insist that a small amount of food be shared equally among starving people, for example, the principle of substantive justice would seek to provide those people with an absolute amount of food adequate to their needs, not just with a fair share of an inadequate amount. Substantive justice has traditionally been less important in Western liberal philosophical and political traditions than formal and distributive justice, but it enters into many discussions of sustainability. A society that distributes an inadequate amount of food equally among all its members, for example, will not be sustainable, although it may be just (through distributive justice). A sustainable society must meet the principles of substantive justice by ensuring that people's basic material and economic needs are met.

Another important social principle for sustainability concerns obligations to future generations. This concern with the future is not central to some forms of social ethics, although it is often important in environmental ethics. The integration of social and environmental concerns in relation to future generations is a distinctive, perhaps even defining, feature of sustainability. Indeed, the term "sustain" itself suggests an ability to endure for a long period of time, and an ethic of sustainability is concerned with the values that must be embodied in a society that can last. For example, a society might exhaust its resources in a few generations while meeting all the demands of justice – procedural, distributive, and substantive. The obligation to leave future generations adequate material resources may demand significant restraint (even sacrifice from future generations), just as the obligation to leave them a fair, democratic society may require that great amounts of time and energy be spent in political action to create and stabilize the practices, laws, and institutions that characterize such a society. Obligations to future generations are discussed in more detail in Chapter Five.

In relation to economic ethics, the most important principle for sustainability concerns the regulation of markets in order to address the true costs of pollution and other social and environmental harms. This issue is sometimes summarized as the **polluter pays principle**, which [as first defined in Chapter Four] states that the individuals, communities, or businesses that create pollution must pay for the cost of removing it

rather than passing the cost of cleaning up that pollution to consumers or to society overall. The polluter pays principle, like many of the central tenets of sustainability, does not simply offer a guideline for a practical action but also represents important moral and philosophical points: requiring polluters – and others who damage natural systems – to pay for their actions suggests that people should properly be held accountable for the harm they cause to commonly-held goods, including non-human nature. The polluter pays principle reflects the values of larger ethical and political frameworks known as "natural capitalism" and "full cost accounting." While these two models are not identical, they both seek to create a more sustainable society through a free market system. These revisions would reduce or eliminate "perverse subsidies" that help make environmentally or socially unhealthy products inexpensive. Perverse subsidies are especially widespread in agriculture, though they exist in energy production and many other industries as well. Full cost accounting would not only cut perverse subsidies but also would eliminate the public funding of clean-up for polluting industries. Were businesses to lose perverse subsidies and pay their own clean up costs, they would no longer be able to offer certain goods for low costs, including certain types of produce grown thousands of miles from where it is consumed, beef, and gasoline, among others. When unsustainable goods became expensive, market principles would dictate that people would seek out goods that are "truly" inexpensive, because they do not have previously hidden costs. In a full cost system, for example, people would find food from small local farms much cheaper than food that is mass-produced far away because fuel and other costs of transporting food across country would no longer be subsidized. Eventually, a society with full cost accounting will become more sustainable as unsustainable goods become prohibitively expensive and fade away.

Some economic principles relevant to an ethic of sustainability go further in their revision of the market. The social mortgage is a Roman Catholic concept that asserts that all property, regardless of ownership, is part of a divine creation that was intended by God for the good of all people. If people use their private property only for private benefit, without concern for (or perhaps even to the detriment of) the common good, the larger society may call in the social mortgage. This principle was stated dramatically at the Second Vatican Council, in its final document, *Gaudium et Spes*, in a discussion of "the common purpose of created things": Because "God intended the earth and all that it contains for the use of every human being and people," the document asserts, all people have a right to "a share of earthly goods sufficient for oneself and one's family belongs to everyone." This means, first, that people are obliged to help the poor and needy and, further, that if such help is not forthcoming, and if a person is in extreme necessity, "he has the right to take from the riches of others what he himself needs."[8] The notion of a social mortgage places a much more severe constraint upon the market and private property than does the notion of full cost accounting.

A number of principles from environmental ethics must also be taken into account in an ethic of sustainability. Most generally, sustainability highlights principles that integrate concern for both human welfare and natural systems. Other aspects of environmental

ethics, including concern for wilderness and discussions of the intrinsic value of ecosystems or natural organisms, receive less attention in relation to sustainability. One of the most important environmental principles for sustainability is the **precautionary principle**, [defined in Chapter Four]. The precautionary principle was formulated to address scientific and technological projects that may have effects on environmental and public health. In its simplest and most general form, the precautionary principle states that in the absence of a strong scientific consensus that an action or policy will not cause harm to human health or the environment, caution should be used in implementing that action or policy. Strict adherence to the precautionary principle would prevent the use of pesticides whose wider ecological effects are not understood, for example. It might also restrict damaging use of certain resources or landscapes – such as mining or grazing – if there is no certainty that the damage can be reversed.

The precautionary principle places the burden of responsibility on those who would act rather than on those who must, after the fact, suffer from or attempt to reverse harm done by new or unproven scientific procedures. Like the polluter pays principle, it reflects larger ethical claims. It assumes that progress or innovation is not an absolute value; that individuals and organizations are responsible for the possible, not just likely, effects of their actions. The precautionary principle also reflects a particular understanding of the relationship between knowledge and morality, insofar as it identifies as immoral actions that are taken without full knowledge of their possible outcomes. The precautionary principle has been widely affirmed by environmental groups and is central to sustainability, as Chapter Five discusses in more detail.

Related to the precautionary principle is the **reversibility principle**, [first defined in chapter Four], according to which scientists or policymakers should not proceed on a potentially harmful course unless its consequences can be reversed. People should not make decisions, other words, that cannot be undone by future generations. A primary example of an irreversible action is the extinction of species. Again, this principle reflects larger ethical claims: that people owe obligations to future generations (and perhaps to non-human nature) and that immediate desires or interests should not be satisfied at the expense of the interests of future generations.

As central tenets of sustainability, the polluter pays, reversibility, and precautionary principles all assert that those who are responsible for implementing technologies must be prepared to address the possible consequences of their implementation. They also require decision-makers to consider as many different options as possible before acting and to consider as fully as possible not just the likely but also the possible outcomes of those actions. They assume, further, that scientists, policy makers, and other citizens must consider both future human generations and non-human nature as part of their deliberation. Individual human interests, even the collective interests of a particular group or generation, are not absolute; they are significantly limited by obligations to other people, including those not yet born, and even to non-human nature. As specific statements of some of the major values of sustainability, then, these principles add concreteness to some of the more general guidelines for ethical decision-making outlined earlier in this chapter.

CONCLUSION

A distinctive aspect of sustainability is the attempt to integrate a diverse set of ethical principles and goals in both theory and practice. Sustainability is not simply a patchwork of disparate values but an integrated system in which the parts work together to reinforce each other. In the case of potential conflicts between, for example, environmental and social principles, an ethic of sustainability should not simply choose one or the other but rather should attempt to maximize both values to the extent possible. This may require considering a wider range of options than usual, including some that might not normally seem desirable or feasible. It may require engaging in dialogue and reaching compromises with individuals or groups that are not one's usual conversation partners. Implementing the values of sustainability might even demand considerable sacrifice of other interests, both private and collective. In this delicate and difficult task, established traditions of ethical thinking offer invaluable resources and insight. They can help to identify the values at stake and clarify the knowledge and assumptions that undergird and justify these values. On a practical level, ethics provides tools that can help people seeking sustainability to adjudicate conflicts, set priorities, and seek consensus or compromise. The aim of this chapter has been to provide information and ideas that can aid in these tasks, and also to set the stage for the more detailed discussions that follow.

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END NOTES

[1] "Economic Justice for All" (http://www.osjspm.org/economic_justice_for_all.aspx

[2] Kant, *Foundations of the Metaphysics of Morals*, trans. L. W. Beck, 437. (Not sure why this jumps to #3.)

[3] Leopold 1949, 239.

[4] Norton, 2002.

[5] Minteer 2006, 194.

[6] Weston 1997, 29-30.

[7] Weston 1997, 39.

[8] Abbott 1966, no. 69.

CHAPTER 4
OBLIGATIONS TO FUTURE GENERATIONS AND THE PRECAUTIONARY PRINCIPLE

Most of the people that we have a moral responsibility to care about are not yet born. Yet it is precisely these people who will be the beneficiaries – perhaps the chief beneficiaries -- of an ethics of sustainability. That is the proposal this chapter asks you to consider.

There are nearly seven billion human beings currently living on this earth. Assuming that no massive catastrophes occur, however, the vast majority of people the planet will ever have known are yet to arrive. They will be our descendants – our children, grandchildren, great grandchildren and their progeny. Indeed, more people will be born in the lifetimes of the younger readers of this text – two billion more -- than currently inhabit the earth.[1]

The decisions we make and the actions we take today will affect the lives and livelihoods of these billions of future human beings. Every discovery we make and every innovation we produce is a gift we bestow on future generations. Our learning, moral and social development, economic prosperity, and technological progress provide our legacy to them. But we not only provide benefits -- we also bestow burdens. Every non-renewable natural resource that we consume leaves less for them. Every pound of carbon dioxide that we emit into the atmosphere contributes to the warming of a planet they will inherit. Every species we cause to go extinct they will never know, except as a loss. If we weigh the moral significance of an action by the number of people it potentially affects, then the impact of our actions on future generations ought to be of paramount concern. This is the realm of intergenerational justice, and it sits at the core of any ethics of sustainability.

It is easy to acknowledge our responsibility to future generations. In practice, however, it is the present that typically claims our attention. Former Vice-President Al Gore, who produced the academy-award winning film, *An Inconvenient Truth,* and won the Nobel Peace Prize, observed that we deplete the earth's natural resources and live unsustainable lives because "the future whispers while the present shouts."[2] A sustainability framework attempts to give equal voice to the future. It prompts us to consider the burdens we thrust upon our progeny as well as the benefits we bestow upon them. While living sustainably requires planning and precaution, it does not entail paralysis. An ethics of sustainability promotes caring about tomorrow, but acting today.[3]

INTERGENERATIONAL JUSTICE

At the heart of most ethical traditions lies a preoccupation with how moral concern is extended in social space. The individual is held responsible to care not only for his or her own interests, but also to consider the welfare of family, of neighbors, of fellow townspeople or citizens, and perhaps of humanity at large. Immanuel Kant's categorical imperative, which we addressed in Chapter 3, states that the rules or axioms guiding one's actions must be universalizable. That is to say, these rules of practice must remain consistent and applicable when extended across an indefinitely wide population. Jeremy Bentham's utilitarian ethics, though traditionally opposed to Kant's duty-based reasoning, also assesses action according to its capacity to be extended in social space. With Bentham's utilitarian calculus, however, the greatest happiness of the greatest

number of people -- rather than doing one's duty for its own sake -- constitutes the guiding principle. In turn, the ethic of the Golden Rule, variations of which are found within most religious and moral traditions, simply states that we should treat our neighbors the same way that we ourselves would want to be treated by them. Here, again, concern is extended beyond the self to larger populations in social space.

While the predominant concern for most ethical traditions has been the extension of moral concern across social space, a parallel -- if historically less salient -- concern has been the extension of moral concern across time. Justice is often thought to entail a fair distribution of resources between members of a particular generation with duty, utility, or a golden rule determining how these resources ought to be allocated. This might be thought of as ***intra*generational justice**. By contrast, and as an extension of this, ***inter*generational justice** is concerned with the fair distribution of resources between generations.

Virtually all ethicists insist that a person's moral worth should not depend upon chance. We would think it wrong, for instance, to privilege people who were born with blond hair while punishing those born with black, brown, or red hair. The date of one's birth is equally a matter of chance. The day, month, year, decade, or even century in which a particular individual is born might be considered as morally irrelevant as the color of his or her hair. It follows that any form of justice that we deem appropriate between the members of one generation might also be applicable between members of different generations. More specifically, the life prospects of members of future generations, given their equal moral worth, should not be worsened by us without some morally defensible reason. It is not at all clear that making ourselves better off today is morally defensible if these actions worsen the prospects of future generations. From this perspective, *inter*generational justice is simply a logical extension of *intra*generational justice: if the prospects of our descendents are worsened by our actions, we bear the burden of proof for justifying these actions. It is incumbent upon us to explain why we choose not to extend across time the same principles, rights, and responsibilities that we deem appropriate to extend across space.

John Rawls employs this sort of reasoning in making the case for intergenerational justice. Employing a Kantian framework, Rawls famously suggests that justice entails making decisions and taking actions from an "**original position**" where one finds oneself behind a "**veil of ignorance**."[4] From behind this veil, we do not know whether we are black-skinned or white-skinned, tall or short, healthy or ill, employed or unemployed, powerful or weak, rich or poor, German or Chinese or Haitian. Unaware of our class position and social status, our race, religion and nationality, our abilities, predispositions, and propensities, we would not design principles of justice that favored a particular social or personal condition. Not knowing what position in society -- or on the planet -- we occupied, we would establish principles of justice that were as fair as possible to everyone.

Behind the veil of ignorance, we would also be ignorant of our date of birth. We might, for instance, have been born fifty years ago, or only arrive in the world next century. It follows that we would design an ethics that was equitable to both current and future generations. In adhering to the principles of justice, Rawls writes, "we are not allowed to treat generations differently solely on the grounds that they are earlier or later in time."[5] In order for the ethical rules or

axioms guiding our actions to be truly universalizable, they must be acceptable to future as well as existing generations.

Leaving ethics aside for the moment, we might note that the development of a concern for future generations is not at all surprising from a biological point of view. And given that we depend on our descendents to carry forward our genetic material, it is not surprising that we concern ourselves with their welfare. Despite the most calculating, self-serving efforts, our physical bodies will disintegrate within a few score years. Hence individuals pursue a genetic form of immortality by way of the costly and often dangerous business of bearing and rearing offspring. In this light, seeking an extended life for our genes through children is a perfectly reasonable thing to do. When women risk their lives to give birth, and when parents make economic or other sacrifices for their children, they are, in some sense, pursuing their own genetic self-interest. The American poet John Trumball (1750-1831) famously doubted whether we owed anything to posterity, rhetorically asking "What has posterity done for us?" Biologically speaking, of course, posterity does a great deal for us. It allows us to live on beyond our four-score years. Posterity gives us a form of immortality.

To speak of progeny providing immortality for our genes is rather inaccurate. Unless we clone ourselves, our specific genes will not live forever, regardless of how many children, grandchildren, and great-grandchildren we have. A child bears only half of his or her mother's genes and half of his or her father's genes. A grandchild carries forward only one-quarter of each grandparent's genes, and a great-grandchild only an eighth. As genes disperse over the generations, the biologically-based bond to posterity weakens in geometric progression. The genes that we share with the great grandchildren of the great grandchildren of our great grandchildren will be only negligibly more numerous than those we share today with complete strangers living on the other side of the globe. By having progeny, we may leave our mark on future generations, but it becomes a very blurry mark.

Of course, concern for the welfare of future generations is not limited to concern for one's offspring. Rachel Carson, the eminent environmental writer who brought the dangers of pesticide use to national attention in the 1960s, highlighted our responsibilities for future generations. Like all prophets, she was much vilified by the powers that be, both within and beyond the chemical industry. A particularly vociferous critic questioned the motives for her action. Why was Carson so concerned for the long-term effects of pesticide use, he queried. After all, she was a spinster and had no children.[6] The critic missed the point: concern for future generations is a moral commitment that goes beyond the caring for offspring. Carson's concern for the future of humanity was not based on her love for a particular child or grandchild and the need to protect his or her prospects. Carson's sense of obligation to future generations, ultimately, was an ethical commitment that went beyond kith and kin.

SUSTAINABILITY AND FUTURE GENERATIONS

While an expanded time horizon is central to an ethics of sustainability, looking to the future has a long and venerable history that far predates contemporary sustainability concerns. Edmund Burke, the conservative 18th century British political thinker and parliamentarian, maintained that the state was "a partnership not only between those who are living, but between those who are living, those who are dead, and those who are to be born."[7] Given this partnership, Burke argued

that current generations ought to be mindful of "what is due to their posterity" and must, above all, refrain from wasting their inheritance. We have no right, Burke insisted, to pass on to future generations a "ruin" rather than a "habitation."[8]

In America, and with a very practical bent, the founding fathers also voiced their sense of obligation to future generations. Thomas Paine insisted that future generations ought not be saddled with the repercussions of former generations' choices. Both George Washington and Thomas Jefferson maintained that each generation must pay its own debts and that the failure to do so burdened posterity with deprivation and the threat of war.

Early national environmental laws and policies were explicitly grounded in ethical obligations that spanned generations. In the United States, for example, the landmark National Environmental Policy Act of 1969 issued the mandate to "Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations."[9] This intergenerational ethics became a cornerstone for environmental thought and action. One of the first official linkages of intergenerational ethics to the language of sustainability appeared in 1987. The World Commission on Environment and Development (aka the Brundtland Commission) famously defined development as sustainable when it "meets the needs of the present without compromising the ability of future generations to meet their own needs."[10] While arguing for economic development to improve the lives of the world's poor, the report's authors also wanted to ensure that current economic growth did not cause environmental damage that would burden future generations with diminished prospects. Current generations, the Brundtland Commission maintained, did not have the right to benefit economically while future generations were saddled with the cost of ecological reparations.

The World Commission aptly titled its 1987 report, *Our Common Future*. The title reflects two important facts. First, we live at a time of global interdependence, and these interdependencies are likely to grow. However separated and independent the lives of nations and peoples may have been in the past, the future will be one of entwined fates. In a shrinking world increasingly connected through global markets, media, environmental challenges, and intersecting cultures, the future will be a common one. Second, the destiny of this planet and the human species is a responsibility shared by all. Since our actions and interactions will create a common future, we have a moral responsibility to shape this future in ways that conform to common principles and ideals.

In 1997, a decade after *Our Common Future* first appeared, the General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) endorsed a *Declaration on the Responsibilities of the Present Generations towards Future Generations.* Explicitly employing the language of sustainability, the Declaration held that "present generations have the responsibility of ensuring that the needs and interests of future generations are fully safeguarded." Taking this responsibility seriously required that "each generation inheriting the Earth temporarily shall take care to use natural resources reasonably and ensure that life is not prejudiced by harmful modifications of the ecosystems and that scientific and technological progress in all fields does not harm life on Earth."[11] The UNESCO declaration was grounded in a sense of moral responsibility, but it was clear that such a statement of moral purpose demanded empirical foundations. Accordingly, the U.N. initiated the largest study to

date of the status of the earth's natural resources and ecosystems. After five years of research by more than 1300 scientists from 95 countries, the Millennium Ecosystem Assessment was completed in 2005.[12] The full report, over 2000 pages long, laid out in great detail how and why the planet's ecosystems may prove incapable of being sustained owing to the strains placed on them by contemporary humanity. The Millennium Ecosystem Assessment was grounded in a sense of responsibility to future generations.

Until the development of nuclear weapons, the question of the continued existence of the human race was not much of a practical or moral concern.[13] That all changed with the building and use of the first atomic bomb during the Second World War and the ensuing Cold War of the 1950s and 1960s. With considerable alarm, people witnessed the tremendous growth of the nuclear arsenals of the United States and the Soviet Union, the world's superpowers, and the proliferation of nuclear weapons among a number of other states. Scientists observed that an extended exchange of nuclear missiles would produce the instant death of tens if not hundreds of millions of civilians in the metropolises of the warring states, and many more deaths from radiation poisoning. In turn, the smoke and soot injected into the stratosphere by the burning of large cities would blanket the earth, drastically reducing sunlight and chilling the planet. Such a "nuclear winter," it was hypothesized, could produce the greatest climate change in the history of the human race. A new ice age might begin, destroying food supplies and wiping out great swaths of life. For the first time in human history, it was conceivable that civilization might actually destroy itself.

As if nuclear annihilation were not enough, a new worldwide threat was perceived in the 1960s. Overpopulation, widespread pollution, and the overconsumption of natural resources raised the specter of a global environmental collapse. A massive "die-back" of populations was predicted if current trends persisted, with the fate of civilization resting in the balance. In subsequent decades, the threat of global warming primarily caused by the burning of fossil fuels once again thrust the future of the human race to the forefront of moral debate. For many, climate change represents the largest and most pressing threat to civilization. Meanwhile, the development of self-replicating "nanobots" and genetic engineering, which might release virulent "designer pathogens," also poses grave dangers to our species. At the dawn of the twenty-first century, we must acknowledge that never before has the human race found so many ways to place the lives and livelihoods of future generations – and the fate of civilization itself -- in jeopardy.

Whether the continued existence of the human race is actually at risk is open to debate. Even the largest human-caused catastrophes may not result in the annihilation of the species as a whole or the complete destruction of civilization. Nonetheless, such disasters -- of large and small scale – will certainly affect the wellbeing of our descendents. The decisions and actions we take today, whether they produce global catastrophes, regional disasters, or isolated and incremental change for better or worse will impact the health and welfare of future generations and their opportunities to meet their needs and satisfy their wants. With this in mind, it is important to recognize that the rights of future generations are not limited to mere existence. What intergenerational justice asks us to protect are the rights of future generations to the same level of wellbeing and the same opportunities as are currently enjoyed by present generations.

To maintain such a quality of life across the generations, the use of natural resources must not exceed the earth's capacity to regenerate them. Consider the loss of ecological diversity that is now occurring on a massive scale across the globe. Currently, there are nearly 7 billion people on the planet. That figure might be compared with the 100,000 gorillas that still populate the earth, the 50,000 polar bears that walk our northern lands, the 10,000 tigers that have managed to survive in diminishing habitats, and the approximately 200 California condors clawing their way back from near-extinction. Other species are disappearing today at a rate one hundred to a thousand times greater than the so-called **background rate**, which is the natural rate of species extinction in the absence of human beings.[14] Species extinction today occurs primarily because of habitat loss or degradation as humans burn down, plough up, build upon, pave over, or pollute massive acreages of forests, scrublands, grasslands, wetlands, and coral reefs. Over half the world's wetlands and old-growth tropical and temperate forests are already gone. Loss of biological diversity is also occurring because of the introduction of exotic (invasive) species, which overtake and eliminate indigenous flora and fauna. Pollution of air, land, and water as well as overfishing, overhunting, and overharvesting are also major problems. Finally climate change increasingly appears to be playing a significant role in species extinction, and its contribution to the devastation will likely increase precipitously in the near future.

It is estimated, given current trends, that half of all living mammal and bird species today will be extinct within 300 years. Other studies are even more alarming: potentially half of *all* species may become extinct within the next century.[15] Species extinction on such a massive scale undoubtedly will jeopardize the welfare of future generations, and will severely constrict their opportunities. While the loss of biodiversity may not lead to the destruction of the human species as a whole or the end of civilization, it certainly will severely degrade the web of life that humans depend upon for their own sustenance, health, recreational pleasure, and spiritual renewal. The inescapable fact is that extinction is forever; once a species is extinct, it will never again grace the planet. Once this generation allows a species to disappear, future generations -- to the end of time -- will be deprived of the opportunity to enjoy its presence or otherwise benefit from its existence.

The biologist E. O. Wilson has said that "The one process now going on that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive."[16] This folly, Wilson predicts, "will be remembered by generations a hundred years from now, a thousand years from now."[17] Conservation biologist Michael Soulé observes that the problem is not solely the destruction of living species but also the elimination of sufficient wilderness space to allow for the evolution of new species. "For the first time in hundreds of millions of years," Soulé writes, "significant evolutionary change in most higher organisms is coming to a screeching halt."[18] Environmental scientist Norman Myers similarly maintains that:

> In addition to eliminating large numbers of species, we are also causing evolution to lose its capacity to come up with large numbers of replacement species.... [W]e are effectively saying that we are absolutely certain that people for the next 5 million years can do without maybe half of all of today's species. That's far and away the biggest decision ever taken by one generation on the unconsulted behalf of future generations since we got up on our hind legs.[19]

Of course, future generations can never be consulted as to whether they want or appreciate biological diversity or any other good. We shall address this difficulty in a subsequent section. For now, the point is simply that we hold the prospects of future generations in our hands. At an ecological level, many of those prospects are diminishing.

With this in mind, individuals and sustainability-oriented organizations have generally made a "future focus" central to their efforts. A popular slogan -- "We do not inherit the Earth from our parents, we borrow it from our children" -- underlines this sense of obligation.[20] Advocates for sustainability ask us to safeguard our children's natural inheritance, an inheritance that took hundreds of millions of years to evolve. Few who adopt the sustainability framework look that far into the future. But, at least in some cases, the future focus is quite expansive.

The Wildlands Project, by way of example, has the aim of preserving and expanding viable populations of the indigenous flora and fauna of the American continent through the creation of wilderness areas and corridors. The goal is to preserve or reclaim 25 percent of the land area of the continent, a goal project administrators acknowledge will only be achieved slowly, with 200- to 500-year projections for recovery in some areas.[21] The legacy of such conservation efforts is meant to endure for millennia.

Likewise, organizations dedicated to establishing sustainable population levels are similarly working with expanded time horizons. Forty years ago, there were half as many human beings on the planet as there are today. The human population of the world has grown ten-fold over the past three centuries and four-fold over the past century. The number of people the earth can sustainably support is much in debate. To determine the true carrying capacity of the planet, the average level of consumption per capita would have to be established. At current levels of consumption, the earth would be able to support far fewer Americans than Europeans, and far fewer Europeans than Asians or Africans. Still, analysts have suggested that the current population is already well beyond what the planet can sustain over the long term, and further growth in population will certainly exacerbate the problem. For individuals and organizations that focus on limiting or reversing population growth, the *quality* of life for future generations stands diametrically opposed to the *quantity* of people currently depleting the earth's resources.

The United Nations' most detailed studies and projections of national and global population growth reach to 2050.[22] By that time, or within a few decades of 2050, it is likely that population growth on the planet will have stabilized, probably around the 9-10 billion mark. With 3 billion more people likely to occupy the planet over the next 40 years, the level of the earth's biodiversity and a number of other indicators of environmental and social health and welfare are very likely to decline. Much of this environmental degradation and the ensuing social hardships will occur in our lifetimes. Sustainability is far-sighted rather than near-sighted, but its horizon of moral concern is not limited to the welfare of distant descendants. It also pertains to the future we will experience in our own lifetimes – whether that future is measured in weeks, months, years, or decades.

THE IMPACT OF TECHNOLOGY

In previous centuries, before the industrial age, human technology was relatively rudimentary. But, as Jared Diamond has demonstrated in his best-selling book, *Collapse,*[23] many rudimentary

technologies, coupled with short-term thinking, led to disastrous consequences. Simple iron, bronze, or even stone axes produced the deforestation of a number of ancient lands and the demise of entire peoples, such as those occupying Easter Island. Agriculture based on primitive mechanical methods of plowing and planting, prior to any use of artificial fertilizer and machinery, led to the widespread erosion and salinization of soil, bringing about the collapse of other ancient societies, such as the Anasazi of southwestern North America and the Maya of Central America. Diamond underlines that environmental destruction is not the sole, or sometimes even predominant, factor that leads to the collapse of civilizations. But, coupled with overpopulation, environmental destruction has played a decisive role in many instances. While technology is certainly implicated in these cases of social collapse, the technology involved was not particularly advanced. A little technology can go a long way in bringing agricultural, economic, and military benefits and in producing environmentally and socially disastrous consequences.

Technology makes our impact on future generations potentially more potent and of longer duration, so technology that produces greater and longer-lasting impacts would presumably demand greater oversight in its development and use if we take our ethical responsibilities to future generations seriously. Within sustainability circles, this measure of moral responsibility often goes by the name of a **"seventh generation" ethic**.

Prior to the European arrival in North America, a confederacy formed from the Mohawk, Oneida, Onondaga, Cayuga, and Seneca tribes in what is now Upstate New York. These confederated "People of the Longhouse," who came to be known as the Iroquois nation (and were later joined by the Tuscarora tribe), developed a "binding" oral constitution called the ***Haudenosaunee*** or **"Great Law of Peace."** The Great Law stipulated that one must consider the impact on future generations in every deliberation. Not only immediate effects, but also long-term risks, costs, and benefits extending over multiple generations were to be considered before taking any action. Decision-makers, the "mentors of the people," were described as having "endless patience" and skins with a thickness of "seven spans." This latter phrase has been interpreted to mean that their decisions attended to the welfare of seven generations. The Great Law asks all mentors and decision-makers to "Look and listen for the welfare of the whole people and have always in view not only the present but also the coming generations, even those whose faces are yet beneath the surface of the ground -- the unborn of the future Nation."[24] Benjamin Franklin and James Madison, two of the founding fathers of the United States, were said to have studied the Great Law of the Iroquois and looked to it in their own efforts to craft an enduring constitution for the young American nation.

Given the Iroquois' level of technological development (and population density), seven generations – approximately 150 to 200 years – would be an appropriate time scale for sustainable decision-making. It would be difficult to imagine any action that these tribal peoples might take whose effects beyond 150 years would not already be apparent within 100 or even 50 years. If the actions they took had no negative repercussions for seven generations, it was likely that they would have no negative repercussions for 70 or 700 generations.

The sme cannot be said today. Our technology has advanced in its power and scope, and with these advances come repercussions that extend their shadows across time. Consider a few examples.

Chlorofluorocarbons (CFCs) were invented in the late 1800s. In the 1920s, an American engineer, Thomas Midgley, improved the synthesis of CFCs, allowing for their widespread, commercial use as refrigerants (and later as solvents and propellants). In 1974, it was discovered that CFCs significantly contributed to the destruction of stratospheric ozone, a band of gas 9 to 22 miles above the planet that protects the biosphere from harmful ultraviolet radiation (UV-B). In the United States, CFCs were banned in nonessential aerosol products in 1978. Concerted action to stem CFC production and use, however, was not taken until scientists had discovered a growing "ozone hole" over the Antarctic. In 1987, an international treaty called the **Montreal Protocol on Substances That Deplete the Ozone Layer** was written. Two years later, the **Montreal Protocol** came into force and advanced industrial nations committed to producing no more CFCs beginning in 1996.

Production of CFCs fell markedly after the Montreal Protocol. Still, ozone depletion may get worse before it gets better sometime in the mid-21st century, as old chlorofluorocarbons continue to work their way up to the stratosphere where they may persist in their ozone-destroying reactions for many years before becoming inactive. That is why stratospheric ozone has continued to decline by about 4 percent per decade since the late 1970s. And there has been a much larger, seasonal decrease in ozone over polar regions – reaching up to 60% -- during this same period. As a result, photosynthetic processes will continue to be disturbed, aquatic plankton will be killed, and many of the earth's creatures, including human beings, will experience higher rates of skin cancer, eye cataracts, and other ailments for many more decades.

The international treaty developed in Montreal provided an inspiring example of international cooperation and foresight. Between 150 and 195 nations signed either the original document or its subsequent revisions. It has been very successful, and will eventually allow for the restoration of stratospheric ozone. Nonetheless, the fact remains that in little more than half a century, a life-protecting atmospheric layer that the Earth required 1.9 billion years to produce was significantly depleted.[25] The damage caused by this depletion of stratospheric ozone harms us today, and will continue to exert its negative effects upon future generations.

The stakes are even higher and the dangers are of longer duration when we examine the impact of radioactive waste. Radioactive waste is produced in the process of building nuclear weapons and making nuclear energy. A highly toxic material, radioactive waste must be isolated for many thousands of years to prevent contamination of the ground water, the earth's surface, and the air. Plutonium-239, the primary material used in nuclear weapons, takes a quarter of a million years to decay to safe levels -- that is fifty times longer than any civilization has yet survived, and longer even than *Homo sapiens* have walked the earth. Other radioactive isotopes, such as iodine-129, take 100 times longer than Plutonium-239 to decay.

When the U.S. Environmental Protection Agency engages in the regulation of the storage and disposal of radioactive waste, it must concern itself with timescales spanning ten thousand to one million years. With the decision in 2009 to discontinue exploration of Yucca Mountain in Nevada as a permanent storage site, the United States remains without a home for its growing

stockpile of radioactive waste, which currently sits in temporary, above-ground depositories. Inevitably, to produce radioactive isotopes today is to saddle future generations with the responsibility of disposing and monitoring a vast tonnage of hazardous material.

Many of the most pressing environmental concerns – climate change, the depletion of natural resources, and the eradication of species and habitats -- have ramifications that will exhibit their greatest force long after present generations are gone. And it is precisely the length of technology's shadow -- the amount of time before its repercussions make themselves fully felt -- that determines whether we are obligated to concern ourselves with the welfare of seven generations or seven thousand generations. Of course, the capacity of technology to affect the future is not always negative -- far from it. There are many enduring benefits, not just risks and costs, that must be considered when assessing the impact of technological developments.

Consider the internal combustion engine. Developed in the latter half of the 19th century, the internal combustion engine mixes fuel with an oxidizer, typically air, in a combustion chamber, typically a piston or turbine. This mixture is then ignited, causing the quick expansion of the fluid/gas mixture and producing the force to the piston or turbine blade that provides mechanical power. The invention of internal combustion engines allowed the development of an automobile industry that has transformed the planet. At the turn of the 20th century, there were less than 10,000 registered motor vehicles in the United States and not many more worldwide. By the late-1990s, 500 million cars were in use globally. Today, the figure is quickly approaching one billion. The internal combustion engines in these vehicles burn approximately 300 billion gallons of gasoline and diesel fuel annually.

The exponential growth in automobile use has caused a great deal of ecological destruction and pollution. Roads and highways bisect and degrade millions of acres of land. The tens of millions of automobiles produced and discarded every day represent a massive depletion of natural resources, a significant source of air pollution from factories, and a huge solid waste problem. Run-off of motor fluids and roadway chemicals is a major cause of water pollution. And, of course, the burning of fossil fuels in internal combustion engines produces hazardous air pollutants, including nitrogen oxides, carbon monoxide, and ozone that frequently blankets cities and contributes to poor air quality. Far from the least concern, over a third of the carbon-dioxide currently emitted in the United States comes the burning of fuels in internal combustion engines. Worldwide carbon dioxide emitted from internal combustion engines contributes a quarter of this potent greenhouse gas.

Of course, the story is not all bad. Before the use of automobiles, cities were also polluted from the mode of transportation in use then as manure from horses often clogged streets and sewers and the carcasses of dead horses found their way into nearby bays and rivers. Replacing horses with automobiles has also provided tremendous economic benefits. The automobile industry, as well as the thousands of other industrial, commercial, and domestic uses for internal combustion engines has proven a massive stimulant to economic growth and development worldwide. In turn, commercial transportation, recreational and business travel, food production and delivery, building construction, and so many other features of contemporary life have been accelerated and often much improved by the use of internal combustion engines. There are, in turn, manifold social and personal benefits. Indeed, it would be difficult – and for many individuals and

industries, rather frightening – to imagine life without the mobility, mechanical power, and independence afforded by internal combustion engines.

Whenever we assess the impact of technology, the story is seldom, if ever, all bad or all good. In each case, there are costs and benefits to be weighed and assessed. These costs and benefits are not uniform, either across social space or time; they vary depending upon the stakeholders involved. For example, snowmobiles may be a boon to people of northern climates who depend on them for transportation during long winter months. At the same time, snowmobiles may be a curse to outdoor recreationists who would much prefer to snowshoe or cross-country ski across winter landscapes unmarred by the sounds and smells of fast-moving machines.

The future-focus inherent to the sustainability framework does not eliminate the need to carefully weigh and compare these diverse costs and benefits. It does insist that one group of stakeholders must be well represented in any assessment. These stakeholders are currently without an effective say in the matter. Being very young or yet to be born, they cannot speak for themselves. Within the sustainability framework, future generations must be given a voice.

Importantly, future generations are not a homogenous group bearing identical interests. The future, like the present, will be populated with many diverse groups of people (as well as diverse species of plants and animals), each with particular interests and perspectives. Incorporating a future focus into deliberation effectively asks us to go beyond weighing the costs and benefits of our actions upon the wide array of current stakeholders. It presents the daunting task of accounting for an equally if not more diverse, and likely more numerous, population of future stakeholders.

DISCOUNTING THE FUTURE

We owe future generations a world that is not substantially diminished in its life-sustaining capacities. We are also obligated to pass on to them the benefits of culture and civilization. With this in mind, John Rawls held that

> Each generation must not only preserve the gains of culture and civilization, and maintain intact those just institutions that have been established, but it must also put aside in each period of time a suitable amount of real capital accumulation. This saving may take various forms from net investment in machinery and other means of production to investment in learning and education.[26]

In many respects, a great deal of capital accumulation – in terms of education, institutions, and infrastructure -- is always being passed on to future generations. But today we are also passing along tremendous amounts of financial debt.

In 2008, the per capita portion of the public or national debt amounted to $36,000. This is money owed on its citizens' behalf by the U.S. government to various domestic and increasingly foreign creditors. Much of the national debt will only be paid off in the lives of the youngest citizens and by future generations of Americans. Our collective decision to burden future generations with our financial debts might simply be an extension of our own willingness to incur personal debts that we struggle to repay over months and years. For most of the decade preceding the financial collapse of 2008, almost half of American families spent more than they earned each year. The average consumer debt – which includes credit card debt and other loans,

but does not include mortgages – nearly doubled in the decade preceding the financial collapse of 2008, reaching more than $8,000 for every man, woman, and child in the United States. This debt must be repaid in the lifetime of the debtor (or through liens on his or her estate immediately upon death) unless personal bankruptcy is declared – something that occurs in the United States at a much higher rate than any other country.

Rather than defer gratification, we often choose – as individuals and nations -- to live beyond our means. While the United States is in the top quarter of nations in terms of the size of its national debt as a percentage of its Gross Domestic Product (GDP), and while it borrows over half of all the money lent to governments in the world, there are scores of other countries, both developed and developing, that also find themselves deeply in hock. Why do people and nations take on such debt, choosing to enjoy the pleasures of immediate consumption while deferring the pain of repayment?

The answer is that the future whispers while the present shouts. Gro Harlem Brundtland described the loud and demanding voice of the present as "the tyranny of the immediate." Such tyranny may be more severe today than in times past, but it is by no means an invention of the 21st century. Indeed, the tyranny of the immediate played a central role in America's national history, which is, in many respects, the history of a frontier conquered for quick profit. A Scandinavian naturalist traveling in America in the mid-1700s observed that "the grain fields, the meadows, the forests, the cattle, etc. are treated with equal carelessness….. [T]heir eyes are fixed upon the present gain and they are blind to the future."[27] The problem of blindness toward the future, while perhaps heightened in the United States owing to its frontier mentality, is hardly restricted to the New World. The tyranny of the immediate is a basic feature of human nature. Economists call it a "positive time preference." Problems that will affect us today receive immediate attention; tomorrow's problems, while predictable, are likely to get ignored. The future, as economists say, becomes "discounted." The further an event is displaced in time, the more its value decreases.

Discounting the future often makes good economic sense. After all, a bird in the hand is worth more than one in the bush. A bird in the hand cannot fly away and is immediately available for use. It might lay eggs, effectively producing income for its owner. Discounting the future at a rate that reflects the inherent insecurities of future endeavors and the loss of income (or compound interest) from current goods certainly makes economic sense. The problem is that good economics often translates into bad ecology.

Would you prefer to be given $100 today or $121 in two years? Most of us would take the money now (and run). That represents a fairly standard discount rate of ten percent a year. Now consider an economic project that would create a $10 million depletion of ecological resources within the century. At a ten percent discount rate, that project would make economic sense as long as it produced a $725 profit today! You can see where this is going. As John Dryzek observes, "a system may be judged economically rational while simultaneously engaging in the wholesale destruction of nature, or even, ultimately, in the total extinction of the human race. The latter result holds because of the logic of discounting the future."[28] When costs of mitigating pollution, grappling with resource depletion, and responding to the effects of habitat destruction are shifted to future generations, and these costs are discounted by present-day

decision-makers, then today's economic rationality portends tomorrow's social and ecological disaster.[29]

So good economics today can become bad economics for future generations. It is natural for us to value a bird in the hand more than one in the bush, but when the bird in question is stewing in someone's cooking pot today, future generations who might have collected its eggs must go without. In such situations, the depletion of "natural capital" (the bird, or perhaps an entire species of birds) leaves future generations without the possibility of living upon the interest that natural capital generates (the eggs).

Natural capital is a stock of natural resources that yields an ongoing flow of natural goods or services. A stock of trees (i.e., a forest), for instance, produces timber that may be used for lumber, energy conversion, or paper products. A stock of water (e.g. a lake) may provide for drinking needs or industrial uses, a sink within which non-toxic wastes may be dispersed and reabsorbed, and fish for consumption. Such natural stocks, if utilized in a sustainable manner, may continue to produce valuable goods and services indefinitely. However, when the exploitation of a stock becomes too great, its natural resources prove incapable of regenerating themselves (fast enough). The natural "income" it produces – the flow of goods and services that would normally be provided indefinitely – becomes tapped out. At that point, any further exploitation exhausts the natural capital. As the stock is depleted, the income it generates also diminishes. In the long term, the depletion of natural capital leaves one without *both* capital *and* income.

If current generations are depleting natural capital, then future generations will face diminishing returns. The ethical upshot, as a national report entitled *Choosing a Sustainable Future* observes, is that current generations of natural resource exploiters are effectively "stealing the environmental capital of future generations."[30] Such ecological debts are created every time we degrade the natural environment or deplete its resources to the point that future generations are left with less than we ourselves inherited.

Our current predicament, then, is rather dire. Not only are we incurring large personal and national debts and depleting our financial capital, but we are also running up massive ecological debts, depleting the natural capital of the planet. Our descendants will be forced to pay these debts -- that is an injustice and some would say that it is also undemocratic. We may reasonably assume that future voters would not endorse their being burdened with reparations for debts made before they were born, debts whose benefits they never enjoyed. Had they a chance to vote on the issue, we may be assured that policies allowing such financial and ecological debts would not be approved. So intergenerational injustice is also an undemocratic process. As one spokespeople for sustainability insisted, "Ecologically responsible democracy must consider the rights of the true majority -- those billions of people as yet unborn."[31]

The depletion of natural capital may ignore the principles of justice and the principles of democratic politics, but it appears to be congruent with the principles of economics. "It is an economic fact that posterity never has been, and never will be, able to do anything for us," William Ophuls writes. "Posterity is, therefore, damned if decisions are made 'economically.'"[32] Of course, it is not only in economic affairs that human beings discount the future. To be sure,

businesses chiefly concerned with the bottom line in a competitive global marketplace are often focused on short-term profits at the cost of long-term sustainability. One might concede the inevitability of this myopia in the business world, taking solace in the hope that longer-term thinking predominates in other realms of life. But in the area of personal health, we know that individuals often let the short-term pleasures of comfort (watching television rather than exercising) and eating (too many fats and sugars and not enough fresh vegetables) jeopardize their long-term health.

Likewise, politicians today – though one might expect them to have extended local, regional, national or global interests at heart – are often equally myopic. Just as today's corporations may focus on quarterly earnings as they confront their self-interested shareholders, so politicians encountering electoral pressures may forgo long-term concerns and perspectives. The temporal horizon of politicians who face re-election in two to four years is often as short as the campaign sound bites they produce. In this respect, the rights of voters yet to be born often get ignored. Certainly, if current voters do not voice concern for the welfare of future generations, politicians will seldom respond to the needs of those yet to be born and yet to vote. As Sierra Club executive director Carl Pope observed, the vision of many politicians does not extend to "future generations: an irrelevant class of people who can't vote, aren't consumers, and don't have political action committees."[33] Just as business people react to a challenging marketplace, so politicians react to current pressure from powerful lobbyists and a demanding electorate. The future and its citizens typically get discounted.[34]

We face a special danger today: the economic, personal, and political discounting of the future may be increasing at precisely the time that technological innovations suggest the need for expanded time horizons. One of the first people to sound the alarm of this incongruity was Rachel Carson, whose book *Silent Spring* almost single-handedly jump-started the environmental movement. The message of *Silent Spring,* published in 1962, was as straightforward as it was disconcerting. Common pesticides of the day, such as DDT (Dichloro-Diphenyl-Trichloroethane), did not just kill pests; they also had the unintended and unexpected effect of decimating entire populations of other animals, including many birds. Absent its birds, Carson predicted American neighborhoods would face a silent spring, free not only of pesky bugs but also of avian singers.

Carson explained in great detail how the age-old attempt to gain "control of nature" through the use of pesticides was self-defeating because it failed to comprehend the intricate relationships that constitute "the whole fabric of life."[35] Carson insisted that pesticides should really be called *bio*cide*s* because they often prove lethal not only to the targeted insects or weeds, but also to many other forms of life or *biota*. Manufacturing and applying them indiscriminately was shortsighted; the pests might be abated in the near term, but many would adapt and return in force. In the meantime, ecosystems would be disrupted, other species would decline, and human health would suffer.

Only recently, Carson observed, has humankind gained the power significantly to alter the planet through technological means. That power is growing exponentially, as are its repercussions on the natural world. Carson insisted that we had a responsibility to future generations to pass on a diverse and life-supporting planet. In a chapter of *Silent Spring* entitled "The Obligation to

Endure," we read that "Future generations are unlikely to condone our lack of prudent concern for the integrity of the natural world that supports all life."[36] The ***obligation to endure*** created a ***right to know*** what was being done to undermine the fabric of life. Ultimately, Carson's efforts stimulated "Right to Know" legislation that allows people to learn what toxic chemicals are being produced and released in their counties and neighborhoods. **(List right to know websites here in box with brief history)**

Rachel Carson was predominantly concerned with the effects of pesticides and other industrial chemicals. "The most alarming assault upon the environment," she wrote, "is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials."[37] If we expand our understanding of "dangerous and even lethal materials" to include greenhouse gases, Carson's groundbreaking cry for caution and foresight, now a half-century old, is equally valid today. It well describes the ways we are fundamentally altering the climate and other life-support systems of the planet.

Most of the insecticides that concerned Carson, if applied to a field or lawn when *Silent Spring* was published in 1962, would have dissipated within their environments to relatively innocuous levels today (though they may have started lethal chain reactions). Today's greenhouse gas emissions, in contrast, may have their greatest effects – in terms of melting glaciers and icecaps, changing climate patterns and weather systems, and disrupting ecosystems – 50, 100, or 500 years down the road. While the devastation may begin in as little as a few decades, the technologies that have allowed us to burn massive amounts of fossil fuels will likely continue to exert their effects on the planet for centuries to come.

As technology extends the impact of our actions across the reaches of time, we would presumably require, in compensation for this increased power, a heightened sense of *moral* responsibility for the welfare of distant progeny, a heightened *scientific* ability to predict the long-term effects of our actions, and a *heightened political* capacity to address these effects and their causes. The ethics of sustainability cultivates this heightened sense of moral responsibility. Science will continue to advance and presumably grow in its power to predict chains of causal relationships. However, if history is any guide, we must assume that its ability to stimulate technological advances will remain more powerful than its ability to predict the social and ecological effects of these advances. Our political capacity to address the causes and effects of human technology is very much an open question, but there are reasons for hope and clear means for improvement. We will address these reasons and means in Chapter 6.

For now, we will explore the challenges associated with the development and adoption of **the Precautionary Principle**. This principle is meant to help define our moral responsibilities to future generations, stimulate scientific inquiry into the effects of our actions, and cultivate the political abilities to control these effects while at the same time acknowledging our limitations.

THE PRECAUTIONARY PRINCIPLE

As was briefly mentioned in Chapter 1, the Precautionary Principle is often considered a foundation stone of an ethics of sustainability. But prudence, the virtue that sits at the core of the Precautionary Principle, far predates the rise of sustainability as a global ethic in the 1980s. Words of wisdom handed down through the generations testify to the widespread endorsement of

the ancient virtue of prudence. We have long heard that "a stitch in time saves nine." Our grandparents shared with us the counsel "better safe than sorry." And the wise throughout the ages have informed us that "An ounce of prevention is worth a pound of cure." The latter aphorism may date back as far as the first century BCE, when Cicero, the ancient Roman orator and statesman, wrote that "Precaution is better than cure."[38] Prudential thought and action, Cicero believed, was the hallmark of good government and the most important public virtue.

To wait until a crisis is upon one before responding is to act imprudently. In many cases, it is to act too late. Things broken cannot always be fixed. Prudence is the virtue of avoiding crises whenever possible and adequately preparing for them whenever necessary -- that is to say, prudence requires acting with the future in mind so as to preempt the need for reparation or regret. Elder statesmen of both conservative and liberal leanings have long endorsed our obligation to prepare for and care for the future. Precaution is the chief means to fulfill that obligation and prevent the need for painful cures.

Implicit endorsements of principles that promote precaution as a means of safeguarding prospects and opportunities for future generations may be found in many legal documents that predate the actual formulation of the Precautionary Principle. The environmental laws codified in the United States in the early 1970s, for instance, such as the **National Environmental Policy Act (NEPA)**, the **Endangered Species Act**, and the **Clean Water Act**, embody a precautionary approach. NEPA requires that projects receiving federal funding first undergo an environmental impact study that demonstrates that there are no safer alternatives. The Act mandates:

> the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may … fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.[39]

Safeguarding the future was the central value of early environmental legislation.

The actual term *precautionary* can be traced back to the German word *Vorsorge*, which means *care for the future*. The first national legislation explicitly articulating a precautionary principle, a ***Vorsorgeprinzip,*** was enacted in the Federal Republic of Germany in the mid-1970s.[40] Targeted at the protection of clean air and the preservation of forests, policies invoking a *Vorsorgeprinzip* outlined the need not only to ward off imminent hazards and repair damage but also to protect environmental resources from *anticipated* hazards and damages. Importantly, such hazards and damages, though anticipated as possible, were not certainties. They did not have to be scientifically *proven* as *inevitable* consequences of (intended) actions. Rather, the precautionary principle entailed taking preventative action to protect natural resources even before scientific research had fully established a clear, causal link between potentially harmful practices and environmental damage.[41]

The "Earth Summit," which brought representatives from 172 national governments and over 100 heads of state to Rio de Janeiro, Brazil in 1992, produced the first truly international agreement that explicitly articulated and endorsed a precautionary principle. Principle 15 of **the Rio Declaration** states that "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of

serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[42] The Rio Declaration gave precautionary thinking and action its first truly global forum. In the United States, later that decade, **the President's Council on Sustainable Development** expressed support for the precautionary principle, stipulating that "even in the face of scientific uncertainty, society should take reasonable actions to avert risks where the potential harm to human health or the environment is thought to be serious or irreparable."[43]

In 1998, scientists, lawyers, environmentalists, and philosophers gathered at **the Wingspread Conference** to develop a formal definition of the Precautionary Principle. This definition has become one of the most frequently cited and employed. The Wingspread Statement read as follows: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof."[44] In this and many other definitions of the Precautionary Principle there are two main clauses.

First, regulation aimed at preventing harm to the welfare of current and future generations should not be precluded owing to (scientific) uncertainty of the precise mechanisms by which the intended actions may cause the anticipated harm. Second, the proponents of an activity, rather than those who might be harmed by (the unintended consequences of) an activity, are required to demonstrate that the level of risk associated with it is acceptable. Effectively, the precautionary principle shifts the burden of proof. No longer do the potential victims have to demonstrate that an activity is unsafe. Instead, the proponents of a potentially dangerous activity have to demonstrate, beyond all reasonable doubt, that the activity is harmless.

The Precautionary Principle has been formally employed in Germany and other European countries since the mid-1970s. It has subsequently been cited, advocated, and implemented around the globe in hundreds of national policies, national and international legal bodies and court cases, and legally binding multilateral protocols, agreements, and conventions. It has also been employed by the **International Court of Justice**, the **International Tribunal for the Law of the Sea**, the supreme courts of various countries, including Canada and India, **the Maastricht Treaty of the European Union**, and many resolutions of the European Parliament.[45] The precautionary principle has also been cited and advocated by international non-governmental organizations, such as Oxfam, and international governmental organizations, such as the World Bank. With the dangers of climate change specifically in mind, for instance, the World Bank stipulates that "When confronted with risks which could be menacing and irreversible, uncertainty argues strongly in favor of prudent action and against complacency."[46]

The precautionary principle has also been referenced in many non-legally binding national and international declarations, resolutions, and decisions that encourage but do not enforce specific actions. These agreements rest on voluntary compliance.[47] In turn, the principle has also been advocated and implemented voluntarily by scores of corporations, including H&M, an international clothing retailer, and Dell, the computer manufacturer. Such corporations employ the precautionary principle in their efforts to screen hazardous chemicals from their products.[48] Wal-Mart, the world's largest retailer serving more than 175 million customers a week in over

7800 stores around the globe, also explicitly embraces "the spirit of the Precautionary Principle." The suspicion that an ingredient in a product it sells may harm the environment or human health will prompt a search for alternatives.[49]

Skeptics claim that the precautionary principle has been so popular precisely because it remains vague. It allows institutions and organizations to give voice to their environmental values without binding them to any particular set of actions. The vagueness of the principle consists in the fact that it does not spell out what level of risk is tolerable or acceptable, to whom, when, or how such risk should be avoided or mitigated.

For instance, the careful reader will have noted that Principle 15 of the Rio Declaration states that the precautionary approach should be "widely applied by States according to their capabilities." The clause allows states to implement the precautionary approach "widely," which is to say, selectively rather than universally. In turn, the implementation of the approach depends upon their "capabilities." The determination of whether a state has capabilities – the economic capacity, technical know-how, or political will – to implement and enforce a precautionary approach is for government officials themselves to decide in each instance. Obviously, this clause allows national governments a great deal of wiggle room in their efforts to employ precautionary standards.[50] Some have argued that it renders the declaration effectively toothless. The same might be said about any number of the other international declarations and agreements that cite the precautionary principle but do not spell out specific procedures or parameters for its implementation.

In this respect, the precautionary principle is like many other ethical principles: it is a general code of conduct outlining the ideals that are meant to guide action. It is not a specific policy statement providing enforceable rules for specific cases. As **the World Commission on the Ethics of Scientific Knowledge and Technology** observed, the precautionary principle "is not a decision algorithm and thus cannot guarantee consistency between cases. Just as in legal court cases, each case [that applies the precautionary principle] will be somewhat different, having its own facts, uncertainties, circumstances, and decision-makers, and the element of judgment cannot be eliminated."[51] Lighting fireworks may be an acceptable level of risk for adults to take in their own backyard. It is not an acceptable risk to take at a gas station or in a dry forest. Likewise, certain forms of economic or technological development may produce different risks in different geographic regions. Building an airport may pose acceptable risks on the outskirts of most large cities, but may not if it intersects flyways of migrating birds or paves over habitat of endangered species.

What, then, does it mean to have a precautionary orientation? To act with precaution is to exercise one's best judgment so as to avoid unnecessary risk: one might say that precaution is a form of risk management.

ASSESSING COSTS, BENEFITS, AND RISKS

The precautionary principle has been criticized for leading to paralysis.[52] Faced with risks on all sides, those invoking precaution as their principle would find themselves unable to act at all. Risk is an inevitable part of life. It cannot be wholly avoided, only limited. The precautionary principle does not ask us to do the impossible by avoiding risk altogether. Rather, it asks us to

manage risks prudently.

To be sure, certain risks – which we may deem unnecessary or too grave – can be avoided altogether. One may personally avoid the risk of being caught in an avalanche, for instance, by staying miles away from snowy slopes. In avoiding or limiting certain risks, however, we inevitably increase others. Staying away from snowy slopes may leave you plying your way through city traffic, with all of its attendant risks. Likewise, medications taken to prevent certain illnesses we wish to avoid may cause other maladies, and some cures prove worse than the disease. By providing inexpensive, effective refrigeration, chlorofluorocarbons (CFCs) reduced the risk of botulism and other illnesses caused by the consumption of bacterially contaminated food. However, CFCs also depleted stratospheric ozone and thus increased risks for cataracts and skin cancer.

Risk management involves trade-offs. This is true of the risks we manage in our personal lives, as well as those we manage collectively, as members of societies and states. At the personal level, for instance, one might choose to drive to one's out-of-state vacation spot rather than fly so as to avoid the risk of an airplane crash. Of course, there are risks associated with automobile travel. Indeed, statistical data demonstrates that the chances of being in a fatal accident are greater for long-distance automobile drivers than airplane passengers traveling the same distance. An even greater risk would be associated with riding one's bicycle on a long-distance trip, though the benefit to health from the exercise might offset much of the increased chance of death by accident.[53] Faced with risks associated with every form of travel, one could always forgo the vacation and stay at home. Of course, there are also risks associated with staying at home. Never leaving the house may decrease risks of travel-related accidents. However, traffic accidents account for less than a quarter of all injury-related deaths in the United States, and unintentional injuries account for fewer deaths than heart disease, or strokes, or respiratory disease, or cancer.[54] So staying at home, particularly given the effects on one's psychological well-being and in all probability, to one's overall physical health from being a shut-in, may not be the safest bet.

The point is that risk is always comparative. Every activity, or lack of activity, incurs some risks. The only way to know whether a certain level of risk is acceptable given the benefits it provides is to compare it to the level of risk associated with other actions that secure similar benefits, or to the risks associated with the absence of any action aimed at securing such benefits.

Going on vacation is a personal choice. Many of the risks that we experience in our daily lives, however, are not voluntarily assumed. They are collective risks that we bear – whether we want to or not -- as members of societies and nations. No modern state could exist without imposing some involuntary risks upon its members. A state that provides the infrastructure for mechanized travel and allows fast-moving, polluting vehicles on its roads effectively imposes involuntary risks to the health and safety of most if not all its members, whether they are drivers, passengers, bicyclists, pedestrians, or urban dwellers.

The imposition of involuntary risks is also associated with food production, healthcare provision, and virtually every other facet of modern life. These risks may be mitigated, but they cannot be wholly avoided. Involuntary risks confront us the moment we sit down to breakfast or set our

foot out the door. And we do not only suffer these risks as potential victims -- we also co-produce them. We are all implicated in creating and heightening environmental and other risks by our participation in social and economic life. We increase risks to pedestrians and cyclists every time we drive our cars. We potentially increase risks to current and future generations every time we create, produce, or deliver a technological product or service.

The effort to measure comparative risk may be seen as part of a more encompassing exercise called **cost-benefit analysis (CBA)**. CBA typically weighs the economic costs of proposed actions (or restrictions of action, such as regulations) against the economically quantified benefits that such actions (or absence of regulations) produce. Costs are usually understood to be primarily economic. But one might also include non-economic costs in one's calculations, such as risks to health and welfare. Indeed, risks are often measured in terms of the economic costs of repairing damage done by the offending action. Maintaining public health in the face of pollution-induced disease, for instance, might be measured in terms of the costs of medical care to treat these diseases and the cost of productive workdays lost to sickness and early death. For this reason, cost-benefit analysis is sometimes called **"risk-cost-benefit analysis" (RCBA)**. RCBA is defined as an assessment that "incorporates notions of probability and uncertainty as a basis for estimating technology and environment-related risks and for determining their values as costs."[55]

CBA is grounded in the assumption that everything has a price and is for sale. Yet spending money to treat disease or to compensate bereaved families and businesses does not produce the same level of human welfare as would be obtained by preventing disease in the first place. In turn, pricing out the costs of environmental hazards or destruction does not address the potential infringement of the rights of those harmed. Some "goods" are simply not for sale: we cannot legally sell our votes in an election and we cannot legally sell ourselves into slavery. Certainly, we would not want the federal government to do a CBA before determining whether it was economically too costly or risky to protect our right to free speech or our other civil rights. These goods, we might say, are priceless.

Many goods that could theoretically and legally be bought and sold are very difficult in practice to quantify economically; these goods are known as "soft" variables in CBA. Because they are difficult to quantify, they may be undervalued in a comparative assessment with hard and fast economic costs. When future generations are involved in our calculations, the difficulties mount.

Consider the protection of endangered species. The preservation of native species in the United States is not particularly expensive, with annual federal allocations approximating the cost of constructing a few miles of urban interstate highway or building a few military aircraft.[56] Still, these costs are real and measurable, and there are other costs to protecting endangered species that are borne by land-owners and developers. Again, these costs are real and relatively easy to quantify.

What of the benefits of preserving endangered species? There may be many economic benefits to the recreation and tourism industries, but these may be difficult to assess accurately. It is not clear, for instance, that fewer people would visit national parks if there were no grizzly bears or

wolves inhabiting them. Indeed, given the fear that these carnivores may induce in potential park visitors, their absence may actually increase tourism. Of course, there are moral, aesthetic, and spiritual reasons to preserve endangered species, and there are corresponding moral, aesthetic, and spiritual benefits of their preservation. But these are very difficult, if not impossible to quantify economically. Measuring such benefits across many generations becomes even more problematic. Yet the economic costs of enforcing the Endangered Species Act is quite easily calculated, and these dollar costs are fully borne by the current generation each year. Since moral, aesthetic, and spiritual benefits are difficult to quantify, such soft variables may get ignored in favor of the easily assessed economic costs of preservation. The same sort of problem occurs whenever industries place a new product on the market. While the cost to a corporation of not selling the product is relatively easy to calculate and project, the health and environmental costs associated with the product – say a new drug or a new piece of machinery – may be much more difficult to determine.

The problem is complicated because CBA does not generally focus on who bears the costs and who receives the benefits. As the World Commission on the Ethics of Scientific Knowledge and Technology observed, cost-benefit analysis may support risky activity "as long as the sum of the benefits outweighs the sum of the costs, even if a small group of people get the benefits and a whole community suffers the costs. Thus aggregation of costs and benefits may obscure ethical issues of fairness and equity."[57] Given these difficulties, some ethicists object to the use of cost-benefit analysis. They feel that CBA privileges technological and economic development by business corporations or other elites while undervaluing the risks and deprivations suffered by the general public and future generations. Cost-benefit analysis may often present inequitable solutions since the dollar costs of regulating or prohibiting economic or technological development is easily calculable and the benefit of protecting current and future populations from uncertain risks and the deprivations of soft goods is often diffuse and difficult to calculate.

Notwithstanding such concerns, engaging the best science in conversation with ethical values in a comparative and inclusive analysis of risks, costs, and benefits is preferred. Neglecting such exercises may keep soft variables from gaining *any* voice and thus maintain the values of the status quo.[58] Inevitably, however, to engage in CBA comparatively and inclusively presents the challenge of pitting the often ambiguous benefits of environmental protection and social welfare against an arsenal of figures detailing the economic costs of regulating or prohibiting economic and technological development. The primary means to combat the tyranny of the immediate that often informs such calculations remains the involvement of a wide array of stakeholders. One possible means to address this challenge is to establish "**technology tribunals**" where citizen juries, informed by scientific data and ethical discourse, evaluate the risks, costs, and benefits of such matters as the production and use of synthetic chemicals or the deployment of new industrial or technological processes.[59]

Whether citizen tribunals, government agencies, or corporate departments are involved in CBA, the best science should play a prominent role. At the end of the day, however, science cannot tell us what things to value above others, what level of risk is acceptable to a given population, or how to balance concern for present generations with the welfare of future generations. Even within its own, narrower limits, science does not speak with certainty. Scientific theories are developed through replicable experimentation and rigorous methodologies. Scientific theories

well describe our world. However, the scientific method is incapable of proving anything with 100% certainty. In point of fact, science does not *prove* anything. Rather, it repeatedly refutes false (null) hypotheses. If a hypothesis cannot be refuted by way of rigorous and repeated experimentation, that hypothesis receives widespread and perhaps consensual support of the practitioners of a field: it becomes the foundation of a scientific theory. Still, the hypothesis might always be refuted at a later date as new evidence is discovered or new experiments are conducted.

The uncertainties mount when the science in question is not about what happens in the controlled conditions of a laboratory but in the uncontrolled, multivariable, highly interactive conditions of the social and biological world. Many pesticides, though relatively benign to non-target species when applied in isolation, may be a thousand times more disruptive of hormone and reproductive systems of non-target species when organisms are exposed to two or more of them over time -- as often occurs in the natural environment.[60] Similar "synergistic" effects are evident in the realms of climate change, where positive feedback loops and interactions between the causes and effects of global warming make predictions particularly difficult.

The writer and agricultural ethicist Wendell Berry observes that the effects of our actions are "invariably multiple, self-multiplying, long lasting, and unforeseeable in something like geometric proportion to the size or power of the cause."[61] The effects of our actions and technological innovations – owing to their interactions and synergies – may become manifest many years, decades, or centuries after their introduction to the world. Such time lags are the rule, not the exception, when ecosystems are disrupted.[62] Effectively, these disruptions defer risks and costs to future generations.

The web of life is so complex that no amount of scientific investigation can fully reveal the intricacies of its patterns or the long-term consequences of severing any particular strand or introducing new relationships. Risk assessment, if pursued from a precautionary approach, underscores the limits of scientific predictions and heeds the fact that these predictions become increasingly speculative the further they extend into the future.

With such uncertainties in mind, and aware of the inevitable need for the assessment of costs, benefits, and risks, economist Richard Norgaard argues that practicing sustainability does not entail exact prediction or firm control of the indefinite future. Such a level of knowledge and power is beyond our reach, even with the best science and technology. If we refuse to act in the absence of certainty, our only choice would be passivity. But passivity, like staying at home instead of going on vacation, bears its own risks. Therefore, a precautionary approach grounded in a thorough understanding of the dynamic interdependencies of the web of life links sustainability not to inaction, but to prudent engagement.[63] To practice sustainability is to exercise caution while strenuously pursuing the best scientific knowledge and the most diverse stakeholder perspectives -- including the imagined perspectives of future generations. As one commentator observed regarding the generationally deferred costs and risks associated with climate change, "If we are to err, then let us, conscious of our responsibility to future generations, err on the side of caution."[64]

COMPENSATION FOR RISKS AND UNACCEPTABLE RISKS

To adopt a sustainability framework is not to stop progress, petrify human experience, or turn the planet into a museum. Human ingenuity is an important feature of the good life that needs to be sustained and evolutionary change is the fulcrum of life on the planet. The precautionary principle, in this respect, does not promote the elimination of risk. After all, risk is an inherent part of life and an intrinsic part of all discovery and creative processes. At times, the risks inherent to fulfilling human lives will be largely borne by current generations. At times, future generations will bear some of the risks, just as they will share in the benefits of our current activities and achievements.

The precautionary principle does not demand the elimination of risks, but it does entail their careful and comparative assessment. In turn, it does not allow us to burden future generations with risks we ourselves would be unwilling to assume. And it requires that we devote resources to the discovery of means to mitigate any risks we find ourselves imposing on future generations. If, for instance, fossil fuels are burned notwithstanding the risks to future generations of climate change, or nuclear energy is produced notwithstanding the risks to future generations of radioactive contamination, then there is an accompanying duty to devote resources to the discovery and development of alternative energy sources that will impose fewer risks on future generations for the energy we enjoy today.[65]

Inevitably, some of the risks we take will have untoward consequences. The precautionary principle suggests that the proponents of such risks remain responsible for any compensation or remediation for these damaging effects. One proposed means of institutionalizing such compensation are financial instruments called "assurance bonds." The value of an assurance bond is based on the best scientific estimates of potential environmental or social damages that might be incurred by a proposed activity.[66] Corporations involved in the development of new technologies would post these interest-accruing bonds to insure that future generations were not saddled with the risks and costs associated with unintended consequences.

Were such a bond-posting system employed, economic and technological development would not be paralyzed by the uncertainties associated with risk assessment. Still, given that money would have to be put on the table, we would have greater assurance that a rigorous risk assessment was conducted. As long as there were no problems, the bonds and the interest would return to the developer of the product after a pre-determined time. If problems arose, however, those who benefited financially from the development and marketing of a product, not its victims, would become responsible for the costs of reparation. Insurance companies today are beginning to take the carbon footprint of corporations into their calculations of the cost of insuring them. The higher premiums paid by large carbon emitters is the equivalent of an assurance bond.

To determine the size of an assurance bond, one has to determine the level of risk. Risk refers to an undesirable future state of damage that has some probability of occurring. To determine the level of risk, one multiplies the magnitude of the damage by its probability. A high probability of insignificant damage (e.g. the risk of getting sore muscles after a long hike) constitutes a small risk. A very low probability of great damage (e.g. the risk of getting struck by lightning on a sunny day) also constitutes a small risk. Large risks are products of relatively high probabilities coupled with relatively high damage. And if the damage is high enough (e.g. the collapse of

civilization owing to climate change), even middle-range probabilities can produce a sufficiently high risk to warrant precautionary action or dictate the posting of a sizable assurance bond.

Are there cases, however, where no assurance bond or any other form of compensation could be large enough to allow the taking of certain risks? As we previously observed, there are goods that are priceless or sacred to us. Presumably, risking these goods, even if compensation were offered for their damage were it to occur, might be deemed illegitimate. Consider the case of genetic engineering.

One day soon we may be able to engage in genetic engineering that makes people healthier, stronger or smarter. The prospect of such genetic engineering raises the specter of Frankenstein-like monsters being created through experiments gone horribly awry. As was the case with the invention of nuclear weapons, however, the most frightening prospect may not be failed experiments. The greatest danger from genetic engineering may not be that it goes wrong, but that it succeeds beyond all expectation.[67] What could be wrong with healthier, stronger, and smarter people? Expanding one's time horizon illustrates the problem.

As Bill McKibben observes in his book, *Enough*, the germline manipulation of human fetuses will likely set off a biological arms race that rivals in its danger the arm race set off in the Cold War by the invention of the atomic bomb.[68] Faced with the prospect of their children's friends and fellow students having enhanced IQs, many parents who otherwise would prefer not to manipulate their children's DNA will feel they have little choice but to do so. To abstain from such manipulation would relegate one's child to an uphill climb in school, to overwhelming competition in the marketplace, and potentially to second-class status in society. To make the problem worse, the techniques for genetic enhancements will likely quickly improve. So the child equipped with a state-of-the-art upgrade today may well find herself outdone by next year's model, which promises an additional 20 or 30 points of IQ. McKibben writes that

> The vision of one's child as a nearly useless copy of Windows 95 should make parents fight like hell to make sure we never get started down this path. But the vision gets lost easily in the gushing excitement about 'improving' the opportunities for our kids. If germline genetic engineering ever starts, it will accelerate endlessly and unstoppably into the future, as individuals make the calculation that they have no choice but to equip their kids for the world that's being made. Once the game is under way, in other words, there won't be moral decisions, only strategic ones.[69]

McKibben concludes that the only time to stop such technology is before it gets started, before the genie of human genetic engineering gets out of the bottle. Keeping such technological genies in the bottle is only possible through the cultivation of a precautionary approach. Prevention is the only option because there may be no cure. Some risks, McKibben suggests, are simply too big to take.

Arguably, humans are a curious, adventurous species, and there is no way to slow down, let alone stop the economic growth and technological development that allows us to pursue every greater comfort, wealth, and power. With this in mind, the difficulties of restricting technological developments in accordance with the precautionary principle are considerable. In the absence of a clear understanding of risks and in the face of our curiosity, our desire to grow

evermore powerful, and the prospect of economic gain, ethical skeptics argue that most technological innovations will proceed apace. In the words of J. Robert Oppenheimer, the original director of the Manhattan Project which produced the first atom bomb: "When you see something that is technically sweet you go ahead and do it and you argue about what to do about it only after you have had your technical success. That is the way it was with the atomic bomb." There are endless numbers of technically "sweet" opportunities available to us today, such as genetic engineering, and in all likelihood such opportunities will increase at an exponential rate. The problem with these new technologies is that once they have been invented – as was the case with nuclear weapons -- they cannot be un-invented.

How, then, do we decide which risks are unacceptable and beyond compensation? We might add this challenging question to a raft of others that this chapter has prompted. How are we to balance the pursuit of current needs and wants with our concern for the welfare of future generations? To what extent should we sacrifice goods so that future generations might thrive? Should we deprive our children of certain benefits if this appears a necessary means to ensure the welfare of our great grandchildren? These are not easy questions to answer. And science, while providing us much valuable data about costs, benefits, and risks, cannot answer them for us. Only ethical deliberation sets us on the right course.

Ethical deliberation sets us on the right course but does not in itself provide answers; we cannot simply reason our way to solutions. Rather, ethical inquiry and deliberation helps stimulate the development of the values and perspectives and processes that will prove indispensable to the crafting of answers. Robert Heilbroner, author of *An Inquiry into the Human Prospect*, explains that

> No argument based on reason [alone] will lead me to care for posterity or to lift a finger in its behalf.… I suspect that if there is cause to fear for man's survival it is because the calculus of logic and reason will be applied to problems where they have as little validity, even as little bearing, as the calculus of feeling or sentiment applied to the solution of a problem in Euclidean geometry.[70]

Heilbroner suggests that the meaning we gain and the moral satisfaction we obtain from caring for future generations cannot be derived from logic or reason – no more so than the care and concern we show to our children, spouse, and friends is a product of rational argument. Reason and logic can help us see the consequences of our actions and they can help us be consistent in the pursuit of our values, but no calculus can make us care.

CONCLUSION

In his book *The Third Revolution,* Paul Harrison suggests that "The time is near when every child will ask its parent 'What did you do in the environment war, mum and dad? Were you one of those who helped to destroy my future? Or were you one of those who helped to save it?'"[71] The prospect of such an interrogation, Harrison suggests, should motivate all (potential) parents to think of tomorrow … today.

A sense of responsibility to future generations is not the monopoly of parents. Rachel Carson and hundreds of thousands of childless couples who adopt the ethics of sustainability are proof of that. Indeed, a sense of responsibility for future generations and a concern for the effects of overpopulation is the impetus behind many couples' decisions not to have any children.

Our ethical relationship to future generations has been likened to a "chain of obligation."[72] The metaphor might bring to mind the strength of our connection to progeny. Alternatively, it may suggest an onerous burden – a heavy chain of responsibility. Being held responsible for the welfare of an indefinite number of future generations may indeed leave the mind reeling. And it may hurt our pocketbooks, significantly restricting the pursuit of economic gain. But is our obligation to future generations a heavy burden, or is it a privilege?

The philosopher Ernest Partridge states that "in acting for posterity's good we act for our own good." Concern for the welfare of posterity effectively helps us to escape the confines of *narrow* self-interest, where immediate pleasures, comforts, and benefits are the only considerations. Escaping these confines is liberation, not a burden. Unless we identify ourselves with "larger, ongoing, and enduring processes, projects, institutions, and ideals," Partridge writes, our lives will become "empty, bleak, pointless, and morally impoverished."[73] Concern for posterity is a catalyst for the expansion of our lives. The obligation to make the world a better place for posterity is really an opportunity to make our own lives more meaningful and fulfilling.

Genetically speaking, posterity offers us a form of biological immortality – or increased longevity in any case. Culturally speaking, it provides the same gift. Future generations carry on and further develop our technological, scientific, social, political, aesthetic, and ethical achievements: they provide us a sort of cultural immortality. By carrying forward our legacy, future generations effectively give meaning and durability to our inevitably limited lives. In exchange, we are obligated to provide them with a world that has not had its ecological resilience or its capacity to sustain human welfare depleted. But it would go too far to suggest that this "exchange" is akin to those that take place in the marketplace and are guided by the principles of economics. As Ophuls suggested, posterity may well be damned if we view it solely as a partner in an economic transaction.

The challenge of caring for posterity, though presenting itself with a new urgency today, is as old as civilization. The youth of ancient Athens were required to graduate from the **Ephebic College** before attaining the status as citizens. At the age of 18, in the midst of two years of civic training, they took an oath that captured the essence of their citizenship. The young Greeks pledged never to disgrace the city by immoral acts, to maintain its ideals, revere its laws, and cultivate the spirit of civic duty. **The Ephebic oath** ended with the words: "Thus in all these ways we will transmit this City, not only not less, but greater and more beautiful than it was transmitted to us." What the ancient Athenians swore to their city, we might well pledge to the local communities and nations we inhabit today, and to the planet that sustains them.

Future generations cannot be surveyed or consulted as to their needs and wants, but we can assume that they will need and want the same basic goods that we need and want -- physical security, health, nutritious food, decent shelter, education, a meaningful livelihood, and a life-supporting planet. In turn, we can assume that future generations will want the opportunity to enjoy and benefit from goods that we have had the opportunity to value: the experience of scenic beauty and biological diversity as well as opportunities to develop scientific, technological, and cultural achievements.

Strictly speaking, future generations will never have our opportunities. They will not have the opportunity to make our scientific discoveries or to produce our technological innovations. Inventions cannot be undone. Time changes everything. To practice an ethics of sustainability, however, means that we preserve for future generations the opportunity to engage in a similar range of practices that we have enjoyed, and that that we preserve the conditions that will allow them to enjoy a similar range of experiences. With this in mind, our responsibility to future generations might best be described as the "conservation of options."[74]

The ethics of sustainability does not aspire to mere existence; to live sustainably is to *enjoy* and *preserve* a high quality and rich diversity of life. Our obligation to future generations, in this respect, is not only to ensure that people yet to be born can meet their most basic needs. Our obligation is to preserve the ideals and opportunities that we cherish today.[75] Dave Foreman, a stalwart of ecological conservation, pessimistically observed that "Ours is the last generation that will have the *choice* of wilderness."[76] Many people who will live in the future, like many of our contemporaries, will take little pleasure from wilderness. To live sustainably, however, is to ensure that future generations have the *choice* of wilderness.

What is said here of wilderness might be said as well about other goods and opportunities many of us enjoy and cherish. Our obligation to future generations is to pass on the legacy of a biologically diverse, resilient, life-supporting planet and a social world equally supportive of human diversity and creativity. This requires the preservation of healthy ecosystems and healthy social systems, the latter including institutions of justice, democratic representation, education, health and welfare, economic opportunity, scientific discovery, and artistic creativity. We should think and act as if the future depends upon us. Unquestionably it does -- in more ways than we can know.

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ENDNOTES

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[3] Lester Milbrath suggests the motto "Think tomorrow, act today." Lester W. Milbrath, *Learning to Think Environmentally (while there is still time)* (Albany: SUNY Press, 1996), p. 120.

[4] See John Rawls, *A Theory of Justice,* Revised Edition (Cambridge: Harvard University Press, 1999), p. 225. The extension of Rawls' framework to intergenerational justice is clarified in Rawls' subsequent work, *Political Liberalism* (New York: Columbia University Press, 2005), p. 274.

[5] John Rawls, *A Theory of Justice,* Revised Edition (Cambridge: Harvard University Press, 1999), p. 295.

[6] Bryan G. Norton, *Toward Unity among Environmentalists* (New York: Oxford University Press, 1991), p. 121.

[7] Edmund Burke, *Reflections on the Revolution in France* (Garden City, NY: Doubleday, 1961), p. 110.

[8] Edmund Burke, *Reflections on the Revolution in France* (Garden City, NY: Doubleday, 1961), p. 108.

[9] NEPA Section 101 Requirement 1.

[10] World Commission on Environment and Development, *Our Common Future* (Oxford: Oxford University Press, 1987), p. 8. The term *sustainable development* may have first been employed in the 1980 publication of the International Union for the Conservation of Nature and Natural Resources, *World Conservation Strategy: Living Resource Conservation for Sustainable Development.* See http://data.iucn.org/dbtw-wpd/edocs/WCS-004.pdf.

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[16] Edward O. Wilson, *Biophilia* (Cambridge: Harvard University Press, 1984), p. 121.

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[18] Michael Soulé, "Thresholds for Survival: Maintaining Fitness and Evolutionary Potential," in Michael Soulé and Bruce Wilcox, eds. *Conservation Biology: An Evolutionary-Ecological Perspective* (Sunderland, Mass: Sinauer Associates, 1980)*,* pp. 166, 168.

[19] Quoted in *Focus*, World Wildlife Fund, March/April 1996 p. 6.

[20] The original version of the phrase has been attributed to David Brower, *Let the Mountains Talk, Let the Rivers Run: A Call to Those Who Would Save the Earth* (New York: Harper Collins, 1995), p. 1.

[21] Steve Trombulak, Reed Noss and Jim Strittholt, "Obstacles to Implementing the Wildlands Project Vision," *Wildearth*, Winter 1995/96, p. 86.

[22] See the United Nations Population Information Network at http://www.un.org/popin/.

[23] Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (New York: Viking Press, 2005).

[24] See http://www.ratical.org/many_worlds/6Nations/EoL/index.html#ToC and http://www.indigenouspeople.net/iroqcon.htm.

[25] See Hilary F. French, "Learning from the Ozone Experience," in Lester R. Brown et al, *State of the World 1997* (New York: W. W. Norton, 1997), pp.151-171; *Nucleus*, Winter 1995-96, pp. 1-3; "Can We Save Our Skins," *Friends of the Earth*, July/August 1996pp. 8-11.

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[36] Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962), p. 13.

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CHAPTER 5
THE GLOBAL COMMUNITY, SOCIAL JUSTICE, AND THE DISTRIBUTIONAL PRINCIPLE

As the previous chapter demonstrated, a concern for future generations lies at the heart of a sustainability ethic. This moral relationship connects us to distant descendants through a set of rights and duties and accompanying relations of benefit and risk. Treating future generations fairly, in a just manner, means that we do not burden them with risks or costs – financial or environmental – that we would not want to bear ourselves. This is a matter of *inter*generational justice, which addresses our ethical responsibilities to people separated by the boundaries of time. The sustainability framework suggests that we also have ethical obligations to people separated by the boundaries of space. This is a matter of social justice, which is *intra*generational.

In recognizing our obligations to future generations, we are acknowledging and affirming a responsibility to people who remain incapable of actively representing their own interests. They have, as yet, no voice. Yet their inability to participate in our decision-making processes does not negate our responsibilities to consider their interests and rights. The same might be said regarding our obligations to those separated from us by social, political, or geographic boundaries.

Many people are incapable of actively representing their interests in the decision-making processes that most affect their lives owing to socio-economic or geo-political reasons. They lack the social, economic, or political resources to ensure that their voices are heard and heeded. Although such marginalized or foreign citizens have no vote, cannot participate in our decision-making processes, or are otherwise relatively powerless, their rights to sustainable livelihoods that are not burdened with disproportionate environmental risks remain intact.

This chapter examines the significance of social justice within the sustainability framework. It demonstrates how an ethics of reciprocity promotes concern for the least advantaged of society, both domestically and within the global community. In turn, the chapter investigates the relationship between social justice on a global scale and environmental caretaking. Principles of distributive justice are explored, as is the role of government and non-governmental organizations in pursuing equity and environmental protection. The chapter concludes with an examination of the sharing of power, the role of transparency, and the need for autonomy in the pursuit of social justice within a sustainability framework.

The Ethics of Reciprocity and Social Justice

As we observed in Chapter 3, justice sometimes refers to the proper administration and enforcement of laws. In this sense, the just is simply the legal while the unjust is the illegal. Of course, we know that there are many things that are legal but that are not just in any traditional sense of the word. During the Nazi rule of Germany, laws were passed by the legislature employing proper rules of procedure. Yet a good portion of these laws – though properly administered and legally enforceable – have been deemed unjust by virtually every contemporary observer. In turn, there are many things that we may consider to be just that are not addressed by existing laws. Laws are typically written, adopted, and enforced by specific political units, such as

nation states. Typically, these laws are written and adopted in accordance with prevailing understandings of justice. While existing laws are meant to codify these prevailing understandings, they do not capture every aspect of them. In turn, changing times produce changing demands of justice. That is why new laws are created and old laws get reinterpreted by the courts or modified.

*Intra*generational justice is a form of social justice. Social justice is often codified in law. But it also extends beyond existing laws, inspiring the creation of new laws and the reinterpretation or modification of old laws. Social justice is concerned with the fair and proper treatment of individuals and groups within society. It is concerned with the allocation of burdens, risks, benefits, and opportunities. In this respect, social justice refers to the fair distribution of advantages and disadvantages within a society. Along with ecological health and economic prosperity, social justice is one of the three pillars supporting the sustainability framework.

Social justice may be grounded in any number of ethical systems. Most fundamentally, however, it pertains to an ethics of reciprocity. Reciprocity refers to relationships of mutual exchange, equal treatment, and reciprocal rights and duties. At a most basic level, the ethics of reciprocity is known by another, well-known name: "the golden rule."

Widely regarded as "*the* supreme moral principle,"[1] the golden rule can be found in virtually every religious and cultural tradition in the world, dating back over two and a half millennia. Confucius (551-479 B.C.E.), the ancient Chinese sage, may have been the first person clearly to enunciate a Golden Rule. In his *Analects*, we read the following dialogue: "Tzu-kung asked, 'Is there a single word which can be a guide to conduct throughout one's life?' The Master said, 'It is perhaps the word "shu" [empathy, or consideration]. Do not impose on others what you yourself do not desire.'"[2] Statements reflecting a similar ethics of reciprocity written at approximately the same time period can be found in the *Mahabharata* of the Hindu tradition, and in Buddhist texts. The Jewish sage, Hillel, when challenged to teach the holy scriptures briefly said, "What is hateful to you, do not do to your neighbor, that is the whole Torah, while the rest is the commentary thereof; go and learn it."[3] In the *New Testament* of the Christian bible, the golden rule is articulated in slightly different ways in the different gospels. But its basic formulation is the same: "Always treat others as you would like them to treat you."[4]

As a supreme moral principle, the Golden Rule has been viewed as "*sufficient* for ethics in the sense that no one could ever go wrong by adhering to it or in the sense that all duties may be inferred from it." It follows, for some ethicists, that "an action must be able to pass the test of the golden rule if it is to be validated as right, and any action that fails the test is wrong."[5] Of course, the golden rule is not without detractors. The 19th century British writer George Bernard Shaw suggested that the golden rule mistakenly assumes that one's own wishes provide a good measure of what others actually want. "Don't do to others as you want them to do unto you," Shaw wrote. "Their tastes may be different."[6] Shaw was a satirist. But he was not wholly off the mark in his criticism. The golden rule should not be taken too literally – at least by some people. The sado-masochist, for instance, or a person with severe psychological disorders producing self-destructive behavior, should not be encouraged to treat others as he treats himself. Obviously, we would not want the suicidal person to operate with a literal interpretation of the golden rule in mind.

In turn, differences in socio-economic status and cultural traditions make any straightforward implementation of the golden rule problematic. The independently wealthy and independently minded may prefer a low-taxing, hands-off government. Such a person, if elected to office, might strip away welfare programs with the golden rule in mind, to the detriment of economically disadvantaged members of the society. Likewise, it is always dangerous literally to enact the golden rule when one is crossing cultural boundaries. Attempting to stimulate the local economy and local food production by starting an environmentally-friendly hog farm may constitute an effort to treat others economically and ecologically with an ethics of reciprocity. But such good intentions will be misplaced if the local community in question is predominantly Jewish or Muslim, where the eating of pork is forbidden.

With these concerns in mind, we might adjust the golden rule to read: "Always treat others as you would like them to treat you if, and only if, you have preferences for the commonly accepted elements of the good life." Of course, this leaves us with the very demanding task of clearly articulating the commonly accepted elements of the good life. At this point, our effort to achieve justice within generations encounters the same challenge we faced in describing justice between generations: we have to figure out what our neighbors – whether they are distant in time or in geo-political or socio-economic space – need and want.

In the absence of any compelling evidence to the contrary, we simply have to assume that, like us, our local and global neighbors (and future generations) want to have their basic needs met – needs for physical security, health, nutritious food, decent housing, education, a meaningful livelihood, and a life-supporting, beautiful, and biologically diverse planet. In turn, we can assume that they want the right and opportunity to participate in the decision-making processes that will determine how these basic goods will be defined and distributed and will want to receive a proportionate share of them. We can also assume that our local and global neighbors (and future generations) want to understand the risks they may face in life, the right and opportunity to participate in the decision-making processes that will determine how these risks will be distributed, and will not want to bear a disproportionate share of them. While outlining the basic goods and risks of life is relatively easy, the task of ensuring their fair allocation at local and global levels is a supreme challenge. This is the challenge of social justice.

Environmental Justice

In 1982, more than 500 people were arrested in North Carolina for civil disobedience. The protestors were objecting to the disposal of toxic wastes in a landfill located in a primarily African American community. The following year, a U.S. government report documented that African-Americans comprised the majority of the population in the counties of a number of southeastern states where hazardous waste landfills were located. Over the following decade, numerous reports, articles, books and summits documented and debated the extent and nature of such "environmental injustice."[7] Academic research confirmed that communities that ended up holding the short end of the toxic stick tended to be populated with minorities. The political and economic powerlessness of these minority communities left them vulnerable to "environmental racism."[8] In response to this charge, the Environmental Protection Agency set up an Office of Environmental Justice and a

presidetial order directed all federal agencies to ensure that minority communities were not disproportionally burdened with environmental ills and risks.

While environmental injustice and environmental racism were originally understood as identical concerns, the notion of environmental justice was soon broadened to include concern for the environmental risks and burdens borne by any disadvantaged communities, such as Appalachian coalminers, regardless of their racial composition. In turn, advocates of environmental justice addressed various forms of environmental inequities beyond the increased exposure to toxic contamination suffered by disadvantaged communities. They addressed hardships produced by environmental catastrophes that fall disproportionately on the disadvantaged, such as the effects of Hurricane Katrina on the poorer, and typically black communities of New Orleans. They addressed the "climate injustice" suffered by those communities, peoples, and nations that will bear the brunt of global warming. And they addressed the "stealing" of genetic material from indigenous populations by pharmaceutical companies that subsequently enforce intellectual property rights through the patenting of living organisms or DNA sequences.[9]

Kristin Shrader-Frechette writes that "Environmental injustice occurs whenever some individual or group bears disproportionate environmental risks, like those of hazardous waste dumps, or has unequal access to environmental goods, like clean air, or has less opportunity to participate in environmental decision-making. In every nation of the world, poor people and minorities face greater environmental risks, have less access to environmental goods, and have less ability to control the environmental insults imposed on them."[10] If we expand Shrader-Frechette's definition to include *social* and well as *environmental* risks, goods, and decision-making opportunities, then we arrive at the broader category of social justice. Robert Bullard, whose 1990 book *Dumping in Dixie* brought the issue of environmental racism to widespread attention, maintains that the concern for environmental justice is indeed an extension of the broader concern for social justice.[11] Within the sustainability framework, the fair distribution of environmental benefits, costs, risks and opportunities is understood as intrinsic to the commitment to a fair distribution of social, economic, and political benefits, costs, risks and opportunities.

The global community

Our moral obligations to future generations are difficult to separate, logically speaking, from our moral obligations to those who inhabit other nations or other classes, genders, or races within the same nation. As the Brundtland Report stipulated, the "concern for social equity between generations ... must logically be extended to equity within generations."[12] Our distant descendants beyond a few generations, we observed in Chapter 5, will share very few of our genes, little more than non-kin currently living on the other side of the globe. If we have a moral obligation to pass on a healthy, life-supporting environment to future generations - the vast majority of whom will be wholly unrelated to us or will have genetic links diminishing at a geometric rate - one might reason that the same sort of obligation pertains to current generations.

The logic of extending care from intergenerational neighbors to intragenerational neighbors is practical as well as moral. In order to protect the environmental health and welfare of our children and grandchildren, it is increasingly necessary to protect the environmental health and welfare of the peoples inhabiting distant neighborhoods and distant lands. The welfare of future generations

is, in many realms of environmental affairs, dependent upon the welfare of our global neighbors. Attempts to shield future Americans from climate change, for instance, must account for the greenhouse gas emissions of China and India. Preserving the ozone layer in the stratosphere so future generations do not suffer increased incidences of eye cataracts and skin cancer cannot be achieved without the cooperation of people from every continent. Ensuring that growing populations do not deplete natural resources and diminish the planet's biodiversity will require the provision of education and sustainable livelihoods to the citizens of developing countries, where 99% of future population growth will occur.

Indeed, at a practical level, it is not only the welfare of future generations that depends upon the actions of global neighbors. It is also our own welfare that is directly affected. Globalization has many benefits, including the increased sharing of knowledge, technology, and cultural values. Ecologically speaking, the world is shrinking as well. Environmental responsibilities, like the air we breathe, do not stop at national borders. Many of today's most pressing environmental problems, such as climate change, ozone depletion, many forms of pollution and resource depletion, as well as diminishing biodiversity, are global threats requiring global solutions.

Smoke from brushfires set by commercial loggers in one country may poison the skies across an entire region of the globe. Dust blown into the atmosphere from storms on the growing deserts of China finds its way into the skies of North America and the lungs of Californians. When increasing population and poverty forces Amazon dwellers to slash and burn rainforests to plant commercial crops, Swedes who might benefit from pharmaceuticals derived from forest flora and fauna suffer for this loss of biological diversity. When Americans release carbon dioxide through the burning of fossil fuels in their cars and trucks, the lives and livelihoods of Polynesian islanders on the other side of the globe are threatened as melting icecaps and expanding surface waters submerge their homeland.

The natural resources consumed and the emissions and waste produced by the world's nations cast "ecological shadows" that extend well beyond their own borders. Technology often extends these shadows further. The 1986 explosion of a nuclear reactor at Chernobyl in the Ukraine demonstrated vividly how technology has breached national borders. Locally, over 300,000 people were evacuated and many thousands died from radiation-induced cancer. But the radioactive fallout from the explosion at Chernobyl did not limit itself to the Ukraine. It reached the western Soviet Union, Eastern Europe, Western Europe, Northern Europe, and eastern North America.

As we observed in the last chapter, the ecological shadow cast by technology does not always come from the most sophisticated inventions. The burning of wood and charcoal and the use of automobiles contributes heavily to carbon dioxide emissions. As a result of climate change, glaciers will melt, rivers will dry out in the summer, agricultural land will lack irrigation, desertification will increase, and low-lying coastlines will flood. These climate-induced changes will produce tens of millions of environmental refugees in the next decade, with worst-case scenarios suggesting that hundreds of millions of refugees may have to flee the environmental destruction caused by global warming.[13] These desperate individuals quitting their homelands will not be contained within national borders. Ecologically, socially, and politically, no less than

technologically, the world has become ever smaller. Now, more so than ever, the fates of neighbors in the global village are joined.

The world is shrinking owing to a myriad of connections that ever more tightly intermesh the lives and livelihoods of peoples across the globe. Norman Myers observes that "Not even the most advanced nation can insulate itself from [global] environmental impacts, no matter how strong it may be economically or how advanced technologically or how powerful militarily."[14] What Myers says regarding the impact of environmental forces is equally true of economic, scientific, technological, social, political, and cultural forces. These crisscrossing linkages circling the planet have made the welfare of individuals and nations inseparably intertwined.

Thomas Friedman, the New York Times columnist and author, has employed the metaphor of a "flattened" world to describe the growing levels of interdependence that characterize contemporary life.[15] Friedman highlights social, cultural and business linkages through the internet, computers, cell phones, and other media, transnational business operations that spread supply-chains, workloads, and customers across multiple continents, and growing cultural and political connections that make independence and isolation increasingly unworkable. While Friedman's metaphor is instructive, it may obscure many of the very real differences in cultures and in opportunties that exist in a world characterized by growing disparities in wealth and power. But there is no doubt that in many respects, the contemporary world, more than ever before, is characterized by what scholars of international affairs describe as "complex interdependence."[16] The complexity arises from the multiple forms of interdependence involved, and from the multiple ways these connections intersect.

The intermeshing of the world's economic, scientific, technological, social, political, cultural, and ecological systems has created both benefits and burdens for human stakeholders. These burdens and benefits are not evenly or equitably distributed, and such unevenness and inequity contributes to the complexity. A small island state and a large mountainous country may contribute equally to global warming. But the expected rise in sea levels will leave only one nation without a homeland. While human and natural systems may enjoy or suffer differentially from their interconnectedness, historian Donald Worster maintains that there is no exception to "the reality or extent of the interdependency itself."[17] The cross-cutting and multilayered linkages that characterize the contemporary world are undeniable and inescapable. In today's world, interdependence is "a strict fact of life."[18]

Understood as a strict fact of life, interdependence was first discovered within the science of ecology. Ecologists study the multilayered, interactive relationships between organisms and their environments that form the dynamic webs of connections called ecosystems. Conflict and competition between individual organisms is intrinsic to such systems. But so is symbiosis, as the life-supporting activities of one species complements or supplements the life-supporting activities of another species. It is the dance of competition, conflict, cooperation, and symbiosis that create the relationships of interdependence between the diverse organisms comprising an ecosystem. Informed by these ecological insights, social scientists have explored the conflict, competition, cooperation, and symbiosis that create webs of interdependence between and within economic, scientific, technological, social, political, and cultural systems. This interdependence is truly

complex. Sharing equitably the burdens and benefits that our relationships of interdependence create is a core feature of sustainability.

Thinking globally, acting locally

The dictum to "Think tomorrow, act today"[19] has its complement in the well-known recommendation to "Think globally, act locally." Thinking globally entails becoming aware of and responsive to the webs of interdependence that connect us to distant peoples, cultures, and ecosystems. The ethics of sustainability requires that we equitably share rights and responsibilities, benefits and burdens with our local and global neighbors. These relationships of shared duties, rights, risks, and opportunities are not dissolved, though they may be attenuated and complicated, by distinctions or divisions arising out of differences in class, race, gender, ethnicity, belief systems, and nationality.

To pursue sustainability is to think and act inclusively, with the welfare of a larger community in mind. Where the specific boundaries of one's "community" lie is a complicated question. For people to effectively pursue sustainability, they have to concern themselves with the local communities in which they live and work. As Wendell Berry writes, "The real work of planet-saving will be small, humble, and humbling, and (insofar as it involves love) pleasing and rewarding. Its jobs will be too many to count, too many to report, too many to be publicly noticed or rewarded, too small to make anyone rich or famous."[20] Berry, as we saw in Chapter 3, is one of the founding thinkers of bioregionalism, a set of principles that insist on the priority of local commitments and caretaking. Sustainability is chiefly grounded in the actions of countless people looking after their own human and biological communities. At times, one might be primarily concerned with the sustainability of one's family, neighborhood, business, or civic association. At times, concern might extend to one's town, city, county, state, or nation. However, all such "local" actions, if uninformed by a global perspective that illuminates ever larger, more encompassing webs of interdependence, may prove counterproductive and shortsighted. Ultimately, the pursuit of sustainability must always be Janus-faced, with one eye turned toward the local community and one eye turned toward the world community.

We might speak of this world community as the global commons. To say that we live in a global commons today is not to deny enduring ideological, socio-economic, racial, religious, or gender cleavages that exist in societies. In turn, national, ethnic, and kin loyalties persist. To say that we live in a global commons is to insist that, notwithstanding enduring affiliations and divisions, the peoples of the world remain inextricably bound together by webs of ecological and social interdependence. Arguably, turning one eye toward the world community is only possible if we already have one eye turned toward local affiliations. It is hard to imagine moral concern for an expanding circle of fellow citizens developing in a person who was not primarily devoted as a youth to family and friends and morally educated by them. As Edmund Burke, the 18th century political theorist, wrote: "To be attached to the subdivision, to love the little platoon we belong to in society, is the first principle (the germ as it were) of public affections. It is the first link in the series by which we proceed towards a love of our country and of humankind."[21] Concern for the near and dear, and being cared for by kith and kin, is generally the prerequisite for broader, more encompassing relationships of moral concern.

Of course, care for the near and dear is not inevitably bound to extend itself to a broader community. Burke, a conservative and patriot, knew well that loving one's own platoon did not always produce a more encompassing embrace. Not infrequently, it produced a fearsome hate of other platoons, other armies, and the other nations they defended. Much of the history of the world, after all, is written with the blood of the victims of tribal conflict, ethnic feuds, and national wars.

Some biologists argue that an ethics of reciprocity that extends moral concern to neighbors is really the evolutionary product of the need for strength in numbers in the face of external threats. That is to say, threats from "outgroups" made solidarity of an "ingroup" the best strategy for survival.[22] We learned to cooperate and care for our neighbors, in other words, because an ethics of reciprocity allowed us to survive in the face of enemies. There are, to be sure, many examples of moralities grounded in brotherhood producing hate directed towards outsiders, and visiting much destruction on the world in the process.

The situation is no different today, notwithstanding growing global interdependencies. The need to secure dwindling reserves of natural resources, such as oil or fresh water, will likely produce armed conflict between sovereign states. In the face of scarce resources, global solidarity threatens to wane as national interests wax. Nations still command great loyalty from their citizens, and likely will continue to do so for the foreseeable future. But allegiances are steadily multiplying. And national governments, in order to fulfill their mandates of providing security, clean air and water, a stable environment, and economic opportunities for their citizens, find themselves necessarily involved in global caretaking in an increasingly interdependent world.

Throughout the vast expanses of human history, most of our ancestors led relatively isolated lives within small kinship groups and tribes. As wandering hunter-gatherers, their actions seldom affected distant neighbors. A hunting and gathering lifestyle requires about a square mile for foraging per individual. The total area of inhabitable land on the planet is less than two hundred million square miles. With a current global population approaching seven billion, it is clear that our species forfeited the option of isolated lives for its members many centuries ago. Today, like it or not, we are all global citizens. The question is whether we can rise to meet the responsibilities of this citizenship, living and working in a way that sustains the global commons.

Life on Spaceship Earth

While typically grounded in local actions, sustainability is generally planetary in its broadest visions. This planetary vision is occasionally described as *globalism*. Globalism means different things to different people. For some, it signals the cultural imperialism of Western power and values, as the planet's diverse peoples become increasingly connected – and homogenized - through modern media and technology. For some it represents the threat of a unitary world government, a globeocracy, that erodes individual freedoms and the sovereignty of nation-states. For some, it represents the growing power of multinational corporations and the integration of economies and consumption patterns across the planet, creating a so-called McWorld, where everyone marches – and eats – to the same corporate beat. And for some, globalism has a more benign meaning and effect. It bespeaks the weakening of dangerous forms of nationalism and tribalism, increased transparency through media, greater interaction and connection of the world's peoples and cultures, and greater opportunities for mobility, employment, and education. It also

suggests, as international relations theorist Paul Wapner writes, "a heightened sensitivity to the fragility of the life-support system of the planet and a sense of human solidarity in a world of increasing interdependence."[23]

This latter, benign understanding of globalism can be traced back to the 1960s, when U.S. ambassador to the United Nations, Adlai Stevenson, popularized Kenneth Boulding's notion of Spaceship Earth. In his last speech to the U.N. delivered in 1965, shortly before his untimely death, Stevenson famously said: "We travel together, passengers on a little spaceship, dependent upon its vulnerable reserve of air and soil; all committed for our safety to its security and peace; preserved from annihilation by the care, the work, and I will say, the love we give our fragile craft." On Spaceship Earth, Stevenson was saying, ecological interdependence sows a common fate and a common task for the human species.

There are problems associated with the Spaceship Earth metaphor. Although the planet's peoples are, in an important sense, 'in the same boat,' the image of all of us as passengers on a single craft sharing a single fate may be deceptive. Not all passengers on Spaceship Earth enjoy the same privileges or suffer the same deprivations. The majority, those with little power and wealth, sweat and all too frequently starve in the smoke-filled engine room. A small percentage enjoy fine dining and issue orders from the air-conditioned bridge. Benefits and risks aboard the planetary craft are not equally shared. Stevenson was well aware of this inequity. Echoing Abraham Lincoln's famous "House Divided" speech given a century earlier where Lincoln announced that the American "government cannot endure, permanently half slave and half free," Stevenson continued his speech to the U.N. with these words: "We cannot maintain [the spaceship] half fortunate, half miserable, half confident, half despairing, half slave to the ancient enemies of mankind and half free in a liberation of resources undreamed of until this day. No craft, no crew, can travel safely with such vast contradictions. On their resolution depends the security of us all."[24]

Stevenson's notion of Spaceship Earth links caretaking of the global commons with social justice. It might be considered an early precursor to the ethics of sustainability. This linkage of global caretaking and social justice has not been uncontested. Some believe that the metaphor of Spaceship Earth, and its implicit connection between environmental caretaking and social justice, is misleading and dangerous. In 1974, Garrett Hardin wrote his famous article on "lifeboat ethics."[25] Hardin agreed with Stevenson that life on Spaceship Earth is inequitable, though he notes, more accurately than Stevenson, that it is not half the population that is poor and despairing, but a significant majority. Given this reality, Hardin proposes that we give up the spaceship metaphor and adopt instead the image of a lifeboat. A small number of people, residents of the rich nations of the world, find themselves safe and secure in the lifeboat. Their needs are largely being met. The vast majority of people, residents of poor nations, find themselves bobbing treacherously on the open seas, without the resources to survive, let alone thrive.

To invite the needy masses into the small boat would be disastrous, Hardin claims. As more and more waterlogged people boarded the craft, it would soon exceed its carrying capacity. Soon enough, the lifeboat would sink, and all its occupants would share a single, inglorious fate. Sharing resources in such a situation - the essence of social justice - might be seen as the only

ethical thing to do. But the results, Hardin concludes, are certain: "The boat is swamped, and everyone drowns. Complete justice, complete catastrophe."[26] Having the best intentions and attempting to meet everyone's needs may be fine prescriptions for an ethical theory, Hardin maintains. But such well-intentioned morality proves problematic, if not disastrous, in practice. Taking care of oneself, one's family, and one's nation is at odds with efforts to satisfy the needs and saeguard the opportunities of global neighbors.

Hardin disputes whether the pursuit of social justice, and morality more generally, produce desirable results in a world of scarce resources. Nice guys finish last, Hardin observes, and selfishness will always beat out good intentions. However, Hardin was not suggesting that unrestrained individual selfishness is the best recipe for protecting the global environment. In an earlier, and even more widely cited article entitled "The Tragedy of the Commons," Hardin used another metaphor to explain why individual selfishness produced environmental catastrophe. [27]

The commons Hardin was describing were pastures in England where people grazed their sheep. A typical livestock owner, Hardin argues, would take maximum advantage of the free forage by grazing all of his animals on the commons. Of course, his likeminded and equally self-interested neighbors, being economically rational people, would act similarly. As relatively few herders and relatively few sheep exploited a relatively large commons, no real problems would arise. But lack of self-restraint practiced by increasing numbers of self-interested herders placing more and more sheep on a limited acreage would quickly produce a pasture eroded by overgrazing. The formerly lush, green commons, like the swamped lifeboat, would be rendered useless. Now all the sheep, and eventually all the herders, would starve.

Hardin's point is that the tragedy of the commons is inevitable when the commons – understood broadly as publically available natural resources – is open to exploitation by individuals in the absence of a central authority to regulate their actions. With no one to control overexploitation, Hardin insists, the commons will be depleted to the point of collapse. Then everyone loses.

In writing "The Tragedy of the Commons," Hardin was concerned not only with the overuse and erosion of public lands, but with the depletion of all natural resources in an overpopulated world. His conclusion was that "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all."[28] The only viable solution to environmental destruction in an overpopulated world of scarce resources, Hardin maintained, was the creation of an authority that could coercively impose restraint.

Hardin explicitly embraces two features of the sustainability framework. In "Lifeboat Ethics," he argues that we must resist the urge to invite everybody into the lifeboat, in part, out of a sense of duty to progeny. It is incumbent upon us to be exclusive if we want to preserve the natural world for future generations. "For the foreseeable future," Hardin writes, "survival demands that we govern our actions by the ethics of a lifeboat. Posterity will be ill served if we do not."[29] In the "Tragedy of the Commons," Hardin insists that the self-interested pursuit of prosperity is an ineradicable feature of the human condition. Any individual or collective venture that does not account for its own economic success is doomed to fail. The obligation to protect the environment for future generations and the understanding of the importance of economic viability put Hardin

two-thirds of the way into the sustainability tent. It is on the issue of social justice that Hardin refuses full entry. Hardin is dubious that all three legs of the stool of sustainability truly support one another. Strengthening the economic and environmental legs, he believes, will necessitate ignoring the leg of social justice.

Hardin makes two major claims that advocates of social justice must confront. First, he claims that in an overpopulated world of scarce resources, the attempt to meet the needs of the poor and disadvantaged will prove environmentally disastrous. The predictable result is that the carrying capacity of the commons - the planet as a whole - will be exceeded, with dire consequences for all. Second, he claims that a sovereign authority is required to protect natural resources, that individuals trying to meet their own needs in the absence of a central authority will destroy the commons. Because people are fundamentally self-serving and shortsighted, a sense of social justice or voluntary cooperation will not produce acceptable results. Let us examine each of these claims in turn.

Will meeting the needs of the disadvantaged prove environmentally disastrous?

Arguing the case for the disadvantaged of the world, physicist and environmental activist Vandana Shiva observes that "Giving people rights and access to resources so that they can regain their security and generate sustainable livelihoods is the only solution to environmental destruction and the population growth that accompanies it."[30] It is with this same conviction that the Brundtland Commission determined, decades earlier, that "inequality is the planet's main 'environmental' problem."[31] Here, Shiva and the Brundtland Commission insist that social justice is not at odds with protecting the global commons. Indeed, social justice is the only thing that can save it.

Empirical research gives weight to these claims. Countries with more equal income distribution and more egalitarian political rights generally do a better job protecting their environments. A similar relationship occurs domestically, when one compares inequality and environmental health in the 50 U.S. states. The conclusion reached by many scholars is that "social justice and environmental sustainability are inextricably linked, and that the achievement of the latter without greater commitment to the former will be exceptionally difficult."[32] In an ecologically and technologically shrinking world, an expanding sense of social solidarity provides a crucial foundation for sustainability. This is, by no means, a universal conviction even among those who label themselves environmentalists. But it is intrinsic to the sustainability framework.[33] To embrace sustainability is to accept that economic security – the ability to earn one's livelihood – is a universal pursuit, a universal right. People will always seek economic security as a means of survival, and given the chance, most will pursue economic prosperity. Given this reality, people will continue to destroy the environment if that is the only way for them to survive economically. The sustainability framework insists that the only way to save the environment is to help people develop environmentally benign livelihoods.

The well-known anthropologist and conservationist Richard Leakey put the point succinctly when he said: "To care about the environment requires at least one square meal a day."[34] Consider the issue of biodiversity in this context. The poor and disadvantaged of western nations, surveys demonstrate, are much more concerned with economic development that will provide them with

steady jobs than with the effort to protect wildlife. As Dorceta Taylor, an environmental justice expert at the University of Michigan, remarks, "It is unrealistic to expect someone subsisting at the margins of the urban or rural economy, or who is unemployed, to support wildlife and wilderness preservation if she or he has no access to or cannot utilize these resources."[35] It is not difficult to understand why meeting basic needs for sufficient food, decent housing, a secure job, and a toxic-free environment rank above wilderness preservation for people struggling to make ends meet. Until basic needs are sufficiently satisfied, the protection of biodiversity will not be widely embraced by disadvantaged populations. Indeed, the protection of wilderness, which makes habitat off-limits to economic development, may be viewed as jeopardizing job creation. In this context, nature preservation may be seen as a luxury of the rich, and a threat to the poor.

The same is true at an international level. Today, one of the chief threats to primates is the destruction of native habitat as subsistence farmers slash and burn rainforests to grow crops for export, such as tobacco (Malawi), palm oil (Indonesia), or soya (Brazil). Equally devastating in some countries is the hunting of "bushmeat" by impoverished people. Preserving chimpanzees and gorillas and orangutans is a wonderful idea. But to those families that might starve in the absence of a meal of bushmeat, or are forced to cultivate crops in former forests, saving wildlife seems a privilege they can ill afford. In Africa, Indonesia, India and elsewhere, early efforts by western environmentalists to preserve wildlife and wilderness areas by cordoning off habitat without thought to the economic needs of local residents met with limited success and great resentment. Typically, it was viewed as catering to the needs of western tourists.[36] In contrast, community-based preservation efforts that tie wilderness preservation to the development of sustainable local economies have been more promising.[37]

The connection between environmental protection and the need for economic development is not limited to the preservation of biological diversity. Zero-emission and low-emission automobiles are now widely available, but their cost may be prohibitive for those who live below the poverty line. Well-constructed, well-insulated housing that conserves energy is also often beyond the economic reach of the poorest sectors of society. While the poor consume far fewer resources than the wealthy per capita, poverty often means that one cannot afford to be energy efficient. In such cases, economic development and sustainability go hand in hand.

In the developing world, a similar relationship exists between poverty and the inefficient use of other natural resources. Although kerosene lamps use fifty times more energy per watt produced than electric light bulbs, many urban slum dwellers and the rural poor still use kerosene lamps, contributing more to greenhouse gas emissions and also suffering from the smoke and unhealthy emissions. Solar cookers use reflected rays from the sun to cook food and, where necessary, pasteurize water. Yet relatively few people have such cookers. Indeed, about 80 percent of the world's peoples still collect and burn vast amounts of wood and charcoal for cooking. Oftentimes, bushes and trees are cut down for firewood faster than they can be replenished, leading to the erosion of mountainsides and savannas, and desertification. In these cases, increased conservation of natural resources and improved human welfare would be made possible through the provision of appropriate technology and sustainable economic development.

The development and deployment of appropriate technology and the creation of sustainable local economies will not happen sufficiently or quickly enough if the disadvantaged of the world are left to their own resources. In large part, that is because the disadvantaged are already integrated into -

and are further pushed into unsustainable livelihoods as a result of - a global economy. The opportunity is available to the wealthier countries of the world, those that consume most of the planet's natural capital and produce most of its toxic pollution, to help foster sustainable economies across the globe.

In 1960, the ten richest countries in the world were 30 times as rich as the ten poorest. Forty years later, they were sixty-five times as rich.[38] The stubborn fact is that great wealth and great poverty are both environmentally disastrous – the former owing to the massive consumption and waste that it encourages, the latter owing to the overpopulation and lives of desperation it produces. Developing countries currently account for well over 95 percent of world population growth. Stemming this tide will entail more than sharing words of concern for environmental protection. It will entail sharing the knowledge, technology, and resources that allow for the development of sustainable livelihoods. Research has consistently shown that education and economic opportunities, particularly for women, are one of the surest and fastest means to lowering reproduction rates and moving toward more sustainable societies.

All this is to say that in theory, and in practice, the protection of the environment may be helped, not hindered, when the impoverished and disadvantaged are aided in their efforts to gain education and economic opportunity.[39] Of course, it is important to stimulate the most sustainable forms of economic opportunity. Tom Athanasiou has said that "History will judge greens by whether they stand with the world's poor."[40] History's judgment, more precisely, will be determined by whether those who pursue sustainability join the world's disadvantaged to make ecological security and economic security mutually reinforcing.

Is a coercive, centralized authority required to preserve the global commons?

Within a group of friends or colleagues, there may be no need to coercively enforce laws forbidding thievery. A sense of care and common morality – the ethics of reciprocity - is sufficient. Within larger groups of individuals, such as nation-states, laws that forbid thievery and guarantee honest transactions appear necessary. These laws might be followed willingly by most people most of the time out of a sense of moral rectitude or cooperative engagement. Still, the presence of a police force and judicial system to enforce the law appears necessary to ensure that stealing does not become an irresistible temptation.

Anarchists disagree. They believe that order can be maintained within large organizations of people without any coercive authority or central government. Anarchism has a long and vibrant history. Its theory is much debated. Occasionally – and usually in very short-lived experiments – it has been put into practice. Embracing the sustainability framework does not entail the endorsement of anarchism. Within nation-states, advocates of sustainability are almost universally supportive of laws that uphold human rights, civil rights, and honest practices, while forbidding transgressions such as thievery and bribery. Governments with coercive powers are understood to be the necessary means of enforcing such laws.

In this respect, the sustainability framework does not dispute the claim that centralized authority may be useful, and is often required, to achieve many goods, including protection of the

environment. But a great deal of environmental preservation occurs in the absence of centralized authority.

In the "Tragedy of the Commons" and "Lifeboat Ethics," Hardin claims that the commons cannot be preserved in the absence of a coercive authority. To be sustained, the commons must either be divided up into parcels of private property (each managed by a sovereign owner) or protected by a sovereign world government. Both options present their own problems.

World government is unlikely to develop any time soon. (The United Nations, Hardin maintains, is a "toothless tiger" incapable of doing the job.) If it did develop, the threat of global tyranny would be ever-present. In turn, the presence of a central world government by no means guarantees ecological wellbeing. Many states with strong central governments – such as the former Soviet Union – had abysmal domestic records of environmental protection.[41] There is no reason to assume that centralized authority on a global scale would be more ecologically benign than the centralized authority of many of the world's states with the poorest environmental records.

The option of privatizing the commons, effectively parceling it up into packages of real estate owned and protected by individuals, is often neither workable nor effective at ensuring its protection. Some commons, the open seas or the atmosphere, cannot effectively be divided up and privatized. And historically, the "enclosing" of common lands has not deterred their depletion, erosion, and destruction.[42] Private property is often abused and destroyed for quick profit.

So centralized authority is no guarantee that the global commons will be preserved. And the privatization of property does not ensure that its natural resources will not be depleted or its ecological health maintained.

As importantly, the absence of a central authority does not make the destruction of a commons inevitable. There is a long history of communally managed resources, often called common pool resources such as pastureland, water sources, forests, and fisheries. These commons have been sustained across the generations through the cooperative engagement of local stakeholders. And this has been achieved in the absence of central, sovereign authorities.[43]

In turn, scores of bilateral and multilateral treaties and agreements between countries have also served to protect the global commons in the absence of a centralized authority. The Montreal Protocol, which protects the stratospheric commons and its protective layer of ozone, is a good example. Likewise, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which monitors and regulates trade in endangered species, has achieved a significant level of protection to more than 30,000 different species of plants and animals without a world government to enforce it. The Antarctic Treaty, adopted in 1961 by twelve signatories and now including 46 states, safeguards our southernmost continent - which like the world's oceans and atmosphere, is a true commons belonging to no nation and shared by all. The treaty protects Antarctica from militarization, nuclear testing, and waste disposal, while promoting peaceful, international scientific cooperation.

Consider efforts to address the transboundary movement and disposal of hazardous waste. Highly industrialized countries produce most of the hundreds of millions of tons of hazardous waste

generated each year. Significant portions of this waste crosses national borders, with most of it moving from industrialized to developing nations. The Basel Convention, which came into force in 1992 and now has 172 signatories, controls the trafficking of many forms of hazardous waste across national borders. The convention upholds the "Legal Principles for Environmental Protection and Sustainable Development" adopted by the World Commission on Environment and Development. A "non-discrimination" principle maintains that states "shall apply as a minimum at least the same standards for environmental conduct and impacts regarding transboundary natural resources and environmental interferences as are applied domestically."[44] In effect, the Basel Convention applies the golden rule to the international relations of toxic waste disposal. And it has proven quite effective. Along with many other multilateral treaties and agreements, the Basel Convention was created and maintained in the absence of a central, sovereign world government.

The efforts of non-governmental organizations (NGOs) to protect the global commons are also noteworthy. The most prominent of these groups, such as Greenpeace, the World Wide Fund for Nature, the Nature Conservancy, and the International Union for Conservation of Nature (which brings together government agencies and NGOs), span the globe and boast millions of members. No centralized authority coerces these groups to do the work they do, or forces members of the general public to join, donate money, time, and effort to furthering their missions. Yet these organizations foster tens of thousands of initiatives that further sustainability around the world. Not infrequently, their efforts eventually stimulate domestic or international governmental action. For example, CITES was originally drafted at a 1963 meeting of members of the International Union for Conservation of Nature, an international NGO, before being adopted over the following decades by 175 sovereign states.

Earth Share, a conglomerate of NGOs formed in the late 1980s, created a motto to capture the sensibility of its constituents. NGO members voluntarily contribute money, time, and effort to the protection of the global commons. The Earth Share motto simply reads: "It's a Connected World. Do Your Share."[45] Doing your share in an interdependent world is more than a moral imperative. It is a practical necessity if sustainability is to be furthered.

But why should anyone do his or her share? Why not simply throw up one's hands in frustration and defeat, believing that nothing one can do personally will make much of a difference? Alternatively, why not sit back and have a "free ride," gaining the benefits of any actions taken by others to sustain the world while contributing little if anything oneself? Why and how, in other words, do NGOs not only form and survive, but succeed and spread?

NGOs, whether oriented toward sustainability or the pursuit of other goods, manage to attract and motivate their members in three primary ways.[46] First, they develop and promote a sense of agency, making concerted action to alter the situation at hand feasible. While it may often seem impossible to make much of a difference to the preservation of the global commons as an individual, joining together with other like-minded people allows a greater sense of empowerment and efficacy.

Second, these groups foster a sense of collective identity or teamwork. At base, *homo sapiens* are social animals. Today, as in prehistoric times, they primarily live, work, and thrive in

communities. We have an instinct for solidarity. Friends demonstrate that they will "do anything" for friends. Athletes belonging to sports associations, and the fans that support them, demonstrate their loyalty and willingness to "give it their all" for the benefit of their teams. Citizens and soldiers do the same for their countries, often sacrificing life itself for the collective good. In the same fashion, NGOs give their constituents a sense of membership and identity. In this way, the success of the group also becomes the member's personal victory.

The third means by which NGOs attract and motivate their members is by identifying an injustice that requires redress. One of the strongest motivators we know as a species is the sense of injustice. Indeed, it often proves stronger than the pursuit of self-interest. Economists and social scientists have demonstrated this fact – already well known to historians – through empirical research.

In an experiment called the "Ultimatum Game," players interact to decide how to divide a sum of money. The first participant chooses how to split the sum while the second participant either accepts or rejects the proposal. If the second player rejects the proposal, neither player receives any money. If the second player accepts the proposal, the money is divided up according to the agreement. In many instances, the first player will propose a 50/50 split, presumably out of a sense of fairness. What is remarkable is that proposals that are too lop-sided typically will be rejected. If the first player proposes a 70/30 split, or an even more lop-sided distribution, the second player will often choose to go home with nothing rather than suffer the perceived injustice of gaining a small portion of the total sum.

The Ultimatum Game demonstrates that people naturally attempt to redress injustice, even if doing so will incur a personal cost. In the same fashion, NGOs that identify and work to redress perceived social or environmental injustice translate this natural sense of moral indignation in their members into collective action.[47]

Garrett Hardin maintains that "In large groups social policy institutions necessarily must be guided by what I have called the Cardinal Rule of Policy: *Never ask a person to act against his own self-interest*. It is within the limitations of this rule that we must seek to create our future." With this Cardinal Rule in mind, Hardin examines an effort by Greenpeace activists to protect whales:

> We are told of idealists on board this [Greenpeace] vessel who appealed by megaphone to the captain of a Russian whaler to cease his activities in the interests of the whales and posterity. The captain's reply was, of course, of the sort that we of the older generation call 'unprintable.' And why should it not be? Whatever sneaking admiration we may have for the idealists of the Greenpeace Foundation--and I confess I have more than a little--their program is quixotic because it violates the Cardinal Rule by asking people to act against their own self-interest.[48]

To be sure, self-interest is always a good motivator. Yet Hardin ignores the fact that Greenpeace has been quite successful in their anti-whaling campaign over the years. And the appeals made by Greenpeace – to the general public and to their political representatives around the globe - have not been directed toward satisfying these individuals' immediate self-interests. Rather, the appeals have been directed to the plight of the whales themselves, to the rights of future generations, and to

the welfare of the global commons. Self-interest is neither the sole, nor always the most powerful, motivation.

NGOs dedicated to environmental conservation have historically appealed to the welfare of endangered animals and to the welfare of future generations. Increasingly – and markedly so in the last two decades - they have also linked their conservation efforts to the pursuit of social justice. The World Wide Fund for Nature (WWF), for example, was initially formed as an agency for the protection of wildlife in biologically rich but economically poor countries. Their early efforts met with mixed success and often alienated local peoples. In the late 1980s, WWF's perspective and strategy changed. The organization shifted from a narrow focus on protecting charismatic megafauna – species such as lions, rhinoceroses, tigers, and elephants – to the preservation of biodiversity and the promotion of sustainability through local economic development and community empowerment.[49] The idea was to make habitat protection a paying proposition for local residents.

Likewise, The Nature Conservancy shifted its strategic orientation a couple decades ago. Earlier efforts were oriented to the purchase of large swaths of ecologically rich land, with the subsequent task that of policing these preserves against poachers or other environmentally destructive practices. Now efforts to preserve landscapes are tied to the sustainable economic development of local populations.[50] The protection of biodiversity is grounded in "community-based conservation."[51] As one Nature Conservancy official stated, "conservation works place by place ... in every ecosystem we're working in, we need long-term community support or we will fail."[52]

A fine example of a successful NGO that focuses its efforts on community-based solutions is Engineers without Borders. This organization supports development programs in communities around the world by helping to design and implement sustainable engineering projects. With more than 400 projects in 47 countries, Engineers without Borders-USA (there are dozens other affiliates in other countries) primarily focuses on low-cost, sustainable water and energy projects. In each case, meeting the basic needs of local residents and developing community leadership and ownership of projects is central to the mission of the organization. For Engineers without Borders, sustainability begins at home, in self-responsible communities that develop the tools and resources to meet their own needs.

While governmental authorities and the laws they promulgate and enforce will always be necessary to protect public goods, including environmental resources, a centralized, coercive force is no guarantee of environmental protection. The role of government is to protect and empower its citizens. Government has the responsibility to protect citizens from the law-breaking of other citizens, from the power of business corporations and other organized groups, and importantly, from the unconstitutional and excessive intrusions of government itself. In turn, government has the responsibility to empower citizens to sustain themselves and their world as individuals and through the non-governmental organizations they form. By way of this empowerment, through the customary and cooperative engagement of local stakeholders and the efforts of transnational non-governmental organizations, the domestic and global commons often gains much-needed protection. In such cases, the successful protection of the commons is grounded in a sense of justice that is perceived to complement rather than contravene long-term self-interest.

Distributional Principles

John Rawls, as we saw in earlier chapters, defines justice as pertaining to the determination of rights and duties and the fair distribution of social advantages.[53] In a just society, Rawls argues, basic civil rights are upheld and the social advantages of education and economic opportunity are equitably shared. Justice also requires the fair distribution of social *dis*advantages, such as environmental risks. In turn, it requires a fair distribution of power and decision-making abilities, as these (political) goods determine how and to whom other social advantages and disadvantages will be distributed. This is a very important component of justice, and Rawls is sometimes faulted for paying insufficient attention to the underlying causes of maldistribution that result from power differentials, discrimination, and oppression.[54]

Why should a government or state be involved in the distribution of social goods? Why not allow each individual (or family) to be on its own, to prosper or suffer the full consequences of its actions, to succeed or fail based solely on its own efforts and resources? One reason is that no one – and certainly not the most powerful people of any society – ever truly succeeds on his own. All benefit from the basic infrastructure and services that society provides, such as elementary and secondary education; roads, bridges, and highways; the administration of civil justice and police forces; and national defense. No one would be able to gain much in the way of knowledge or economic opportunity without this basic infrastructure. Given that social advantages can only be obtained by way of a foundation provided by society at large, there is reason to insist that these advantages be distributed fairly within society.

A *fair* distribution of social advantages does not mean an *equal* distribution. Absolute equality in the distribution of social goods would be very difficult to achieve and maintain. And it is not clear that such a distribution would be fair or just. Arguably, fairness and justice entail the appropriate rewarding of effort. Since unequal individual efforts may be involved in the pursuit of social advantages, a fully equal distribution of these advantages may be unjust and unfair to those who exerted more effort.

Rawls grapples with the challenge of achieving a fair distribution of advantages in society by developing what he calls the "difference principle."[55] We recall that for Rawls justice can best be conceived by asking how we would order society and distribute the benefits and costs of social life from the original position. Here, standing behind a veil of ignorance, we would not know our socio-economic status, or any of our personal attributes or history. Rawls argues that people behind the veil of ignorance would insist that basic civil rights be safeguarded. That is to say, they would ensure equal liberty. They would also insist on equality of opportunity. This would ensure that individuals were not prevented from seeking education or competing for jobs or offices. Invoking the difference principle, Rawls then argues that unequal distributions of social and economic benefits should only be allowed when these inequalities can be demonstrated to benefit the least advantaged in society and are (in accordance with the equal opportunity principle) attached to offices or positions that are open to everyone.

In other words, once everyone's civil rights are secured, and equality of opportunity ensures that everyone is able to seek education and compete fairly for jobs, positions, or offices, then inequalities that arise out of this competition are acceptable if, and only if, these inequalities

benefit the least advantaged in society. So, for instance, if everyone including the least advantaged in society benefit from the most knowledgeable, most skilled, and hardest-working scientists and engineers filling the most important positions in their respective institutions or corporations, and if paying higher salaries can be shown to ensure that the best scientists and engineers apply for and retain these positions, then inequalities in income would be considered acceptable. To generalize, a meritocracy in a particular field of endeavor that rewards the best people the most may produce acceptable inequalities if the least advantaged in society benefit from that meritocratic organization more than they would were rewards (salaries) equally distributed regardless of merit. Consequently, goods should be more equitably distributed if this redistribution does not make the least advantaged in society worse off.

What, then, of social disadvantages? Should they also be shared equitably? Consider environmental risks. We have observed that risk in life cannot be eliminated, only comparatively assessed and mitigated. Managing risks within a precautionary framework entails reducing the gravity and frequency of adverse events. It also entails ensuring that those who produce environmental risks remain responsible for justifying their acceptability and compensating those who suffer harm. Another important feature of risk management is "spreading risks across a group such that particular individuals or sub-classes are not inequitably subject to non-compensated risk."[56] In other words, just as the advantages that come with collective life ought to be equitably shared, so, too, must the disadvantages.

Currently, the poor and powerless members of society – those without the economic or political means to get their needs met – also tend to be the most vulnerable to environmental risks, such as exposure to high levels of pollution or toxic material in their neighborhoods and workplaces. As sociologist Ulrich Beck argues, wealth tends to accumulate at the top of the socio-economic spectrum, while risks accumulate at the bottom.[57] These risks are not limited to health hazards from increased exposure to pollution or waste. Non-governmental organizations also address what is being called "climate justice."[58] Those people already living near subsistence levels around the world will undoubtedly bear more than their fair share of the effects of climate change, such as decreased agricultural yield, flooding and other effects of weather pattern changes, increased desertification and water scarcity, and sea-level rise with its accompanying displacement of residents and farmers of low-lying coastal lands.[59] Even if a precautionary approach minimizes such risks, we are still left with the problem of achieving a fair distribution of them. Unlike the issue of economic compensation and opportunity, a meritocratic approach is not likely to yield acceptable results in the arena of environmental risks. There is no reason to believe that the least advantaged in society benefit from bearing more than their fair share of environmental risks. If anything, were the most advantaged members of society to bear more environmental risks, one might presume that efforts to limit or eliminate the environmental hazards would be increased.

The chief means of ensuring that advantages and disadvantages, including risks, will be more equitably distributed in society is to ensure that political power and decision-making processes are themselves more equitable.

Sharing power

America's "father of conservation," Gifford Pinchot, spearheaded the creation of the U.S. Forest Service and was its first chief from 1905-1910. The agency was in charge of managing public lands newly established as national forests. It found itself battling the "boomers" and "land-grabbers" of the day, men who plundered western lands for mineral wealth and timber. What Pinchot said about conservation at the turn of the century applies well to contemporary sustainability. Pinchot wrote:

> The central thing for which Conservation stands is to make this country the best possible place to live in, both for us and for our descendants. It stands against the waste of natural resources which cannot be renewed, such as coal and iron; it stands for the perpetuation of the resources which can be renewed, such as the food-producing soils and the forests; and most of all its stands for an equal opportunity for every American citizen to get his fair share of benefit from these resources, both now and hereafter.[60]

Conservation, Pinchot maintained, was a moral duty. It entailed the "application of commonsense to the common problems for the common good," producing a "wise use of the earth" with the goal of attaining "the greatest good of the greatest number for the longest time." [61]

Gifford Pinchot argued that conservation was an inherently democratic movement. The same might be said about sustainability – for two reasons. First, as recent empirical studies have demonstrated, democratic forms of deliberation and interaction tend to promote a future focus, an expanding sense of community, and holistic thinking, all of which dovetail nicely with sustainability values.[62] Second, the social justice facet of sustainability requires not only the equitable distribution of social benefits and risks, but the equitable sharing of power. As the World Commission on Environment and Development observed, "the pursuit of sustainable development requires ... a political system that secures effective citizen participation in decision making."[63] Of course, democracy is no panacea. To the extent democracy is tied to a hyper-individualistic consumer culture or to nationalistic commitments, it may thwart long-term, global sustainability. However, if we define democracy as the equitable distribution of political power such that citizens (or stakeholders of businesses, universities, or civic groups) become widely and meaningfully involved in the processes of deliberating and securing the common good, then democracy is indeed an inherent feature of sustainability. Sustainable governance, grounded in democratic principles and practices such as civil rights, the rule of law, open elections, and transparency, sustains environmental caretaking and social justice. [64]

Marshall McLuhan, the well-known communications theorist who coined the phrase "global village" to describe today's interdependent world offered a powerful image to describe the relationship between democratic participation and sustainability. "There are no passengers on Spaceship Earth," McLuhan said, "everybody's crew." The responsibility of being crew derives both from the nature of the threats to Spaceship Earth and from the chief means of meeting these threats. On our planetary craft, given current levels of social and environmental interdependence, a threat to one ultimately is a threat to all. Sustaining the craft, in turn, will require widespread, cooperative effort involving all stakeholders.

Of course, not all crew members bear the same level of responsibility. Democratic political power, while in theory dispersed across the entire citizenry, is in practice primarily held by elected

officials. We might invoke an adapted version of the "difference principle" here to justify this unequal distribution of political power.

Large populations make direct democracy, where the citizenry turns out en masse to deliberate and make decisions, a practical impossibility. Representative political institutions translate the democratic power equally vested in each citizen into workable decision-making bodies composed of elected officials. The difference principle would suggest that the inequitable political power held by elected officials is acceptable if it is attached to offices that are open to everyone (a feature of all true democracies) and if it benefits the least advantaged of society. Given that direct democracy in mass societies is practically impossible, the absence of representative bodies would create an unworkable political system. Without a functioning government in place, the least advantaged in society would in all likelihood be further disadvantaged by the most powerful individuals and groups, who could pursue their self-interest in the absence of democratic control.

The principle of transparency

In any democratic system, power is primarily held by representative bodies whose members are elected to office. In such systems, the principle of transparency is a crucial means of ensuring responsible government. Transparency refers to the openness of decision-making processes to examination by the general public. Open parliamentary debate and open legislative (roll call) votes are key features of transparency in government, allowing the public to hear arguments in favor and against each piece of legislation and to know which elected representatives voted for or against it.

Transparency in government goes beyond what happens on the floor of the legislature. It addresses the public's right to know how legislators were influenced in their decision-making processes prior to debating and voting in the chambers of government. Of course, legislators may be influenced by myriad people and events. There is no practicable way of keeping track of all these potential influences, or determining which of them proved particularly salient. However, many governments require their elected officials to keep formal logs of meetings. Perhaps more important, elected officials are often required to keep records of their meetings with professional lobbyists, and to disclose the names of donors to their (re)election campaign funds. The assumption here is that money often speaks with a particularly loud voice. Making the influence of professional lobbyists and campaign contributors public information is one of the more effective means of bringing transparency to government.

Transparency in government aids citizens in their own decision-making processes. Citizens have a responsibility to elect the best candidates to office. Determining which candidate will make the best representative requires information. Knowing what candidates campaigning for re-election said in legislative session, how they voted, and whom they met with and received money from are crucial pieces of data to inform the discerning voter.

Likewise, transparency in business corporations is a crucial means for consumers concerned with sustainability to inform their own decision-making processes. In this case, the data do~~es~~ not help the public decide between competing candidates in open and free elections. Rather, it helps the public decide between competing products in an open and free market. The idea is that

consumers have a right to know what social and environmental impacts the products they buy have on their local communities and on the planet.

In the late 1970s, a step was taken toward such transparency in business with the creation in Germany of the "Blue Angel" environmental label. The Blue Angel organization gave their seal of approval to those products that had minimal environmental impact. Effectively, consumers could now see deeper into products and businesses. A decade later, the "Green Seal" program was initiated in the United States.[65] To earn the Green Seal, a product must meet certain environmental standards set out by the organization which tests the products employing scientific methods. Since the mid-1990s, a conglomeration of 25 organizations, including Green Seal, formed the Global Ecolabelling Network (GEN) to promote and improve environmental performance monitoring and labeling across the globe, allowing consumers to distinguish brands by their environmental impacts.

Ecolabelling is not the only means to achieve greater transparency in business. A number of organizations evaluate and rate products in the marketplace employing social and environmental criteria and provide this information to the public on websites. Effectively, they provide the sustainability equivalent of *Consumer Reports*. These evaluation and rating organizations, such as Goodguide,[66] rank products and companies based on their health risks, environmental performance, and social impact. Though no labels actually appear on the products they evaluate, greater transparency is gained through the information they provide, allowing sustainability-oriented consumers to make better-informed choices. Shoppers today appreciate the federally mandated labeling that displays the ingredients as well as fat, protein, sodium and caloric content of packaged foods. Ecolabeling and rating services attempt to provide similar transparency regarding the environmental and social impacts of many of the other things we buy.

Ecolabeling and environmental rating services constitute third-party efforts to assess and certify products employing sustainability criteria. Many businesses today take on this task in-house. Their efforts are built upon a burgeoning field of industrial ecology, which employs various techniques of design and analysis to provide detailed information of - and subsequently minimize – the social and environmental impacts of their products and services.

One of the primary techniques employed in industrial ecology is life cycle assessment (LCA). LCA provides data on the social and environmental impact of products and services by investigating the complete "life" of products and services from "cradle to grave." That is to say, LCA begins with the social and environmental impact of the extraction and use of raw materials, examines the full set of manufacturing processes, calculates the effects of distributing the product, assesses its use by consumers, and, finally, investigates how the product is disposed of at the end of its productive life. If products are designed well enough such that they can be wholly reused or recycled at the end of their productive life, then LCA may expand to a "cradle to cradle" analysis. In examining each of these phases in the life cycle of products and services, LCA analysts address toxic waste production and pollution (including greenhouse gas emissions), habitat destruction, land degradation (including salinization and desertification), natural resource depletion, and a potentially extensive list of indicators measuring social impacts, which may include employee compensation, labor and human rights practices, working conditions, and diversity policies.

The origins of environmental transparency stem not from the assessment of the environmental impact of purchased goods, but rather from the assessment of risks. As we saw in the previous chapter, Rachel Carson's investigation of the effects of chemicals on local ecologies stimulated "Right to Know" legislation that created greater transparency in the production and release of toxic chemicals. This information allowed workers and residents to become more informed about the safety of their workplaces and neighborhoods. By extending our "right to know" from the category of toxic chemicals to a broad range of social and environmental impacts of goods in the marketplace, ecolabeling, environmental rating services, and life cycle assessment provides consumers with the means to evaluate the sustainability of their purchases.

In an economically interdependent world, where consumers enter a global marketplace, transparency is a crucial element of social justice. The purchaser of a steak or hamburger in New York may not realize that the cattle that produced his meat were nourished with feed exported from soya plantations in Brazil, plantations that have destroyed millions of acres of rainforest. The consumer of doughnuts in Los Angeles may not realize that her product contains palm oil from plantations in Malaysia and Indonesia that have leveled rainforests in these tropical lands, destroying vital habitat for million of
species and contributing to global warming. Likewise, consumers of shrimp and prawns farmed in Thailand may not realize that their meal has contributed to the destruction of thousands of hectares of mangrove swamps, which are critical breeding grounds for fish and other sea life.

In all of these cases, products designed to satisfy the needs and wants of distant consumers – often from western countries – have had the effect of decreasing biodiversity, contributing to climate change, and undermining the sustainable livelihoods of local subsistence hunters, gatherers, small farmers, and fishermen. The chief threats to global sustainability, with this in mind, is not only or even primarily the very visible overuse of resources by the growing populations of developing countries, but the ever increasing demand for resources by non-local consumers, primarily from developed countries.[67] Providing these consumers with useable information about the products they buy is crucial to the development of a sustainable global marketplace.

Transparency and Technology

Francis Bacon, the seventeenth-century polymath, famously said that "Knowledge is power." The principle of transparency is one of the central features of the more encompassing ethical obligation of sharing power. Transparency in business affairs entails sharing knowledge of the components or ingredients of products and services, and the social and environmental costs and risks associated with their production, distribution, use, and disposal. This puts more power in the hands of consumers, workers, and residents, who can make environmentally and socially informed decisions about what they purchase, where they work, and where they live.

Knowledge is power. But more data and information do not always translate into more knowledge. For example, many consumers do no understand the health or environmental implications of the various ingredients listed on their packaged foods. To complicate matters, much of today's technology – whether provided through agricultural services, medical and pharmaceutical services, media services, industrial and construction services, or military services - remains several steps removed from the consumer. The consumer of services may never become

aware of the technology employed to conduct tests on her blood, the pesticides used in growing her food, the resources involved in making the films, television shows, and internet websites she enjoys, the machines and components that produce her appliances, or the craft and weaponry developed to outfit the armed forces mandated to protect her. Yet all of this technology has social and environmental impacts. More than not, the technology is so sophisticated that consumers would not be able to evaluate the data describing it even if it were made available.

Certainly government has a role to play in assessing the social and environmental impact and risks of technology. There are, in turn, various NGOs, many of which serve as "watchdog" groups, that have taken on this task. The Union of Concerned Scientists, for instance, with over 250,000 members, is a leading science-based NGO working in the sustainability field. Its founding statement, issued in 1969, contained these words:

> The vastly increased importance and complexity of technology has, in effect, increased the ignorance of the public and its elected representatives… Only the scientific community can provide a comprehensive and searching evaluation of the capabilities and implications of advanced military technologies. Only the scientific community can estimate the long-term global impact of an industrialized society on our environment. Only the scientific community can attempt to forecast the technology that will surely emerge from the current revolution in the fundamentals of biology. The scientific community … must engage effectively in planning for the future of mankind, a future free of deprivation and fear…. Far-reaching political decisions involving substantial applications of technology are made with virtually no popular participation. It is our belief that a strengthening of the democratic process would lead to a more humane exploitation of scientific and technical knowledge, and to a reduction of the very real threats to the survival of mankind.[68]

Today the Union of Concerned Scientists focuses on making transparent the benefits and risks of technological developments, government policy, demographic change, and consumer patterns related to energy production, transportation, security, agriculture, wildlife conservation, and climate change. Arguably, those who have benefited from higher levels of expertise, such as scientists and technical professions, have a heightened responsibility to assess, evaluate, and disseminate the social and environmental impacts and risks posed by technology.

The Principle of Autonomy

The principle of transparency is grounded in the assumption that all who potentially bear the risks associated with the development and use of technological innovations and processes, products and services, have a right to be informed of these risks and involved in evaluating their acceptance or rejection. Arguably, government agencies mandated with evaluating such risks should include or seek counsel from representative bodies involving multiple stakeholders – independent scientists, business representatives, as well as consumer and citizen advocacy groups. If the risk involved is deemed too high, products should not be allowed to be sold. When the risk involved is determined to be within acceptable limits, the product may be made available for purchase. In such cases, transparency still demands that the level and nature of the risk be made patent, so that individual consumers may exercise their autonomy in deciding for themselves if this is a risk they are willing to bear.

What happens in cases where risks are not restricted to those consumers who purchase the new technology, product and service? When, if ever, is it legitimate for an individual or agency to foist risks on a wide range of consumers or citizens without their awareness or consent, effectively stripping away their right to choose for themselves? In the last chapter, we touched on this concern regarding the issue of the genetic engineering of humans. The autonomy of parents to refuse the technology was limited in such cases by what might be considered market forces. But this autonomy was not wholly denied. There are many examples, however, where the autonomy of stakeholders to refuse new technology and products, and the risks associated with them, is denied.

Consider the case of genetically modified crops. The United States currently produces more than half of all the genetically modified crops in the world, with soybeans and corn engineered to be resistant to herbicides composing the largest portion of this total. Up to 75% of all processed foods in the U.S. contain a genetically modified ingredient.[69] There is significant scientific research indicating that genetically modified organisms (GMOs) are safe to eat. However, concerns remain about possible allergens and other safety issues to consumers. In turn, since many of the plants that are engineered are modified to be more resistant to herbicides or pesticides, it is possible that GMOs will have the effect of increasing the use of biocides, which will have unanticipated and undesirable environmental effects. There are also concerns that gene transfers may occur between GMOs and weeds, making the latter more resistant to biocides. In turn, genetically modified crops may be harmful to other organisms. As noted in Chapter 1, Monarch butterflies appear to be harmed by the pollen from genetically modified corn that incorporates the Bt toxin. Finally, genetically modified crops may prove too expensive for many farmers in developing countries, potentially undermining the pursuit of sustainable livelihoods.[70] In short, there are comparative risks associated with GMOs. In the face of such comparative risks, is it possible for consumers and farmers to refuse GMOs? Can they exercise their autonomy by effectively opting out of this technology?

First, it is important to recognize that in the United States (unlike many European countries), food that contains GMOs is not required to have any special labeling. This violates the principle of transparency. Yet there is more at stake. Genetically modified crops may cross-pollinate with regular crops. If and when this occurs, farmers of non-genetically modified crops, and consumers who wish to eat only non-genetically modified foods, have no effective way of ensuring that what they produce or consume is indeed free of GMOs.

In the same vein, people who choose not to benefit from fossil fuel use still have to bear the effects of climate change. People who choose not to benefit from satellite technology still have to view the night sky marred by the reflections of hundreds of orbiting machines crossing the horizon. People who may choose not to benefit from nanotechnology will still face the risks of "green goo" if self-replicating nanobots get out of control. In all of these cases, and many more, the ethics of sustainability confronts us with the obligation not only to ensure transparency but to safeguard, to the greatest extent possible, the rights of individuals and groups to opt out of technologies whose costs and risks they are unwilling to bear.

The pursuit of social justice does not require that we eliminate risks, only that risks be equitably distributed in society. It also requires, to the greatest extent possible, that individuals retain the

autonomy to determine, in the light of information made available through transparent processes, which risks they choose to endure.

Conclusion

Two millennia before Garret Hardin penned "The Tragedy of the Commons," Aristotle wrote in *The Politics:* "That which is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest."[71] Protecting a commons – including the global commons - will never be easy. Shortsightedness and self-interest make sustaining of public goods a hefty challenge. Social justice, which attends to the good of society as a whole, is an ideal that we only ever approach, never fully achieve. Like sustainability, it is a path to be walked, not a destination to be reached.

Can we forego the effort to pursue social justice, reject distributive principles, and simply deny the reality of a global community? Kofi Annan, Secretary-General of the United Nations, addressed the World Summit on Sustainable Development in Johannesburg, South Africa in 2002 with these words: "A path to prosperity that ravages the environment and leaves a majority of humankind behind in squalor will soon prove to be a dead-end road for everyone …. Unsustainable practices are woven deeply into the fabric of modern life. Some say we should rip up that fabric … I say we can and must weave in new strands of knowledge and cooperation."[72] Annan insists that sustainability and social justice are not quixotic ideals. They are not even possibilities among other options. Rather, they are necessities for survival. Knowledge and cooperation are the means to their pursuit.

At times, knowledge and cooperation may produce new national and international treaties, protocols, agreements, policies and laws that promote sustainable development through legally and politically enforceable means. At times, knowledge and cooperation may produce new businesses and products that foster sustainable development by employing the market to deliver green technology. At times knowledge and cooperation may produce voluntary associations of NGOs working to foster sustainable livelihoods. At times, knowledge and cooperation may produce new relationships and efforts to realize sustainable development through institutions of democratic decision-making, power-sharing, education, and self-governance.

Slavery was once considered a natural and unavoidable institution. It had been practiced since the dawn of civilization in ancient Sumer, Assyria, Egypt, and Greece and was assumed to be an indispensible means of economic survival and the inevitable product of human nature. Slavery was a part of life in Britain since prehistory, from before the time of the Roman invasion. As its empire grew in the 1700s, Britain had established the largest slave-trade of any country in the world. Then, quite abruptly in the early 1800s, Britain outlawed slavery throughout its dominion, owing in large part to efforts of the Abolitionist movement – an early NGO - that viewed slavery as inherently immoral and unjust. While the end of slavery was opposed by some, and linked to the end to British economic might and global power, history turned out quite differently. Within decades of the outlawing of slavery, Britain's industrial revolution came into full force, providing the engine for its growth into the largest empire the world has every known by the early 1900s.

The sustainability movement might look to the end of slavery as a demonstration of the power of ethical resolve over ancient prejudice. It might argue, with the abolitionist movement as its

exemplar, that the pursuit of social justice within the global community will not be the harbinger of decline, but the catalyst of greater prosperity.

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CHAPTER 6
ENVIRONMENTAL ETHICS: OTHER SPECIES AND THE COMMUNITY OF LIFE

As noted in Chapter 3, an ethic of sustainability involves three distinct subfields within ethics, corresponding to the environmental, social, and economic issues that sustainability encompasses. Chapter 3 introduced all three ethical fields, with special attention to social and economic issues. In this chapter, we look in more detail at the ethical dimensions of our relations to other species and the community of life more generally. This brings us to environmental ethics, a relatively recent area within ethics that focuses on the value of non-human nature, including nonhuman animals as well as ecological communities. The chapter will provide an overview of major issues, thinkers, and theoretical approaches in environmental ethics. Issues of special interest include the role of scientific, especially ecological, principles and ideas in environmental ethics, and also the relationships between social and ecological communities in relation to environmental justice.

This chapter also addresses arguments about the ethical status of nonhuman animals, both as individuals and as parts of species or populations. This includes discussion of the ways that non-human animals enter into environmental ethics, particularly in relation to arguments about individual rights or interests, as distinct from the more holistic arguments that are dominant in many environmental philosophies. We also address the moral status of domestic animals and their relationship to an ethic of sustainability, using the notion of a "mixed community" in which humans coexist with non-human, and particularly domestic, animals.

Finally, building on the discussion in Chapter 3 and elsewhere, this chapter articulates the specific characteristics and requirements of an ethic of sustainability. Because environmental ethics is so central to sustainability, we must understand the differences and similarities between environmental and sustainability ethics in order to achieve sustainability.

EMERGENCE OF ENVIRONMENTAL ETHICS

Environmental ethics in the most general sense – philosophical reflection on the moral value of nonhuman nature – has as long and varied history of philosophical ethics. Nature's value and its relation to human life are important themes from the very origins of both religious and secular ethics, appearing in the work of foundational Western philosophers such as Aristotle and Ptolemy and in the sacred texts of most world religions, both Asian and Western. While nature is a continuous concern, it has been highlighted in the work of certain thinkers, whose work provides a reference point for many contemporary environmental philosophers. Among the most influential Western thinkers who have given nonhuman nature sustained reflection are Saint Francis of Assisi and the Transcendentalists including Henry David Thoreau (1817-1862) and Ralph Waldo Emerson (1803-1882). These thinkers influenced early Western environmentalists such as John Muir (1838-1914), who put forth the basic philosophical claim that nature

had intrinsic value and deserved protection and even veneration regardless of its instrumental value for humans.

While the history of philosophical reflection on nature is long and varied, the birth of modern environmental ethics is generally dated to the work of Aldo Leopold (1887-1948). Born in Iowa, Leopold worked for many years for the U.S. Forest Service, first in the Southwestern U.S. and then in Wisconsin. In 1933 he became a professor of Game Management at the University of Wisconsin in Madison, where he lived until his death fighting a forest fire on a neighbor's land. Leopold's career coincided with the early development of the field of ecological science was just developing, and he had great influence on a range of fields from ecology and wildlife management to philosophical ethics.

Leopold's greatest and most lasting impact came through his essay titled "The Land Ethic," part of a posthumously published collection of essays titled *A Sand County Almanac* (1949). "The Land Ethic" revolutionized philosophical thinking about the value of nonhuman nature and paved the way for the emergence of environmental ethics as a distinctive subfield. In the essay, Leopold took an evolutionary approach to ethics, citing an ethical history through concentric circles that dates back to the roots of society. The first circle or stage of ethics was in the relations between individuals; the second circle was an extension of individualistic ethics to encompass individuals and society. The third step in this sequence is to extend the moral circle from just people and society to include nonhuman nature. As Leopold summarized, "The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land."[1] The land, for Leopold, was not merely soil, but what we now think of as an ecosystem, or "a fountain of energy flowing through a circuit of soils, plants, and animals."[2] This interconnected web of inorganic elements and living beings deserves to be treated with love and respect, for it has not only instrumental but also intrinsic value. The goal of environmental ethics, in Leopold's vision, is to encourage people to think about how they use land as not simply an economic concern but also an aesthetic and especially a moral issue. The land ethic provides a basic guideline by which people can judge the moral correctness of different attitudes and actions regarding nature. Leopold writes: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."[3]

Though Leopold's land ethic is a very simple premise, extending the circle of moral concern to the land, it was revolutionary and counter to the prevailing notions of his day. The land ethic called for a shift from *land as resource* to *land as community*, with the proper role of humans as "plain members and citizens" rather than conquerors. Leopold made a move away from a more anthropocentric (human-centered) view of the land to a more ecocentric (nature or ecologically-centered) one. His ecocentrism is considered to be a holistic in that what is best for the land, or nature, is what best preserves the ecological integrity of the entire community and not just for individual elements – human or otherwise. As a result, environmental decisions must be made in light of what best preserves the integrity of nature and not on what is most convenient, useful, or economically expedient to people.

Although the academic field of environmental ethics has grown exponentially in the past sixty years, Leopold's land ethic continues to be one of the major models. The "land ethic" is the best known example of a holistic, ecocentric ethic, which has spawned many variations and modifications – and not a few critiques. Leopold's work remains a reference point and touchstone even for philosophers who ultimately advocate different sorts of ethics, e.g., those that are more individualistic or more anthropocentric (human-centered) than Leopold's vision. In part, the power of the land ethic lies in its brevity: it sets out an agenda for an entire field in just a few short pages, with enough specificity to prompt lively debate while also leaving most of the work of practical systematizing still to be done.

Following on "The Land Ethic," environmental ethics – and environmentalism generally – reached another major turning point with the 1962 publication of *Silent Spring*, by Rachel Carson (1907-1964). Carson, a biologist and naturalist, wrote *Silent Spring* as an impassioned and detailed attack on the destructive ecological consequences of pesticide use, but it is also an attack on the notion that scientific progress is always beneficial. Sometimes, Carson argued – as in the case of pesticide use – scientific progress is more destructive than anyone could have anticipated. Carson especially criticized the widely used chemical known as DDT (dichlorodiphenyltrichloroethane). Chemicals such as DDT were efficient and economical ways to eradicate pests and increase crop yield, but they also had unintended consequences to humans and the environment alike. In the absence of detailed studies and without guidance by any sort of precautionary principle, not only farmers but also public health officials – seeking to reduce mosquitoes – used DDT widely, in the U.S. and other parts of the world. One of the key ecological problems of DDT was that it is soluble in fat but not water, which leads to bioaccumulation in microorganisms that would then be eaten by larger organisms. In other words, DDT becomes increasingly concentrated as it moves up the "food chain." Carson made the case that DDT bioaccumulation in birds decreased calcium in their egg shells rendering the eggs unable to withstand incubation and other environmental variables.

The dangers and damages reported by Carson in *Silent Spring* led to both an outcry against pesticide use by the public and defenses of the agricultural necessity of pesticides by the manufacturers of the chemicals. Though these companies vigorously tried to discredit Carson and invalidate her claims, the book was widely praised and mobilized many Americans against the dangers of DDT. More generally, *Silent Spring* is recognized to have launched the environmental movement in the United States. As a result of the book's popularity, many Americans became more aware of the interrelations of humans and nature and how human technologies can have wide-ranging effects that cannot be bargained against the health and well-being of our planet, human or non-human. DDT was banned in 1972 for agricultural use in the U.S., in no small part due to the Carson's work. The banning of DDT in the U.S. is one of the major reasons for the recovery of the bald eagle, among other endangered bird species. (The chemical is still used in some developing countries.)

One of the key ecological and philosophical messages of *Silent Spring*, echoing Leopold's argument, is that of interdependence. Leopold insisted that the natural world can only be understood as a whole – "the land," consisting of webs of relationships among animals, plants, and the physical landscape. Carson's arguments built on this assumption, highlighting the damage that is done when humans ignore natural interdependence and pursue their own scientific or economic goals without addressing the consequences. Interdependence is central both to contemporary ecological science and to contemporary environmentalism, which takes as one of its central tenets John Muir's assertion that "When we try to pick out anything by itself, we find it hitched to everything else in the universe."[4] A more recent and popular version of this notion is found in the "laws of ecology" commonly attributed to Barry Commoner (1971). The first law is that "Everything is connected to everything else." Two of the other rules also highlight interdependence: "Everything must go somewhere" and "There is no such thing as a free lunch." The last of Commoner's rules, "Nature knows best,"[5] emphasizes the incompleteness of human knowledge, an important point for Carson and Leopold as well. Both interdependence and incomplete knowledge reinforce the wisdom of the Precautionary Principle – if every action has potentially momentous consequences, and we cannot know all the possible consequences of any action, then caution and humility should be our guiding principles.

Carson and Leopold wrote primarily as scientists, drawing on their professional experience and training as the foundations of their moral attitudes toward the nonhuman world. Ecological science remains central to environmental ethics today, which is generally dominated by scholars trained in humanistic disciplines such as philosophy, religious studies, and history. These scholars draw on the work of earlier thinkers include Transcendentalists such as Thoreau and Emerson, Muir (who was influenced by the Transcendentalists), and a host of religious thinkers, including Saint Francis and Buddhist and Taoist scriptures, among many others. Many of the secular philosophical approaches discussed in Chapter Three, including pragmatism, utilitarianism, and rights theories, have also found their way into contemporary environmental ethics.

One of most important documents in the development of environmental philosophy is a controversial article, "The Historical Roots of Our Ecologic Crisis," by Lynn White Jr., a historian of science. In his essay, published in 1967 in the journal *Science*, White argued that human values deeply condition human practices, and specifically that religion deeply conditions environmental practices. White made this claim in the course of his critique of Christianity and its influence on deleterious environmental practices throughout history. White claimed that Christianity is the most anthropocentric religion in the world, as some manifestations of the religion hold that it is God's will for humans to dominate and subdue the earth. Creation was made to serve human purposes, which justified increasing exploitation of nature as technology advanced over time. In light of the strong correlation between certain deleterious Christian ideas of nature and environmental degradation in certain historically Christian societies, White asserts that "What people do about their ecology depends on what they think about themselves in relation to things

around them. Human ecology is deeply conditioned by beliefs about our nature and destiny -- that is, by religion."[6]

At the root of White's thesis is that environmental practice is inherently a religious issue, even for those who are not religious, because religion has so pervaded history and society that it cannot become disentangled from general views on nature. "What we do about ecology depends on our ideas of the man-nature relationship. More science and more technology are not going to get us out of the present ecologic crisis until we find a new religion, or rethink our old one."[7] White thus posed environmental problems as essentially social and moral problems rather than scientific and technical ones. The attitudes and principles that guide our scientific research and technological developments, in other words, are more important than the science and technology themselves. This has become one of the central claims of environmental ethics: there can be no purely technical solution to environmental problems. The best way to approach these moral issues, however, is subject to much debate.

ISSUES AND APPROACHES IN ENVIRONMENTAL ETHICS

Environmental ethics shares many common themes and approaches with other subfields within ethics and draws upon many of the same thinkers. What distinguishes environmental ethics or philosophy is that attention is directed primarily toward nonhuman nature. Thus the lens and the resources of philosophical ethics are brought to bear upon an area that, some argue, challenge certain foundational assumptions of Western philosophy. In other words, part of what makes Western (especially Enlightenment-based) philosophy distinctive is its humanism, which environmental ethics questions and sometimes rejects outright. Because of this, some philosophers argue that environmental ethics, at least in its ecocentric, or ecosystem-based versions, represents what land ethicist Baird Callicott an effort "to build, from the ground up, new ethical (and metaphysical) paradigms."[8] Environmental ethics, in this view, does not merely add a new topic but rather transforms established ways of thinking about ethics. Taking nonhuman nature seriously is such a radical step that traditional philosophical and moral models are inadequate to the task, and entirely new approaches are necessary.

It is not clear whether the same is true for the ethics of sustainability, which values nonhuman nature and integrates those with more traditional moral concerns such as social justice and economic equity. Environmental ethics is, as we have been arguing, one of three distinct ethical fields that are brought together in an ethic of sustainability. Precisely because sustainability integrates environmental and social concerns, more anthropocentric (human oriented) ethics are generally more congenial than ecocentric approaches, which are harder to integrate with some of the social and economic values that are also central to sustainability. We will discuss this question in more detail below when we turn to the relations between environmental and sustainability ethics. In this section, our goal is to outline some of the major theoretical approaches that have emerged in environmental ethics, as a necessary foundation for understanding its role in and relationship to the ethics of sustainability.

All ethics pose the question of "What is of primary moral concern?" In environmental ethics, this question is first and foremost about the value of nonhuman nature. However, this focus allows for many different approaches. One of the most important variables for thinking about the moral dimensions of nonhuman nature – and for human social life – is whether the main unit of concern is individuals or larger collectives. For some thinkers, the individual being is the only measurable unit that can be accounted for in any moral equations. This is especially true for many advocates of animal welfare, who focus on the rights or interests of individual sentient beings. Both rights-based (deontological) and utilitarian (consequentialist) approaches have been used in arguments about the moral status of individual nonhuman animals. Precisely because of this individual focus, animal welfare is sometimes considered an issue separate from environmental philosophy. However, animals' moral status is linked to thinking about the value of nonhuman nature more generally, and thus it must be addressed in any consideration of environmental ethics. This is especially true for reflections on the ethical dimensions of sustainability, because sustainability entails economic and social issues in which the fate of nonhuman animals is inextricably caught up with that of humans.

In contrast to the individual-based morality common to many (though not all) treatments of animal welfare, a number of environmental philosophers adopt a more holistic approach. One of the most influential holistic models is Leopold's land ethic, especially as interpreted by J. Baird Callicott. Callicott claims that the land ethic is compatible, with slight scientific and philosophical modifications, with contemporary scientific models of ecology and is the most appropriate model for contemporary environmental ethics. Callicott has developed a form of the land ethic that is evolutionary in nature and ecologically holistic: the ecosystem is primary and the individual is simply an outcome of the interaction of that species in a niche in an ecosystem. Therefore individuals are of much less concern than the more primary and important categories of with ecosystems and species. Ecological holism has been criticized for subordinating the interests of individuals or minorities to those of the larger group, a criticism also leveled at holistic or majoritarian ethics more generally, including utilitarianism.

One of the most thoroughly and explicitly holistic types of environmental ethic is Deep Ecology, a strain of environmentalism that was first developed in the 1970s by Norwegian philosopher Arne Næss. Naess was already well-known both as a mountaineer and a philosopher when, in the 1960s, he became a radical environmentalist – influenced, he said, by *Silent Spring*. His systematic reflections on environmentalism began with a 1973 article, "The shallow and the deep, long-range ecology movements," in which he defined "deep ecology" over and against "shallow ecology." Naess defined shallow ecology, which he saw as the predominant trend in environmentalism, as the anthropocentric practice of protecting resources and fighting pollution primarily for the sake of the quality of life of the "well-off" in society. Here the natural world is seen as the environment in which humans operate, and the goal of its protection is human well-being. Næss contrasted this view with deep ecology, an ecocentric (nonanthropocentric) venture that places humans squarely in the natural world as beings who are interdependent with and morally equal to other life forms on the planet. According to Naess's "biospherical egalitarianism," all organisms have an equal right to live and

flourish.[9] Deep ecology is thus more holistic, viewing nature as a large community that must be protected and valued for its own sake because it has intrinsic value, rather than the instrumental value of shallow ecology.

Naess and the many subsequent advocates of Deep Ecology argue that humans should live in harmony with nature by realizing their selves in relation to nonhuman nature. With an expanded sense of self, humans are defined not by isolated individualism but by their interactions and relations with the many facets of nature. In this, some have seen the parallels between deep ecology and certain forms of religion, such as Buddhism and New Age religions. Naess himself was influenced by Buddhism, as are later Deep Ecologists such as the Australian John Seed and the American Joanna Macy. Deep ecology is considered a form of radical environmentalism and exists today in a number of forms that are distinguished according in relation both to spirituality and to political militancy.

Another form of radical environmentalism is ecofeminism, which argues that human destruction of nature is linked to gendered dynamics of dominion, subordination, and power. Just as men have subordinated women, humans (particularly males) have subordinated and dominated the natural world, especially in the West. Carolyn Merchant helped launch ecofeminism with her 1983 book *The Death of Nature*, which documented parallels in the history of patriarchy and the domination and subordination of nature. Today ecofeminism takes many different forms, including some with a strong spiritual bent and others that are more philosophically or politically oriented. Like other environmental ethicists, ecofeminists draw on longstanding philosophical schools including rights theories and utilitarianism, while also looking to more recent intellectual developments such as feminist care ethics, which finds moral guidance in relationships and emotions, as well (or sometimes instead) of reason and abstract principles. Ecofeminism tends to be fairly ecocentric in orientation, affirming ecological interdependence and the intrinsic value of nonhuman nature. Rather than prioritize either gender inequities or ecological problems, ecofeminists often believe that both emerge from the same problematic ways of thinking and acting, and therefore must be analyzed and resolved together.

Along with ecofeminism and deep ecology, another radical branch of environmental philosophy is social ecology. Social ecology has roots in anarchism, socialism, and other left social justice movements. Its most important founding thinker is Murray Bookchin, an anarchist who began writing about these issues in the 1960s. Bookchin and other social ecologists argue that environmental problems are rooted in unjust, hierarchical social, economic, and political relations. Because it tends to prioritize social causes and solutions to environmental problems, social ecology tends to be more anthropocentric than Deep Ecology or ecofeminism. In this sense it is more akin to sustainability than these more ecocentric approaches to environmental ethics. However, few sustainability advocates adopt social ecology's radical critique of economic and social institutions.

A less radical way to link social principles to environmental concerns has been developed by thinkers working within the pragmatist tradition of philosophy. As discussed in Chapter 3, pragmatism was developed in the early 1900s by American philosophers John Dewey, C. S. Peirce, and William James, who emphasized moral pluralism and practical goals in an effort to overcome some of the problems of monistic philosophical thought. Philosophical monism presents a universal ethical framework, which provides the only (true or accurate) way to look at all formulations and situations. Many of the major models in environmental ethics, including deep ecology, ecofeminism, and social ecology, tend toward monism insofar as they attempt to explain environmental problems (and sometimes social and gender dynamics) through the lens of one overarching analytical lens.

In contrast, pluralistic approaches such as pragmatism explore a number of theories and values, with the understanding that more than one model or formulation of ethics may provide the best solution. Pragmatism is a concrete and particularistic form of ethics that looks at individual circumstances in order to evaluate the best possible route to achieving the overarching goals. For this reason, it is especially valuable for sustainability, which is less a single analytical approach than it is an attempt to achieve practical goals. Environmental pragmatists such as Bryan Norton argue that people whose reasons (philosophical foundations) for action differ can still work together for the same goals. Pragmatists acknowledge that environmentalists often disagree about the bases for environmental action and practices. Some claim, for example, that nature has value in itself (inherent value) while others argue that nature is simply here for human use. However, in these opposed views, there often reside similar goals, such as preserving a park or keeping water clear of chemical runoff. Environmental pragmatists argue that these goals are important in and of themselves, and that the search for shared theoretical foundations is often unnecessary and even destructive. Another important environmental pragmatist, also mentioned in Chapter Three, is Ben Minteer, who has developed a "civic philosophy" in which social, economic, and political concerns are central to environmental ethics.[10] Pragmatism has become increasingly influential within environmental ethics because of its emphasis on concrete action and policy, its advocacy of democratic deliberation, and its respect for scientific evidence.

Another growing and action-oriented approach within environmental ethics is bioregionalism, which asserts that many of the environmental and social problems we face today, especially in the United States, stem from our refusal to live within local ecological limits. This refusal is linked to a rejection of local cultural knowledge, including knowledge about native animals and plants, agricultural traditions, and landscape features. Such local knowledge is thought to have enabled some Native American tribes, along with other small-scale indigenous societies, to have cultural practices more adapted to local resources. This local knowledge was not important to European immigrants, who rarely learned about or cared for their local places, according to bioregionalist critics. Instead, they lived according to a "frontier mentality" that has had disastrous environmental and social consequences, argues Wendell Berry in his influential 1977 book *The Unsettling of America*, a founding bioregionalist text. Unlike

most Native Americans, according to Berry, European immigrants "did *not* look upon the land as a homeland."[11]

Bioregionalists call for people – especially Americans – to become native to their "little places" as a necessary first step toward becoming native to – and living sustainably in – their larger place.[12] Living as much as possible within the limits of a bioregion both reduces energy and resource usage and increases knowledge, care, and efficacy. Further, beginning at the local level makes it possible to solve environmental and social problems that are overwhelming at larger scales. As prominent bioregionalist thinker Wes Jackson asserts, "the majority of solutions to both global and local problems must take place at the level of the expanded tribe, what civilization calls community."[13] Bioregionalists argue that operating in terms of the local is the only way to maintain and repair ecological systems and human communities. A focus on the local enables people to develop both knowledge of and attachment to their particular region, including the land and its nonhuman inhabitants as well as local human cultures.

One critique of bioregionalism is that it has parochial or insular tendencies – encouraging people to focus on local problems while ignoring the larger contexts in which those problems have developed. Some environmental thinkers have called for a cosmopolitan bioregionalism, as Mitchell Thomashow puts it, that is concerned and informed about the wider world while living according to local ecological constraints and cultural traditions.[14]

Bioregionalist thinkers have paid special attention to food and agriculture. The move away from local knowledge and culture, and away from the ecological constraints of a particular watershed, is especially in people's food production and distribution and eating habits. Most Americans today eat foods that have been transported many miles, burning fossil fuels and other resources in both production and transportation. They do not eat what is grown locally and in season, but expect year-round availability of many products. These products are grown not only far away from their ultimate destinations but also, in many cases, with methods that are not sensitive to local conditions. Mass-produced and transported food is often grown in large farms with a single crop (monocrop), using high doses of artificial pesticides and fertilizers. The local food ("locavore") movement that is growing in the U.S. draws heavily on bioregionalist ideas.

Bioregionalists and locavores often advocate not only environmental but also economic and cultural shifts, toward farms and businesses that are not only locally oriented but also smaller in scale and more diversified. Similar values are important to the New Agrarian movement , which like bioregionalism emphasizes the importance of land and place. Agrarianism, according to one of its leading advocates, "is a deliberate and intentional way of living and thinking that takes seriously the failures and successes of the past as they have been realized in our engagement with the earth and with each other. Authentic agrarianism, which should not be confused with farming per se . . . represents the sustained attempt to live faithfully and responsibly in a world of limits and possibilities."[15] Like bioregionalism, contemporary agrarianism looks to the values of

local rural cultures, based on reliance and connection to the land, as appropriate for urban as well as rural dwellers today. However, agrarianism may highlight cultural and moral issues more explicitly, especially with its focus on the dual character of cultivation: cultivation of the land and cultivation of character. Agrarians rail against the destructive popular commercial farming practices of the West, citing the damage that monocultures and synthetic chemicals have caused across the globe. For agrarians, one of the most sustainable lifestyles is a self-sufficient, communal, and "simple" life that revolves around hard work and respect for nature as well as attachment to neighbors and local institutions.

Both bioregionalism and agrarianism are relevant to sustainability in particular because they explicitly link social, economic, and environmental problems and solutions in the light of an overarching moral analysis. They differ from many other environmental ethics in that they take social and economic problems just as seriously as ecological ones. Issues such as food and agriculture show how environmental, social, and economic systems and values are connected, suggesting, according to bioregionalist and agrarian analyses, that they cannot be solved separately. While not all sustainability ethics share the local orientation that is central to bioregionalism and agrarianism, these approaches are important models for any ethic that aims to bring together the social, economic, and environmental dimensions in a coherent way.

One additional type of environmental ethics that requires attention here is the religious, already discussed above in relation to Lynn White's influential 1967 essay. More recently, a number of environmental scholars have argued that attitudes and practices regarding nature are deeply conditioned by religious beliefs. Religion, they assert, holds a singular place for many people as an overarching narrative that guides and shapes both beliefs and practices. This speculation is upheld by empirical research that has found that even individuals who do not invoke God in other contexts do so in order to talk and think about nature. In particular, researchers found, people use the concept of divine creation to "express the sacredness of nature. Regardless of whether one actually believes in biblical Creation, it is the best vehicle we have to express this value."[16] More generally, the ways that religious narratives define the human position in relation to nature often have a dramatic impact on people's environmental attitudes and practices.

Some religions, including the anthropocentric forms of Christianity condemned by White, encourage destructive attitudes, including a notion of humans as lords and masters over the natural world. However, as White himself noted, there are alternative views of nature within Christianity, with more positive attitudes toward nonhuman nature. White himself suggested Saint Francis of Assisi as the "patron saint of ecology," a title formally bestowed by Pope John Paul II in 1979. Among the many other environmentally beneficent approaches to nature within Christianity, perhaps the most important is stewardship. Stewardship sees creation as belonging to God, and humans are thus not the owners or masters of nature but rather are entrusted to care for the planet as devotion or response to God. Many Christian eco-theologies adopt a stewardship perspective, which tends to prioritize human goods while also constraining human freedom to act in destructive or despotic ways. The great value of stewardship ethics, as secular

philosopher Baird Callicott explains, is that they solve the problem of where nature's inherent value comes from – God's act of creation – while at the same time acknowledging humans' special role in the creation. This special role requires people to treat nature respectfully, as good caretakers, rather than as despots.[17]

Other theologians highlight ecological interdependence, including James Gustafson, who describes humans as "interactive participants in the ordering of the natural world."[18] Although Gustafson's ethic is theocentric (God-centered) rather than ecocentric, his less exalted view of human importance is, in some ways, more akin to Deep Ecology than to Christian stewardship ethics: "If there is a sense of divinity, it has to include not only dependence upon nature for beauty and for sustenance, but also forces beyond human control which destroy each other and us. If God saw that the diversity God created was good, it was not *necessarily* good for humans and for all aspects of nature."[19]

Gustafson's rejection of anthropocentrism is not typical of mainstream Christian approaches to nature but does echo themes found in some non-Western and indigenous religions. These traditions have not influenced modern Western (especially North American) cultures as strongly as Christianity has, they offer distinctive approaches toward nonhuman nature which are important both to academic environmental ethics Some ecologically-concerned theologians and philosophers have turned to indigenous and non-Western religions, which often encourage people to think of themselves as part of a larger web of life and thus foster more humble and modest use of natural resources. For example, the Buddhist concept of the interdependent self de-centers humans, just as Buddhist principles of compassion and nonviolence may encourage more caring and enlightened respect for humans and nature alike. Similarly, many environmental philosophers find promise in Native American cultural emphases on "walking lightly" on Earth and respecting the agency of other creatures. The problem posed for an ethic of sustainability is how these ideas, valuable as they may be, can have a significant impact in contemporary Western societies.

Religious ideas, practices, and institutions have undoubtedly had a powerful influence on attitudes toward nature – and about social and economic issues – throughout the world, including supposedly "secularized" Western societies such as the U.S. People interested in achieving a more sustainable society must take religion seriously as a powerful shaper of values, regardless of their own personal convictions. For many scientists and technology professionals, however, as for many environmental philosophers, scientific principles are the most important factor in determining ideas about nature and the world in general.

The approaches to environmental ethics discussed here do not by any means exhaust the variations within the field. We have not discussed a number of theoretical models, including some that are very influential within environmental philosophy, because they are exceedingly abstract and thus less relevant to sustainability. Many introductions to environmental philosophy are available which outline the different kinds of ethics, major thinkers and works, and central issues.

ECOLOGICAL PRINCIPLES IN ENVIRONMENTAL ETHICS

The relationship between ecological science and environmental ethics is intimate and complex. Ecology is the study of the interactions between living organisms (plants and animals) and their surroundings, including physical landscape features and climate. It began as a serious scientific endeavor the nineteenth century, with the work of Alexander von Humboldt (1769-1859), Charles Lyell (1797-1875), and Alfred Russel Wallace (1823-1913), among others. The history of ecological science reflects not a single unchanging agreement but rather both continual debates within an ever-changing historical consensus. In his influential book *Nature's Economy: A History of Ecological Ideas*, historian of science Donald Worster documents both the development of scientific ideas in ecology and their interactions with wider cultural forces. Among the earlier models that Worster describes is the "Romantic" view that stresses harmony and balance in nature, an approach that was displaced when the work of Lyell, Humboldt, and Darwin brought conflict and competition to the forefront. In the early twentieth century, the work of Frederic Clements (1874-1945) helped shape a new approach, focused on the dynamics of ecological succession in plant community (Worster 1994: 209). While these models have been subsumed in many ways, all have contributed elements to contemporary ecological science. Newer themes that are important for ecology include work in physics on complexity, resilience, unpredictability, and chaos.

All these approaches have ethical implications. The way that people perceive nature to operate often serves as a model, even a standard, for human actions and society. This is obvious in regards to themes such as competition and conflict, which – exaggerated and often distorted from their scientific origins – have fed into "Social Darwinism"

The exchange between ecological ideas and popular attitudes toward nature has been mutual. However, it is possible to identify themes from ecological science that have had a special impact on environmental values. Perhaps the most important is the principle of interdependence and mutual causality, which are central for Leopold along with many contemporary scholars, and probably the most important element of ecological understanding for the general public.[20] This popular understanding is well reflected in Commoner's Laws of Ecology, which highlight interdependence – "everything is connected to everything else," "everything goes somewhere," and "There is no free lunch." These "laws" do not necessarily reflect cutting edge ecological science but are important as popular interpretations of the science that have clear value implications. Widely publicized environmental problems of recent decades, including ozone depletion, insecticides, and now global warming, reinforce the emphasis on interdependence.[21] This emphasis supports a number of the values of sustainability, including the Precautionary and Reversibility principles. If everything is connected to everything else, and everything goes somewhere, then all of our actions have ecological consequences, about which we know relatively little.

Ecological science sheds light not only on the interdependence among different elements of an ecosystem but also on the historical development of these relationships over time – a study heavily influenced by theories of evolution by natural selection. Evolution has not been central to popular or philosophical interpretations of ecology, even though Darwin is "the single most important figure in the history of ecology over the past two or three centuries," as Donald Worster argues.[22] Among the most important themes of evolutionary science are continuity and connection among species.

ENVIRONMENTAL ETHICS AND NONHUMAN ANIMALS

The above themes are also central to contemporary philosophical work on the value of nonhuman animals. The evolutionary continuity among species suggests that species share not only physiological but also behavioral similarities, as well as intertwined histories and futures. If nonhuman animals share many of the same capacities and feelings, some argue, their moral status cannot always be sharply distinguished from that of humans. This raises questions about many of the ways that both wild and domestic animals are treated, in contexts including agriculture, scientific laboratories, park management, and even urban development and building construction. The philosophical debates about human treatment of nonhuman animals is related to discussions about the natural environment more generally but also include a number of specific issues, mostly regarding the moral value of individual creatures.

Ethical thinking about individual animals is often very different from that about the environment more generally. Perhaps most important, environmental ethicists are historically more concerned with ecological wholes, while those concerned with the interests of nonhuman animals are generally more concerned with individual beings. Moral considerability, some argue, cannot be attributed to generalities such as ecosystems, but rather inheres in individuals – whose interests are overlooked in holistic perspectives. More specifically, values come from individual characteristics such as intelligence or the capacity to suffer and social relationships among individuals. The moral value of individual creatures may be described, in deontological perspectives, in terms of rights, as developed in the writings of Tom Regan.[23] Other philosophers approach the topic from the perspective of Utilitarianism, most notably the influential Australian philosopher Peter Singer. Singer argues that individual sentient animals have an interest in avoiding pain and in having their basic needs met (e.g., for food and shelter), regardless of species. Singer uses the term "speciesism" to suggest a parallel between racial discrimination among humans and the equally arbitrary (to Singer) discrimination among species. While Singer and Regan disagree about philosophical foundations, they share a common commitment to the welfare of individual animals and an opposition to holistic approaches to ethics.

The work of Regan and Singer hints at the diversity and complexity of debates about the moral status of animals. Equally lively are the debates between advocates of animal welfare and environmental ethicists. Many philosophers in both camps perceive the two subfields as not just distinct but conflicting, due to the individualistic focus of most animal ethics and the holism of many environmental philosophies. These distinctions

raise a number of issues that are relevant for sustainability. Some of these entail fairly abstract questions about matters such as the role of science in ethics or the validity of rights theories. Other issues are more concrete, such as those involving the relations between domestic (or feral) and wild species in a given ecosystem or the environmental consequences of particular agricultural methods. Many of these practical issues involve social and economic problems as well. An ethic of sustainability might help sort through debates about, for example, the relative social, economic, and environmental benefits of agricultural methods that are more humane for the domestic animals involved, such as free-range organic farming.

This leads us to some of the additional questions raised when we think about domestic animals and their social and economic, as well as environmental, roles. For all of our species' history, human communities have included both wild and domestic animals and plants. English philosopher Mary Midgley uses the notion of a "mixed community" as the context for human cultural evolution.[24] Midgley argues that because humans are biologically similar to other animals and have evolved together with them, we have a direct capacity "for attending to, and to some extent understanding, the moods and reactions of other species."[25] Though this capacity is somewhat limited, we are granted with a unique capacity of viewing animals as members of our moral community, a position that has some similarities with environmental stewardship ethics. The fact that we participate in different communities, many of which include other animals, can help mediate the apparent conflicts between holistic ecological ethics and animal welfare, according to Midgley. All the communities to which we belong have some moral claims on us, even though they are not all the same. We need not, Midgley argues, think about these moral claims as merely competing. While it is true that we are naturally more inclined toward our own families and species, we are not emotionally or rationally limited in the range of our morality. The mixed community ideal calls for a move beyond abstractions of animals as a whole or humanity as a whole and a reconsideration of the existence of actual, concrete animals and humans living together in a mixed community.

Midgley's work provides a crucial resource for Baird Callicott in his efforts to resolve the conflict between animal and environmental ethics. Callicott originally criticized animal rights theories as both philosophically weak and "utterly unpracticable,"[26] arguing instead for a holistic land ethic that does not prioritize the welfare of individual organisms. More recently, however, he has come to believe that "it would be far wiser to make common cause against a common enemy – the destructive forces at work ravaging the nonhuman world – than to continue squabbling among ourselves."[27] Callicott seeks "a moral theory that embraces both programs *and* that provides a framework for the adjudication of the very real conflicts between human welfare, animal welfare, and ecological integrity."[28] He uncovers grounds for such a theory in Midgley's concept of the mixed community, which he finds compatible with Leopold's land ethic. Callicott argues that "we are members of nested communities each of which has a different structure and therefore different moral requirements."[29] We are subject to the claims of close relationships, with people and with domestic animals such as pets, and also to the claims of larger wholes, such as those articulated in ecocentric ethics. These varied claims do not cancel each

other out, even though they may require that we prioritize and sometimes make hard choices.

Midgley's notion of moral communities, and Callicott's extension of this idea, are important not only because it helps us think about the specific issues raised by nonhuman animals but also because it provides a framework for integrating multiple moral claims – the central challenge of an ethics of sustainability. Callicott and Midgely remind us that different types of moral claims may be equally valid, even though we cannot always fulfill them all. This is true not only of the claims of individual creatures and ecological wholes but also of different types of claims based on social, environmental, and economic criteria. When it is impossible to give equal priority to all the things we value, ethics can provide resources to evaluate, prioritize, and choose. (It can also help us know when a dilemma is truly unavoidable, as discussed in Chapter 3.) In order to reach positive resolutions, we must think clearly about the different values that we and other people bring to a problem or situation – meaning we must be clear about what we value, why, and how our different values are related to each other.

ENVIRONMENTAL ETHICS AND ENVIRONMENTAL JUSTICE

Environmental and social ethics are distinct components of an environmental ethic, but they also come together in many situations, when social values and environmental values cannot be easily separated, or even distinguished. In other words, there are situations in which it is not a question of balancing social versus environmental concerns but rather a question of identifying and upholding values that are both social and environmental at the same time. This is especially true in relation to environmental justice, which addresses the question of who benefits or risks harm in environmental decisions. Environmental justice advocates are particularly concerned with the ways that pollution, toxic wastes, land use, climate change, urban sprawl, and other ecological problems disproportionately affect poor and minority communities. These issues are crucial to sustainability, both as practical problems and as situations that require an integrated sustainability framework.

When environmental justice advocates assert that the goals of social justice and environmental protection agree, they are usually speaking from a distinctive ethical perspective, one which tends to be more anthropocentric than ecocentric in relation to nonhuman nature. Their environmental values, in other words, center upon the protection of natural resources and places that support the quality of life for particular human communities. Thus environmental justice usually focuses upon urban problems such as toxic waste and other environmental hazards to human health. This is reflected in the origins of the environmental justice movement in the U.S., usually identified with the activism of Lois Gibbs in the Love Canal neighborhood of Niagara Falls, New York. The blue-collar neighborhood and school had been built on a chemical waste dump, which caused a number of health and reproductive problems. In 1978, Gibbs began organizing her neighbors, an effort that led to the evacuation of 800 families, the cleanup of the site, and, ultimately, to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, more commonly known as the "Superfund" bill. The principles on which Gibbs began her campaign – that poor and

working class families are entitled to the same environmental and health protection as all Americans – remain central to the environmental justice movement, which has spread to Native American, African American, and Latino communities throughout the U.S., in addition to many international manifestations.

With its usual focus on urban problems, environmental justice does not concern itself with "nature for nature's sake" or the intrinsic value of nature, but is more concerned with instrumental values – the ways natural places and resources serve (or prevent) human goods. As a result, environmental justice approaches sometimes conflict with more ecocentric ethics, especially in regards to wilderness protection. In a number of cases in the U.S. and elsewhere, indigenous people have challenged policies and restrictions regarding their access to protected wilderness areas, either for permanent homes or for hunting or fishing, citing values of environmental justice as well as native sovereignty. Sometimes Native communities have come into conflict with environmentalists seeking to preserve "pristine" wilderness areas, free of any human intervention or use. Increasing, however, environmental justice and wilderness advocates seek to work together to permit sustainable uses of wildlands while preserving their ecological integrity.

Several philosophical models shed light on the relations between, and possible integration of, the goals of social justice and ecological protection – both central to sustainability. One, discussed above, is based on Midgley's notion of nested communities. Applying this model to environmental justice, we might aim to protect the health of families and neighbors, while also recognizing the claims of nonhuman animals and places, which are also threatened by many of the same hazards. Many toxic chemicals, for example, ranging from deliberately applied pesticides to discarded PCBs, are dangerous to humans and nonhuman animals, as well as destructive to soil and water. It may well be possible to protect the interests of all these constituencies or nested communities – for example, through systematic clean ups such as those supported by the Superfund – without having to choose between competing values.

The environmental ethics associated with a bioregionalist perspective can also offer helpful tools for thinking about environmental justice. The local focus of bioregional (and agrarian) thought encompasses social and natural goods. What is good for nature in a given place, in other words, is often good for humans, both in terms of community values and in terms of economic security. Small scale, diversified farms, for example, using environmentally sounds methods and serving a local economy, can both protect local watersheds and strengthen the justice and economic security of the human community. As Wendell Berry argues, "nature and human culture, wildness and domesticity, are not opposed but are interdependent."[30] The key to strengthening both natural and human values is to maintain a proper scale, thereby avoiding the destructive consequences of mass production, homogenization, and what Berry calls the "monocultures" of industrial civilization, which suppresses both cultural and natural diversity and democratic processes.[31]

Bioregionalism and environmental justice are but two of the various approaches to environmental ethics that aim to integrate social and ecological values – or at least, certain kinds of social and ecological values. Lois Gibbs's passionate advocacy for working class families and Wendell Berry's critique of industrial capitalism both reflect distinctive moral stances, which justify particular social positions, such as the obligation of government to protect vulnerable communities or the demand to transform modern agricultural methods. It is possible to integrate social, economic, and environmental values in a wide variety of ways, some of which can be considered as ethics of sustainability. We turn now to a discussion of what distinguishes the ethics of sustainability and its relationship to environmental ethics.

CONCLUSION: ENVIRONMENTAL ETHICS AND THE ETHICS OF SUSTAINABILITY

Earlier we defined environmental ethics as an important dimension of the ethics of sustainability but not the only or determining one. In order to develop an adequate ethics of sustainability, it is necessary to understand the development and main themes of environmental ethics, just as it is necessary to have an overview of social and economic ethics, as outlined in Chapter 3. It is important to understand that environmental ethics encompasses a wide range of perspectives, with differing positions on many of the theoretical and practical issues involved in sustainability. Especially important are the distinctions among more and less ecocentric and anthropocentric frameworks, the role of science in various approaches, and the ways some models have integrated social and environmental values.

One of the most important questions to answer in regards to the relationship between environmental and sustainability ethics is whether one, the other, or both are involved in a given situation. Here the challenge for the sustainability ethicist is how to identify what values are at stake and how to address them. This is true of some technology and science issues, which might raise questions about environmental values but not sustainability, or vice versa. Arguably, some of the questions surrounding wilderness, including the preservation of endangered species and ecological restoration, are primarily environmental, at least in their ethical dimensions – and economic or social considerations come into play primarily as practical rather than philosophical concerns. On the other hand, some uses of technology involve mainly social or economic issues, because the environmental impact of various choices is either negligent or the same in every option. And, of course, some scientific processes entail ethical concerns that are not really about the natural environment or sustainability. This is true for some of the moral issues that arise concerning the treatment of nonhuman animals or humans in medical or scientific experiments, for example. Thus the question of whether environmental ethics, sustainability ethics, or both are involved must be decided before the relationship between the two can be analyzed.

Sustainability advocates have adopted a wide range of environmental ethics, and as noted earlier, sometimes sustainability and environmental are used almost as synonyms for each other. In general, however, the framework for thinking about environmental value that is

most common and probably most fitting within sustainability ethics is fairly anthropocentric. More human-oriented approaches can accommodate the other values that must also be brought into play. Ecocentric ethics, in contrast, prioritize the claims on nonhuman nature, and especially of ecological wholes, necessarily subordinating at least some human values. An ethic of sustainability can be defined as an ethic that coherently integrates environmental, social, and economic values without consistently prioritizing any single one.

According to this definition, some environmental philosophies can be considered sustainability ethics. This is especially true of pragmatist, bioregionalist, and agrarian approaches, some but not all of which emphasize social and economic as well as ecological concerns. A good example is the work, discussed earlier, of Ben Minteer, whose environmental civic philosophy is highly pragmatic and anthropocentric, placing as much emphasis on social, political, and economic concerns as on nonhuman nature. (In contrast, the work of Minteer's fellow pragmatist Bryan Norton defines sustainability as above all the effort to protect ecological wholes and would not be readily classified as an ethic of sustainability according to our definition, despite Norton's use of the term.) Some bioregionalists and agrarians have also developed integrated sustainability ethics, although others within those streams of thought prioritize ecological concerns above social ones. The same is true, as discussed above, of some work in ecofeminist and social ecological perspectives. In contrast, very few philosophers writing in the tradition of land ethics or Deep Ecology have made social and economic concerns central to their work.

This raises the question of the relations among different values. While an ethics of sustainability must integrate social, economic, and environmental concerns, it is not clear that these must be considered equally in every circumstance. More generally, even when we acknowledge the validity of different moral claims, it is not always possible or even desirable to treat every claim the same. Thus in a sustainability ethic that includes environmental, social, and economic values, there are times and circumstances when one particular kind of value – social, economic, or environmental – might be most important. The question is how to determine what is called for in a particular situation. Here the work of economic ethicist Warren Copeland[32] is helpful. Copeland argues that we can value different qualities, such as equality, individual liberty, and social solidarity, while also emphasizing one of these values over others in a particular setting. It is not necessary to pick a single value over all others, and in fact philosophies that have only one foundational concern often become irrelevant in complex, changing settings. Copeland advocates first identifying the values of primary concern, then carefully analyzing the particular problem or situation to evaluate how these values are being enacted, or not, and how they might be better fulfilled. In any given situation, it is likely that one value is more fully developed than others, which means that principles of balance and compensation should be invoked.[33] In concrete political terms, Copeland argues, we should advocate for whatever is most missing.

This sheds some light on efforts to balance and integrate diverse values in the ethics of sustainability. In analyzing a particular problem – involving, for example, a laboratory

experiment, the construction of a building, or a public policy – we should first identify the social, environmental, and economic values that are most important, then ask to what extent each of these is being enacted and how it might be more fully implemented. This approach will not satisfy many environmental ethicists and advocates, who want to prioritize the claims of nonhuman nature consistently. However, it is certainly possible to argue, in many situations, that ecological concerns receive much less effective attention than social and economic ones and thus, according to Copeland's guidelines, should receive more attention in order to achieve better balance.

It is also important to note that some environmental philosophers (and some economic and social ones) assert that their philosophical frameworks do take into account all important moral factors. Deep ecologists, for example, would interpret economic, political, and social issues in light of their understanding of ecological interdependence, which makes all human problems by definition natural ones as well. Ecological interdependence is not only the primary value here but also the first and most important explanatory factor for other problems. Thus there is no need to "balance" social, economic, and environmental concerns, since attending to ecological problems in the proper way will inevitably resolve other, secondary issues. This single-minded approach is far from unique to Deep Ecologists. There are philosophers and activists who place their faith in the explanatory power of economic, racial, gender, or other dynamics and subordinate all other concerns to these. We do not need to decide or even debate these issues here, but merely to point out that for the ethics of sustainability, no single variable will suffice. Sustainability is not a single goal, and it cannot be understood in light of a single issue or achieved by attending to only one kind of problem.

The emphasis on interdependence of some ecological ethics is worth serious attention from those interested in sustainability, perhaps less for the substance than for the theoretical model it provides. The sustainability framework not only aims for social, environmental, and economic goals but also asserts that these goals are related. Not only should social equity not be achieved at the cost of economic or ecological collapse, but – according to the ethics of sustainability – the values of social justice, environmental preservation, and economic security should reinforce each other. It should not and need not be a question of choosing among them. Some of the practicalities of this integration, in regards to economics, are the topic of the next chapter, which explores ecological economics.

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END NOTES

[1] Leopold 1949, p. 239.
[2] Leopold 1949, p. 253.
[3] Leopold 1947, p. 262.
[4] (John Muir Cite)
[5] (Barry Commoner Cite)
[6]White 1967, p.
[7] White 1967, p.
[8] Callicott 1989, 4.
[9] Naess 1989, 28.
[10] Minteer 2006.
[11] Berry 1977, 4.
[12] Jackson 1994, 3.
[13] Jackson 1994, 2.
[14] (Thomashow cite).
[15] Wirzba 2004, 4.
[16] Kempton et al. 1995, 90, 92.
[17] Callicott 1994, 21-22.
[18] Gustafson 1994, 58.
[19] Gustafson 1994, 44.
[20] Kempton et al. 1995, 60.
[21] Kempton 1995, 219.
[22] Worster 1994, 114.
[23] Regan 2004.
[24] Midgley 1983.
[25] Midgley 1983, 114.
[26] Callicott 1989b, 60,
[27] Callicott 1989c, 249.
[28] Callicott 1989c, 251.
[29] Callicott 1989c, 256.
[30] Berry 1980, 11-12.
[31] Berry 1980, 151.
[32] Copeland, 1988.
[33] Copeland 1988, 97.

CHAPTER 7
SUSTAINABLE ECONOMICS

A new economic theory, *ecological economics*, is evolving to support sustainability and plays such a key role that it is sometimes referred to as the *science of sustainability*.[1] Ecological economics emerged in the late 1980's after two decades of gestation as an economic theory whose principles support sustainability.[2] Capitalism, the dominant economic system in the world, clashes with the concept of sustainability over several issues, but especially over the role of the global ecosystem in the economy. Consequently the contemporary economic theory underpinning capitalism, *neoclassical economics*, is deficient when sustainability is being used as the guiding framework for shifting to a state in which the economy produces goods and services, yet also protects and nurtures natural and social systems.

The contemporary economic system is dominated by capitalism. Capitalism is a relatively simple concept – it is based on private ownership of capital, assets that can be used to produce yet more assets. Capital has several forms: financial capital or money; physical capital such as buildings or machinery; human, social, and cultural capital, assets that include knowledge, cooperation and collaboration, and the important artifacts of society that may include art, music, architecture and traditions; and natural capital, which may be thought of as nature, the environment, and ecosystems. Capitalism focuses principally on the first two types of capital: financial and physical. Sustainability, while considering all forms of capital, maintains that natural capital must not be degraded. Where ecological economics values nature as one of the key factors in the quality of life for future generations, capitalism treats nature as simply a factor of production. Neoclassical economics models the production system as a black box with inputs and outputs. It considers nature and natural resources to be unbounded and infinite while ecological economics understands the Earth to be finite with limited resources and fragile ecological systems that are critical for the survival of all forms of life. Neoclassical economics assumes the Earth has infinite capacity for absorbing the waste generated from production and consumption; ecological economics considers that nature has a limited capacity to absorb some types of waste while others are unacceptable because they pose a threat to life.

The focus of ecological economics is on the important role that nature and natural systems play in the economy. In a paper by Robert Costanza and his colleagues in 1997, they estimated the economic value of the world's ecosystems. Published in *Nature*, the article estimated this value as $33 trillion, with a range from $16 trillion to $54 trillion at a time when the total global Gross Domestic Product was $27 trillion.[3] This result meant that the value of the world's ecosystems at that time was 1.8 times greater than global economic output. A wide range of ecosystem services are free and would have to be replaced with high cost technology if the ecosystem were damaged to the point where these services were compromised. For example, the pollination of wine grapes by bees in Europe was estimated as a free service worth $2 billion because that would be the labor cost of manually pollinating the flowers.

In comparing ecological and neoclassical economics, the major differences are:
1. Ecological economics views human society as a subset of the sustaining global ecosystem. Neoclassical economics ignores both systems and focuses only on human production and consumption.

2. Ecological economics acknowledges that the global ecosystem, including humans, obeys the physical laws of thermodynamics (which physicists refer to as the supreme laws of nature) as well as the laws of ecology. Neoclassical economics is silent on physics and ecology but does make extensive use of mathematical models which treat the economy as a black box of inputs and outputs.

3. Ecological economics recognizes that the global ecological-economic system is highly complex, non-linear and continually evolving and that simple answers or models to difficult questions rarely exist. Neoclassical economics does not address the role of the ecological system in the economy.

4. Ecological economics requires a systems approach to economic theory and decision making in order to address modern economic challenges and opportunities. Neoclassical economics is fairly simplistic, focusing on one issue, business. Milton Friedman, an American winner of the Nobel Memorial Prize in Economics in 1976, clearly articulated its relatively simple outlook when he said, "The business of business is business."

This chapter will define and describe ecological economics, its history, the key principles, and its current state, and its role as in supporting sustainability. The emergence of Corporate Social Responsibility is also described because it dovetails with the intent of sustainability and the principles of ecological economics.

FROM CLASSICAL ECONOMICS TO ECOLOGICAL ECONOMICS

Economics emerged in the latter half of the 18th century during a time of great social change and scientific discoveries. Science brought with it the potential for new technologies and improved quality of life, particularly in a material sense. And the result was a conflict between larger social goals and the ability of individuals to gain material security. The first questions addressed by economics were moral questions regarding the rights of the individual to material gains versus the greater social good. Thus the notion of the "invisible hand," by which markets guide individual behavior to achieve the common good, emerged. Economics was one of the first examples of transdisciplinary scholarship in which social science and scientific progress were examined together to gain a better understanding of the functioning of the system of exchanging goods and services. Ecological economics has its roots in classical economic theory but did not emerge as a separate discipline until the late 20th century when the development of ecological theory flourished.[4] The work of Thomas Malthus and David Ricardo, both of whom suggested limited resources and limited quality agricultural land would set limits on the human population, mark the beginning of an alternative view of economics which eventually evolved into ecological economics. In the mid-19th Century John Stuart Mill argued that the economy had to be based on rules or property use and a sense of social responsibility that favored the common good. Karl Marx added to the debate by

criticizing capitalism for the accumulation of land and capital by a small fraction of the population. W. Stanley Jevons was one of the first economists to recognize the role of energy in the economy. Also in the later 19th Century, the science of ecology emerged with Ernst Haeckel providing the first definition in 1870. Ecology emerged as a practical science in the first two decades of the 20th Century. Both ecological systems and the interaction of humans with ecological systems were addressed, particularly the interaction of the economy with nature. In the 1920s Alfred Lotka was the first to integrate ecology and economics in a scientific manner, arguing that nothing could be understood without understanding the entire system of biotic and abiotic components, including those produced by humans. Based on the work of Lotka and others, Arthur C. Pigou articulated the concept of externalities, forces that are external to markets and do not affect how they operate, but have impacts on society and nature. The logic of exploitation of resources was explained by Howard Hotelling and the conditions under which conservation or depletion would occur. The following paragraphs provide a more detailed explanation of the work of these key figures in the history of ecological economics, along with brief description of the work of key contemporary figures in the evolution of ecological economics such as Kenneth Boulding, Herman Daly, and Robert Costanza.

The Advent of Economics: Adam Smith (1723-1790)

Adam Smith, who was a moral philosopher, is generally considered to be the founder of modern economics and was the originator of the "invisible hand" metaphor about how markets function. The key ethical question he attempted to address was whether or not individual greed could be in the best interest of society. He reasoned that if two individuals making a transaction were fully informed of the consequences of their decisions, then both would be better off because both were achieving a desired outcome. Thus the "invisible hand" was posited to be in the background, an extension of the Almighty, guiding the economic system for the good of society. Although Adam Smith was a moral philosopher, his concept of economics made morality less important as individuals were free to pursue their greed. An improved materials well-being had an important negative effect, the detachment of individuals from their supporting communities. Prior to this era the individual depended on community and their relationships with others in the community for their survival. With the advent of essentially unbridled pursuit of individual well-being and quality of life, community relationships were less important. And with the breakdown of these relationships came the breakdown of humanity's relationship with nature because the pursuit of wealth permitted the exploitation of everything needed to increase wealth and material benefit. At the start of the 21st Century the sustainability framework is still striving to reinstate nature and community as vital links to quality of life and community.

Carrying Capacity: Thomas R. Malthus (1766-1834)

Another important figure in early economic thinking was Thomas R. Malthus who for the first time suggested that famine and war were not the result of Divine providence, but could instead be traced to human behavior and thinking. His basic argument was that human population could not continue to increase at an exponential rate because food and other items needed for human survival would quickly prove to be inadequate to support a

large and rapidly growing human population. Even though he assumed that the food supply could be expanded somewhat, he suggested that due to technological advances, the supply could only grow arithmetically, unable to keep up with the exponential expansion of human numbers. The end result would be wars over food and other resources and the human population would be forced to shrink until it could be supported by available resources. Malthus' model has never been fully demonstrated on a global basis but there have been several regional examples where population outstripped the resource base and went through a period of decline. The Great Hunger in Ireland in the 1840s and the civil war in Rwanda in the late 1980s were at least in part due to overpopulation and local food shortages. His model influenced the development of economic theory – for example, John Maynard Keynes used it to explain the rise and fall of the business cycle and the control of product inventories. Malthus' model is important from a sustainability perspective because it emphasizes the finite size of the earth, its limited resources, and the impacts of population and consumption on the planet's health. It also introduced the concept of carrying capacity for the first time, still an important concept that is central to the sustainability concept.

Resource Quality: David Ricardo (1772-1823)

David Ricardo introduced another model of economic system behavior that related to the environment. His model was an attempt to justify how landowners received a 'rent' or income from land ownership due to the value of the crops grown on the land. He modeled how the more fertile and valuable land would be farmed first and receive a higher rent because it could produce the most output for the least labor input. Less productive land that would be farmed later as valuable land was depleted would require far more labor and there would be less of a margin between the rent and the value of the crops. The model showed how increasing population would force people to farm in less favorable areas, and how previously undisturbed land would be eventually farmed. It also provided insights into how technology such as pesticides and fertilizers would eventually be needed to maintain production to justify the rents. His work showed how changes in food prices could lead to new farms, farm failures, and the farming of marginal land. It also described the interplay between population growth and food prices, and the role of ecological systems in human survival. Ricardo's work also foreshadowed the conflict between neoclassical economics, which largely ignored the role of ecological systems in the economic system, and ecological economics for which nature and the environment are central to a healthy economy. It also set up the battle between the unlimited economic growth mindset of conventional economic thinkers and the finite planet and resource assumptions built into ecological economics. While Malthus suggested the concept of carrying capacity, Ricardo carried this thinking a step further by suggesting that the next available resources would be of lower quality. The result of their joint work was the labeling of economics as the "dismal science."

The Steady State: John Stuart Mill (1806-1873)

The son of social philosopher James Mill, John Stuart Mill was one of the early economists. His notion was that the common good was of the utmost importance and that the economy had to be based on rules of property use and social responsibility. He also believed that material prosperity should not be an end in itself and that continuous growth

in material well-being was impossible. He understood that natural capital had to be protected and that humans had to mindful about converting natural capital into financial or manufactured capital. He also argued for the protection of biodiversity and suggested that a steady-state economy was possible in which the economy stopped growing and the extraction of natural capital was maintained at a level consistent with the ability of nature to provide renewable resources. The notion of a steady-state economy was later elaborated by Herman Daly in the 1980s. Mill was also concerned with the social ills of the time, particularly the subjugation of women, considering it to be both immoral and an enormous waste of talent. His work and thinking foreshadowed the current concept of sustainability as the balancing of Earth's natural, social and economic systems.

Ownership of Resources: Karl Marx (1818-1883)

Karl Marx is best known for his many critiques of capitalism and one of the issues he addressed in these critiques was resource ownership and resource distribution. Marx suggested that the concentration of capital in the hands of the few was not sustainable and would have consequences, the ultimate consequence being the decay of capitalism. One of his major contributions to economic theory was the *Labor Theory of Value* in which he argued that the value of commodities was tied to the value of the labor needed to produce them. Contrary to popular belief he did not believe that labor was the only value. Marx noted that nature was also an important source of value: "Labor is not the source of all wealth. Nature is just as much a source of use values (and it is surely of such that material wealth consists!) as labor which is itself only the manifestation of a force of nature, human labor power."[5] He wrote that one of the consequences of misdistribution of resources would be poor farmers working the property of rich land owners, without any motivation to tend to the long term health of the land because it was not theirs. The landowner would then have to invest considerable resources to monitor the farmer, either expending their own time or diverting management resources to ensure the productivity of the property is maintained. Marx maintained that for there to be social justice, the equitable distribution of resources must be considered to be very important, both initially and in the allocation of resources over time.

Resource Scarcity: W. Stanley Jevons (1835-1882)

W. Stanley Jevons is an important figure in the emergence of ecological economics because of his recognition of the critical importance of energy in the economy. In 1865 Jevons wrote the *The Coal Question* which drew attention to the gradual exhaustion of Britain's energy supplies in the form of coal. It was in this work that he coined the phrase *Jevons' Paradox* (also called the *Jevons Effect*). England's increased consumption of coal after the introduction of James Watt's more efficient coal-fired steam engine led to an increase (rather than a decrease) in the rate of consumption of coal. In effect, the Paradox called attention to the counter-intuitive result that increasing the efficiency of resource use can lead to its accelerated depletion. This phenomenon is now called the *rebound effect* and it has been observed in the increased consumption of gasoline due to the introduction of highly fuel efficient hybrid cars.[6] Some research indicates that one of the forces driving the increase in the size of the American home has been improvements in heating, cooling, and lighting technologies which permit the operation of a larger house at relatively low cost. Although Jevons' Paradox and the rebound effect have been

applied to energy resources, it is though that the general effect also governs improvements in the efficient use of resources in general.

The Emergence of Ecology: Ernst Haeckel (1834-1919)

Ernst Haeckel is credited with coining and defining the concept of *ecology* in 1866: "By ecology we mean the body of knowledge concerning the economy of nature—the investigation of the total relations of the animal both to its inorganic and to its organic environment including above all, its friendly and inimical relations with those animals and plants with which it comes directly or indirectly into contact—in a word, ecology is the study of all those complex interrelations referred to by Darwin as the conditions of the struggle for existence." Haeckel noted that ecology is the study of the economy of nature, while economics was the study of the ecology of humans. Various definitions of ecology evolved over time, with the eventual focus being on the relationships of organisms to their environment. Haeckel, a trained physician who abandoned his practice in 1859 and later became a professor of comparative anatomy in 1862, was also famous for having discovered, described, and named thousands of new species, mapping a genealogical tree relating all life forms, and coining many popular terms in biology still in use today.

Systems Thinking: Alfred Lotka (1880-1949)

Alfred Lotka had a broad range of interests including chemistry, physics, biology and economics and is primarily known today for formulating the Lotka-Volterra equations of population dynamics, also known as the predator-prey equations.[7] These equations, a pair of first-order, non-linear, differential equations, were introduced by Lotka in order to describe the dynamics of biological systems in which two species interact**.** He was the first of his time to attempt to integrate ecological and economic systems in quantitative and mathematical terms. His view of the world as biotic and abiotic components acting as a system, where everything was linked together and nothing could be understood without an understanding of the whole system, influenced both ecologists and economists of his time. Lotka is also well known for his development of systems criteria to drive evolution, also called Lotka's energy principle or Lotka's power principle, stating that systems survive by maximizing their energy flow. According to Lotka, "The principle of natural selection reveals itself as capable of yielding information which the first and second laws of thermodynamics are not competent to furnish. The two fundamental laws of thermodynamics are, of course, insufficient to determine the course of events in a physical system. They tell us that certain things cannot happen, but they do not tell us what does happen." Howard T. Odum, a systems ecologist, used Lotka's work to develop The Maximum Power Principle which Odum and others claimed was essentially the Fourth Law of Thermodynamics. Lotka's energy principle foreshadowed the development of general systems theory as well as the later reintegration of ecology and economics.

Market Failure: A.C. Pigou (1877-1959)

A.C. Pigou is best known for his work with welfare economics. His *Wealth and Welfare*, published in 1912, drew attention to welfare economics and conveyed his perception that governments could internalize externalities through implementing a combination of taxes

and subsidies in order to correct market failures. Pigou's work is described below in the section, Shifting the Burden: Internalizing the Externalities.

The Efficient Use of Resources over Time: Harold Hotelling (1895-1973)
Harold Hotelling was a mathematical statistician who developed a model that examined and described the conditions governing resource conservation or depletion. He was particularly interested in what he called *exhaustible* or *non-renewable* resources. Hotelling described a situation where an owner of land containing mineral resources could choose either to mine the resource or to leave it in the ground to be mined in the future. For a rational owner, the decision of when to mine is a function of the bank interest rate versus the appreciation of the resource. If the perceived appreciation in the value of the resource is greater than the interest rate, the prudent owner would choose to leave the resource in the ground. Similarly if the interest rate was thought to be greater than the forecasted appreciation rate, the owner would likely mine the resource and put the money in the bank. For renewable resources Hotelling's model describes a similar scenario. For low interest rates, owners of a renewable resource such as trees in a forest would increase the rate of harvest as the interest rate increases. At some point the rate of harvest, driven by increasing interest rates, will exceed the regeneration rate of the forest, resulting in its decline. Clearly the expected interest rate and expected future price of a resource are crucial in deciphering how biological resources should be managed. High interest rates may lead to depletion and the loss of biodiversity while low interest rates favor a conservation strategy. According to Hotelling's model, a species that is not generating a flow of services at a rate greater than the rate of interest "should" be depleted. This raised questions among many economists as the concept of extinction is certainly a highly controversial outcome. The debate over the impact of capital market strategies on resource depletion continues as does the role of discount rates in decisions about resource conservation versus harvesting.

Energetics and Systems: Georgescu-Roegen (1906-1994)
Georgescu-Roegen is best known for his contribution to ecological economics through his magnum opus, *The Entropy Law and the Economic Process* (1971). Georgescu-Roegen claimed, based on the Second Law of Thermodynamics, that the economy faces limits to growth, an assault on one of the key tenets of neoclassical economics. By subjecting the economy to the constraints posed by the Second Law, he challenged the assumption of unlimited economic growth, deeming it impossible based on the laws of physics. His insights gave birth to a new discipline called *evolutionary economics*, a school of thought inspired by evolutionary biology, which stressed complex interdependencies and resource constraints.

Spaceship Earth: Kenneth Boulding
The Economics of the Coming Spaceship Earth (1966) by Kenneth Boulding described a shift in thinking about human welfare.[8] In this paper Boulding contrasted the "cowboy economy" which views the economy as existing in an open and unlimited system, to the starker reality of a "spaceman economy" in which the economy resides in a closed system, similar to a spaceship. In the cowboy economy, consumption and production are good, resources are unlimited, and success is measured by throughput, that is, the greater

the rate of consumption and production, the more successful the approach. In the cowboy economy, the concept of Gross Domestic Product (GDP) measures throughput, unable to discern the consequences of resource depletion and waste generation. For example, the Exxon Valdez disaster in March 1989 resulted in an oil spill of 11 million gallons which contaminated 1,300 miles of coastline. The cleanup cost of $1.3 billion increased GDP by that amount. In the spaceship model, the planet is finite, resources are limited, and the waste resulting from production and consumption affects life and health. In the latter metaphor the Earth is likened to a spaceship with humanity as the crew, the only resources are those onboard, and any waste will affect the occupants unless recycled into useful products. Boulding's thinking which emphasizes an economy powered by renewable energy, materials from renewable resources and recycling, and the careful consideration of the impacts of waste, has become an important aspect of ecological economics

Emergence of Ecological Economics: Herman Daly (1938 -)

Perhaps Herman Daly's most recognized contribution to ecological economics is his *Steady State Economics* (1973) which acknowledged that the earth is materially finite and the economy is a subset of this finite system. Daly also further expanded the transition in the concept of economics by discussing economics as a life science rather than a physical science. This fundamental change in the perception of what economics entails led to a new perspective regarding resource conservation and biological conservation.

Valuing Nature: Robert Costanza (1950 -)

Robert Costanza is well known in the field of ecological economics for his work focusing on the interface between ecological and economic systems. His research expands on this interface at larger temporal and spatial scale and includes landscape level spatial simulation modeling, analysis of energy and material flows through economic and ecological systems, valuation of ecosystem services, biodiversity, and natural capital, and analysis of dysfunctional incentive systems and ways to correct them. Throughout his publications Costanza discussed the local politics of global sustainability and outlined goals, agenda and policy recommendations for ecological economics. One of his main efforts has been to encourage the integration of the natural and social sciences among decision makers.

THEORY AND PRINCIPLES

Ecological economics is a transdisciplinary field that draws from neoclassical economics, ecology, and physics. Consequently the still emerging theory of ecological economics reflects the influence of these fields. Unlike neoclassical economics which treats the environment as an external factor of production, with unlimited resources and infinite waste assimilation capacity, ecological economics makes natural systems the central issue of economics, with particular emphasis on the limits to nature's productivity and its ability to absorb the debris from human production and consumption. It addresses the value of nature to the economy by virtue of the wide range of essentially free services provided by nature. It also examines the connections of environment and economy to carrying capacity, health, biodiversity, poverty, population, and quality of life, to name but a few. The following paragraphs describe the theory and major principles that are part of the fabric of ecological economics.

The Global Ecosystem and the Economic System

A good starting point for rethinking economic theory to align it with sustainability, is the reality that the economy does not exist as an independent, open system just with production inputs and product outputs. The economy resides in a system, the Earth, which is largely closed except for solar energy and some incoming matter in the form of meteors and other space debris. All of the matter and most of the energy that are inputs to the neoclassical black box model of the economy come from the global ecosystem and even the workforce factor of production is totally dependent on the health and productivity of nature. The depletion of resources and generation of waste from extraction of resources, disposal of waste and end of life products, energy and chemical intensive agriculture, and the emissions from power production and factories all degrade natural capital. The main activity of the economy is the transformation of the earth and natural production by its inputs and outputs. And as currently operated the economy is not capable of preserving intact the productivity of nature. Degradation of natural capital can only lead to higher costs for capitalism and reduced profits. The economy's degradation of its own means of production is clearly a contradiction because it cannot grow forever while destroying key inputs. In his book, *The Enemy of Nature: The End of Capitalism or the End of the World?*, Joel Kovel describes an ecological crisis resulting from the economy's degradation of its own conditions of production at an ever increasing scale. He notes that, "This degradation will have a contradictory effect on profitability itself...either directly, by so fouling the natural ground of production that it breaks down, or indirectly, through the reinternalization of the costs that had been expelled into the environment."[9]

Herman Daly describes this contradiction by contrasting the Empty World versus the Full World model. In the Empty World, the economy is relatively small and it resides in the global ecosystem with relatively small effects, creating what economists call welfare or quality of life for people. As the economy grows it occupies more and more of the global ecosystem until it reaches the physical limits of resources and waste disposal, the result being that production drops off and welfare decreases. The problem posed by ecological economics is how to determine the scale of the economy relative to the global ecosystem such that welfare is maximized.[10]

Natural Capital and Substitutability

In neoclassical economics, capital is one of several factors of production, the others being labor, land, organization, and management. Capital is not just money but also factories, machinery and infrastructure. In the past several decades the notion of capital has evolved to include human capital, social capital, and cultural capital. Ecological economics adds a form of capital to economics that was not previously considered, namely natural capital. Natural capital can be defined as any stock of natural resources or environmental assets, such as oceans, forests or agricultural land, that yields a flow of useful goods and services now and in the future. One of the problems for the concept of natural capital is that, unlike the other forms of capital used in production, it has no monetary value. As noted earlier, in 1997, a group led by Robert Costanza attempted a valuation of the global ecosystem and concluded that the value of the services provided

by natural systems was about $33 trillion. Half of the value went to nutrient cycling. The open oceans, continental shelves, and estuaries had the highest total value, and the highest per-hectare values went to estuaries, swamps/floodplains, and seagrass/algae beds.

Clearly natural capital does have value but the question of how much of this critical asset must be maintained is a difficult and unresolved question. In addressing this issue, there are two extreme points of view. At one pole is Weak Sustainability, the province of neoclassical economics, whose adherents suggest there are substitutes for natural capital and that what is important is to maintain the combined total stock of human-made and natural capital. At the other pole is Strong Sustainability whose proponents argue that other forms of capital cannot replace natural capital and that, even more importantly, some forms of natural capital are critical and truly irreplaceable. The ozone layer protecting the Earth from ultraviolet light is an example of what may be called critical natural capital. Consequently proponents of Strong Sustainability advocate that the stock of natural capital must be maintained and must not be degraded.

The issue of substitutability of physical capital for natural capital is an important issue ecological economics. Neoclassical economics suggests that the substitution of one form of capital for another is doable, for example natural resource assets can be replaced with produced assets, such as human and physical capital, on a dollar for dollar basis. However natural capital is not only a factor of production in an economic sense, it also is often the very basis of societies and the well-being of the society. The loss of natural capital, for example an entire ecosystem, surely cannot be made up with an increase in physical capital. Agriculturally productive prime farmland displaced by development and covered with buildings and infrastructure has no real substitutes that are not extremely costly and energy intensive. Some forms of natural capital are indeed critical and it would be prudent for society to hedge its bets by implementing policies that are very protective of all natural systems. As Robert Costanza and Herman Daly noted, "A minimum necessary condition for sustainability is the maintenance of the total natural capital stock at or above the current level. While a lower stock of natural capital may be sustainable, society can allow no further decline in natural capital given the large uncertainty and the dire consequences of guessing wrong. This 'constancy of total natural capital' rule can thus be seen as a prudent minimal condition for assuring sustainability, to be relaxed only when solid evidence can be offered that it is safe to do so."[11]

The Scale of the Economy and Carrying Capacity

The size of the economy directly affects the global environment and ecosystems because virtually all the materials and energy resources needed for economic production have their origins in nature or in geologic structures which underlie and support natural systems. In general, the rate of destruction of natural systems and structures is directly proportional to the scale of the economy, the larger scale, the greater the mass of materials movement. Determining the upper boundary of the size of the economy is an important issue for ecological economics because at some point the natural systems which support life may be so severely impacted that the delivery of important services

such as clean air, potable water, and food may be compromised. When the scale of the economy is being addressed, the scale of the human population is also an important issue because more people place more demand on resources. The Earth's human population carrying capacity, first addressed by Thomas Malthus, is a central concern of ecological economics because, by definition, exceeding this limit indicates the onset of severe destruction of natural systems, not to mention severe consequences for humanity.

A good index of the scale of human impact on nature is the percentage of photosynthetic production that has been appropriated for human use. The term, *net primary production* (NPP), can be used to help determine the scale of these impacts. NPP is the amount of solar energy captured by primary producers, less that used in their growth and reproduction. According to a 1986 study led by Peter Vitousek, humans were appropriating about 25% of total NPP (includes both terrestrial and aquatic production).[12] Of the terrestrial NPP, humans were appropriating about 40% of the total production. Since the appropriation of NPP is likely proportional to population, with one doubling of the then human population of 4.9 billion, almost all the terrestrial NPP would be used by one species, humans.[13] When world population reaches 7.0 billion the likely human appropriation of terrestrial NPP will be about 60%. The problem of course is that no one can predict the consequences of this cooption on global ecosystems. However, it is likely that the diversion of terrestrial and aquatic resources for human use is contributing to the widespread extinction of species and genetically distinct populations, and the genetic impoverishment of many others. It should be noted that NPP appropriation is proportional to per capita income, with richer countries consuming far more NPP per capita than poorer countries.

Humans are also appropriating enormous quantities of the natural flow of water on the planet for their uses, much of it connected to the economy. In 1996, a research project led by Sandra Postel found that total sustainable potable water available to the earth's land mass was about 110,000 km^3, comprised of 70,000 km^3 of evapotranspiration (ET) by plants and 40,000 km^3 of runoff (R). Of the R portion, only 12,500 km^3 is actually available (AR) for human use due to temporal and geographic factors. At the time of the research it was found that humans were appropriating 26% of ET and 54% of AR for their own uses, or about 30% of all the potable water powered by the natural water cycle. Because water consumption is roughly proportional to population it is likely that at present 40% of ET and 60% of AR are being used to meet human needs.[14]

Non-renewable resources are key ingredients of the human economy, from fossil fuels such as coal, oil, and natural gas to metals such as iron, copper, and aluminum. Some non-renewables are indeed being regenerated, but at a rate so slow that for all practical purposes the regeneration rate is zero. Fossil fuels are an example of this latter case. Non-renewable resources are all dwindling and as the rich deposits are depleted, ever more energy is required to remove more dilute, lower concentrated, and distant deposits. The extraction of iron ore, for example, requires the removal of overburden and the extraction of the rock containing the iron ore. As the rich deposits of iron ore are exploited, the remaining sources have lower concentrations of ore, requiring even more overburden and rock removal. A concentration of 0.1% iron ore requires 10 times more

materials movement than a deposit with a concentration of 1.0% iron ore. Thus the combination of economic growth and the exhaustion of high concentration deposits results in an exponential rise in materials movement and natural system destruction. The phenomenon of mass materials movement to extract non-renewable resources is sometimes referred to as the *ecological rucksack*. The ecological rucksack of a material is defined as the total mass of materials movement required to obtain a unit mass of the material. For example, the ecological rucksack of aluminum is 85 because 85 kilograms of materials must be extracted and processed to produce 1 kilogram of aluminum. In comparison the ecological rucksack of recycled aluminum is 3.5 while that of gold extracted from ores is 350,000.[15]

Renewable resources are also inputs to the economy and the desired utilization of these resources to maintain a sustainable economy is to extract them at a rate that is equal to the regeneration rate of the resource. Sustainable forestry, for example, relies on good management practices in which wood is extracted from the forest not only at its regeneration rate, but also in a manner that will not cause damage to the ecosystems of which the forest is a part. Sir John Hicks, a winner of the Nobel Prize in economics, defined sustainable income, sometimes referred to as *Hicksian Income*, as the maximum amount that can be produced and consumed in the present without comprising the ability to do likewise in the future. He specifically defined sustainable income as the maximum amount that a person or a nation could consume over some time period and still be as well off at the end of the period as they were at the beginning.[16] When applied to renewable resources this could be interpreted as using the surplus or interest of the natural system, rather than consuming the core of the natural system itself.

Of course the economy consumes both renewable and non-renewable resources and by definition non-renewable resources are being depleted while renewable resources, with sustainable management can be consumed indefinitely. In the context of sustainability, there are practical and ethical questions about the consumption of non-renewable resources in the sense that, once consumed, they are unavailable for future generations. Even with aggressive recycling programs, non-renewable resources are lost in each cycle of recycling, dissipating into the environment at their background concentration. J. Hartwick suggested that some of the income from the sale of non-renewable resources should be invested in the expansion of renewable resources.[17] This is commonly refer For example, a country such as Saudi Arabia with large deposits of oil, could invest some of the income from its sale into the education of its citizens, thus creating a renewable resource, an educated population that can develop a diverse economy to substitute for one based on a finite resource.

Shifting the Burden: Internalizing the Externalities

Production produces pollution and waste, almost always with negative and often unintended and initially unknown consequences for people and the environment. Air, water, and solid emissions affect health and contribute to the degradation of ecosystems. Neoclassical economics presumes that the global 'commons' are free with respect to emissions and waste and thus they are not factored into the cost of production. In ecological economics these emissions are often referred to as *externalities* or negative

impacts of an activity on a third-party without compensating them. In a broader sense externalities can impact ecosystems as well, for example the degradation of forests by acid rain. Until relatively recently, companies were unconcerned about their discharges, their waste disposal, or the consequences on communities or ecosystems. Human history is littered with examples of this pattern of behavior, from the Love Canal in New York where 21,000 tons of buried toxic chemicals which were discovered in the late 1970s, to the Bhopal accident in which 6,000 people were killed in India in the 1980s, the Exxon Valdez accident of 1989 which caused untold damage to the ecosystems of Prince William Sound in Alaska, not to mention past episodes with DDT, PCBs, and a wide variety of other toxic chemicals. And of course there is the continuing problem of routine emissions of sulphur dioxide, particulates, and nitrous oxides from coal-burning power plants, radioactive waste from nuclear power plants, and chemicals from factories, wastewater treatment plants, metal plating operations, steel mills, paper pulp plants, and a host of other sources.

The problem with externalities is how to compensate those negatively impacted by emissions. The problem of how to quantify all the social costs of the externalities of an activity such as a petrochemical plant is a difficult one as is how to compensate those affected. Research on emissions provides some insight into determining health costs, damage to infrastructure and buildings, forests, and other systems affected by the emissions. The problem of determining the level of compensation for people affected by externalities can at least to some degree be quantified and the costs of a unit of emissions can be determined. Converted into a tax or fee, the externalities can *internalized*, that is, included in the cost of production.[18] Taxes that attempt to internalize externalities are sometimes referred to as *Pigouvian Taxes*, after A.C. Pigou. He defined an externality as a phenomenon that is external to markets and hence does not affect how markets operate when in fact it should. Pigou suggested that by internalizing previously external costs, that is, making them affect how the markets operate, the external costs could be compensated for. For example, in the case of a coal-fired power plant, its emissions could be taxed and the resulting revenue could be used to restore damaged forests and compensate those whose health has been affected. Pigou also suggested that the value of biodiversity could be protected since it is not included in the market signals that guide the economic decisions of producers and consumers. One proposal regarding how to protect the value of critical natural resources has been to designate responsibility and rights of these resources to private parties. The potential problem with this suggestion is that in some circumstances it may encourage individuals to charge consumers higher prices in order to generate money that would be directed to the conservation of the resource. In other circumstances charging too little would result in inadequate for protecting the resource. This could then actually ccelerate the deterioration or even extinction of certain resources rather than the conservation of them unless other controls are placed on resource use. Furthermore, because there is no negative reinforcement in the form of taxes of penalties for the depletion of a resource or species, there is no disincentive for consumption. By placing an economic value on species and affecting current market signals, the loss in biodiversity could be decreased. Valuation of ecosystems and biodiversity could prove to be a beneficial tool in encouraging people to protect these natural assets by assessing the costs and benefits of development.

The Polluter Pays Principle

The Polluter Pays Principle (PPP) is simple in concept and squarely addresses the problem of how to internalize externalities by requiring that the costs of pollution be borne by those who cause it. PPP was originally aimed at determining how the costs of pollution prevention and control should be allocated based on the concept that those causing the impacts should pay to compensate those impacted by their activities. Its immediate goal is internalizing the environmental externalities of economic activities and ensuring the prices of goods and services fully reflect the costs of production. Bugge (1996) identified four different interpretations of the PPP:

1. the PPP as an economic principle; a principle of efficiency;
2. the PPP as a legal principle; a principle of just distribution of costs;
3. the PPP as a principle of international harmonization of national environmental policy; and
4. the PPP as principle of allocation of costs between states.

In its interpretation as an economic principle, the purpose of the PPP is to reduce pollution by internalizing its social costs. The pollution charges could also be seen in the context of the PPP as a legal principle in which the costs of pollution are efficiently and justly allocated among those causing the pollution and redistributed to those affected by it.

The scope of the PPP has evolved over time to include accidental pollution, control and clean-up costs, in what is referred to as the *extended Polluter Pays Principle*. Today the PPP is a generally recognized principle of International Environmental Law, and it is a fundamental principle of environmental policy of both the Organisation for Economic Co-operation and Development (OECD) and the European Union.

The PPP is generally implemented through command-and-control and market-based approaches. Command-and-control approaches include performance and technology standards that set maximum pollution levels for various activities. In the case of a power plant, government regulations requiring scrubbers and other technologies to be installed in the plant to limit emissions to maximum levels is an example of a command and control approach. Market-based instruments include pollution taxes, tradable pollution permits and product labeling. Cap and trade schemes in which carbon dioxide is allocated and traded on a carbon exchange are examples of a market-based instruments. The elimination of subsidies is also an important part of the application of the PPP. At the international level the Kyoto Protocol is an example of the application of the PPP. Signatories to the Protocol agreed that they have an obligation to reduce their greenhouse gas emissions and must bear the costs of reducing, through prevention and control, their carbon dioxide emissions.

Beneficiary Pays Principle

Cost sharing is the application of the beneficiary pays principle (BPP) to the solution of the problem of externalities. The basic concept is that each entity that is likely to benefit from solving a problem contributes to the costs of solving the problem in proportion to his/her gains. For example, the rapid destruction of Amazonian rainforest in Brazil together with the recognition that the loss of this rich store of biodiversity would be an international tragedy has resulted in suggestions to Brazil that they not only stop but also reverse its destruction. However protecting and restoring the rainforest means that Brazil would not only forgo the extraction of resources and development of agriculture, but also have to make a sizable investment in regenerating the destroyed ecosystems. Because the international community stands to benefit from the restoration of the rainforest and as a result will benefit from not only the preservation of biodiversity but also from the sequestration of carbon, Brazil should be compensated for the loss of economic development and the funds invested in the rainforest. Another application of the BPP is requiring industrialized countries to compensate resource-poor farmers in tropical countries for adopting soil carbon management practices.

In each case the contribution of the beneficiary is based on their perceived benefits. Another example is the cooperation of ranchers by making efforts, including forgoing production, to help maintain highly valued landscapes as diverse as alpine meadows, the Hell's Canyon in Oregon and African savannahs. In the case of Hell's Canyon the threat to landscape and biodiversity was the proposed development of hydroelectric power installation. Those who benefit from the recreational opportunities provided by these protected landscapes should compensate the ranchers for the ongoing costs of landscape maintenance. For example, the opportunity cost of wildlife conservation in protected areas of Kenya, measured in terms of forgone livestock and agricultural production, has been estimated to be around $203 million per year, or 2.8 percent of total GDP, while revenues from wildlife tourism and forestry contribute only around $42 million per year to the national economy (Norton-Griffiths and Southey, 1995). The authors argue that, given the global nature of the benefits of Kenya's conservation efforts, it is quite appropriate that the international community bear some of the costs of conservation.

The BCP applies to a wide variety of situations where it is appropriate for those foregoing economic opportunities for environmental benefit:

1. Carbon sequestration and storage, for example a German electricity company paying farmers in the tropics for planting and maintaining additional tree;

2. Biodiversity protection where conservation donors pay local people for setting aside natural areas.

3. The restoration of natural areas to create a biological corridor, paid for by communities that were built in a manner which resulted in the removal of the corridor.

4. Watershed protection where downstream water users pay upstream farmers for adopting land uses that limit deforestation, soil erosion, and flooding risks.

5. Protecting landscape beauty, for example a tourism operator paying a local community not to hunt in a forest being used for tourists' wildlife viewing.

Extended Producer Responsibility

The concept of Extended Producer Responsibility (EPR) was first formally introduced in Sweden by Thomas Lindhqvist in a 1990 report to the Swedish Ministry of the Environment. The formal definition of EPR is that it is an environmental protection strategy designed to decrease the total environmental impact of a product by making the manufacturer responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product. EPR initiatives include product take-back programs, deposit refund systems, product fees and taxes, and minimum recycled-content laws. EPR puts the onus upon the manufacturer and to many, represents a mandatory approach.

Extended Producer Responsibility (EPR) uses political means to hold producers liable for the costs of managing their products at the end of life. This tactic attempts to make the transition from traditional end-of-pipe waste 'diversion' programs (funded by local government and therefore the public, and of no responsibility to the producer) to 'cradle to cradle' recycling systems designed, financed, and managed by the producers themselves. EPR promotes that producers (usually brand owners) have the greatest control over product design and marketing and therefore have the greatest ability and responsibility to reduce toxicity and waste.

The major impetus for EPR came from northern European countries in the late 1980s and early 1990s, as they were facing severe landfill shortages. EPR is generally applied to post-consumer wastes which place increasing physical and financial demands on municipal waste management. EPR is based on the PPP, making manufacturers responsible for the entire lifecycle of the products and packaging they produce. One aim of EPR policies is to internalize the environmental costs of products into their price. Another is to shift the economic burden of managing products that have reached the end of their useful life from local government and taxpayers to product producers and consumers. In Germany, EPR is being implemented via government policy, and has reduced packaging waste about 4% per year for several years after its implementation in 1991. The European Union has legislated that automobile manufacturers must provide free take-back locations for waste automobiles, referred to as End-of-Life Vehicles or ELVs, and must recycle a minimum of 80% of the mass of the vehicle.[19]

A related approach, Product Stewardship, is gaining in popularity because of its less regulatory nature and its recognition that other parties have a role to play. Product Stewardship means that all parties - designers, suppliers, manufacturers, distributors, retailers, consumers, recyclers, and disposers - involved in producing, selling, or using a product take responsibility for the full environmental and economic impacts of that product. An example of Product Stewardship is a program in Oregon in which the manufacturers of paint sold in Oregon, or a stewardship organization representing manufacturers, are required to set up and run a convenient, statewide system for the collection of post-consumer architectural paint.

Full Cost Accounting, Full Cost Pricing, and Life Cycle Costing

Another terminology related to internalization is *full cost accounting (FCA)*.[20] FCA includes not only the internalized costs of the externalities produced by production but also includes the life cycle costs of the product or activity. FCA applies to a wide range of accounting systems, from national to business or government. At national level, FCA requires a modification to Gross Domestic Product (GDP) as a measure of performance to include other societal and environmental impacts. This adjustment results in what are sometimes referred to as Alternative Measures of Welfare which modify GDP to account for environmental impacts, such as pollution, and social costs of, for example, prisons and people not covered by health insurance.

For enterprise or government accounting systems, the US EPA developed a four tier system for management to use to account for the environmental costs portion of FCA:[21]

Tier 0: Conventional Capital and Operating Costs

These are the normal costs of a project and include capital expenditures such as buildings, equipment utilities, and supplies plus operating and maintenance expenses such as materials, labor, training, insurance, and permitting.

Tier 1. Hidden Costs

There are a number of environmental costs that may not be accounted for as such as monitoring, paperwork and reporting requirements. These include upfront environmental costs, regulatory or voluntary environmental costs, and backend environmental costs (see Table 1). Upfront costs are incurred prior to the operation of the process or facility and related to the siting of facilities, qualification of suppliers, evaluation of alternative pollution control equipment etc. Regulatory and voluntary environmental costs include items such as environmental insurance, permitting costs, environmental monitoring and testing, recordkeeping, voluntary audits, remediation, recycling activities etc. These costs are often assigned to overhead accounts rather than allocated to departments of products directly. Backend environmental costs are usually also ignored in current decision making as they are not incurred at the present time. Such costs include the future costs of decommissioning a laboratory, or product take-back requirements.

Tier 2. Contingent Costs

Contingent costs are costs that may or may not be incurred at some point in the future and include penalties, fines, and future liabilities. They can only be estimated in probabilistic terms - their expected value, or the probability of their occurrence. Examples are personal injury claims related to product use, future remediation costs, and fines or penalties.

Tier 3. Less tangible Costs

These are the difficult to estimate costs associated with maintaining corporate image, good relationships with investors, employees, and customers etc. These costs would include the costs of environmental outreach activities (annual community cleanup days or tree planting days for example), and publication of environmental reports, to name a few.

The ultimate goal of FCA is actually what might be called *Full Cost Pricing* in which the full social and environmental costs of a product are included in the price paid by the consumer. The consumer is then making a decision based on a price for which these costs have been paid.

ALTERNATIVE MEASURES OF WELFARE

Indicators for measuring the well-being and standard of living are important for assessing changes in the quality of life of a nation. In this section we describe standard macro-economic indicators such as GDP that are used as an indicator of a society's welfare and other so-called *alternative measures of welfare* that are designed to provide a more accurate assessment of the health of a society.

The Problem with Gross Domestic Product (GDP)

The most well recognized macro-economic indicator is GDP which was developed by Simon Kuznets. GDP is widely used by economists and policymakers for assessing a nation's economic performance and is defined as the market value of all final goods and services made within the borders of a nation in a year. Its purpose is to provide a measure of the economic production and growth for a given nation and allows some level of comparison between countries.

There are two approaches used for calculating GDP, the income and expenditure methods. The *income method* includes total compensation to employees, gross profits for incorporated and non-incorporated firms, and taxes less subsidies. The *expenditure method* calculates GDP by totaling consumption, gross investment, government spending, and net exports. Either approach should yield approximately the same value. Today's economists divide consumption into the two categories of *private consumption* and *public sector spending*. In order to make comparisons of annual economic performance more convenient, GDP is reported in both current dollar and constant dollar forms. The constant dollar method involves converting current economic data into some standard era dollar, such as 1997 dollars. It is important to note that GDP does not take into account goods and services produced by a nation's companies operating in foreign countries. Gross National Product (GNP) is an indicator which includes both the domestic and foreign activities of a nation's companies.

GDP is the most commonly used indicator of an economy's economic performance. Thought to be a direct indicator of an economy's health, some relate the concept of GDP to the nation's standard of living or welfare. Although changes in this indicator are often simultaneous with changes in profit margins, stock prices, unemployment, and wage changes, is not actually a good gauge of a nation's standard of living or welfare because there are several other tangible and intangible factors that are not accounted for in the calculation of GDP which affect individual welfare. There are many problems associated with linking GDP and welfare but perhaps the greatest fallacy is thinking that when a market performs well, people benefit and this contributes to the greater welfare of a nation. GDP was not originally intended to measure well-being but rather economic productivity. National income is not necessarily a measurement of welfare. Some critics even argue that growth of GDP has been costly in psychological, sociological and

ecological terms. However there has been no real consensus an alternative to GDP as a measure of welfare and thus it continues to be used for this purpose. And some would argue that if GDP does ignore social costs, then by definition it tends to overestimate welfare.

GDP does not take into account the underground economy and has also been criticized because it does take into account government spending that could be the result of natural disaster damage mitigation, prisons supporting more criminals, a society burdened with more health care costs due to unhealthy citizens, acts of terrorism, other accidents or corporate fraud. While each of these costs contributes to spending, it seems counterintuitive to link these costs with an increased quality of life or welfare, yet using GDP as an indicator of welfare does just that. After 9/11, billions of dollars were spent in rescue, cleanup and related costs alone covering only the short-term impacts of this tragedy. Should this spending be included in the calculation of an indicator measuring welfare? Another example of spending that is included in the calculation of GDP but perhaps should not be is the cost of the depletion of natural resources. The more oil we pump the more depletion of a key natural resource, yet GDP increases. GDP also excludes the entire sector of volunteer services including activities such as mentoring, child and elder care, and many other activities that actually do enhance welfare. GDP has also been criticized for being extremely insensitive to the distribution of income within nations. Countries with very different percentages of poverty could have similar GDPs based on a combination of other differing factors.

Another important note to make regarding GDP is its reliance on imports. As a community becomes more independent and self reliant, thus decreasing its imports and increasing local commerce, GDP decreases.

Measure of Economic Welfare (MEW)

William Nordhaus and James Tobin proposed the Measure of Economic Welfare (MEW) in 1972, as an alternative measure of welfare to GDP. MEW adjusts total national output and includes only the consumption and investment items that contribute directly to economic well-being. This indicator is calculated making additions to GNP such as the value of leisure time and the underground economy as well as deductions such as environmental damage. The adjustments to GDP to determine MEW have three categories: 1) reclassification of GNP expenditures as consumption, investment, and intermediate, 2) imputation for the services of consumer capital, for leisure, and for the product of household work, 3) correction for some of the disamenities of urbanization, such as the loss of productive farmland.[22]

The most significant issue addressed by MEW is the recognition that GNP is a measure of production, while economic welfare is a measure of consumption. Nordhaus later commented on the comparison of GNP versus MEW data, suggesting that both indicators are inaccurate and even after adjusting for the main issues concerning GNP, MEW is just as deficient.

Index of Sustainable Economic Welfare (ISEW)

Another of the best known alternative measures of welfare is the Index of Sustainable Economic Welfare (ISEW), created in 1989 by Herman Daly and John Cobb based on Nordhaus and Tobin's concept of MEW with the intention to develop a more sophisticated indicator of welfare. The ISEW balanced consumer expenditure with factors such as income distribution and costs associated with pollution and other forms of environmental degradation. ISEW can be calculated by adding personal consumption, public non-defensive expenditures, capital formation and services from domestic labor and subtracting private defensive expenditures, costs of environmental degradation and depreciation of natural capital.[23]

When developing ISEW, Daly and Cobb took into account major factors such as net capital growth, foreign versus domestic capital, natural resource depletion, environmental damage, the value of leisure and the value of unpaid household labor. One of the major differences of this index compared to others is that its base is derived from personal consumption rather than production. Although some believe this is a more effective indication of welfare than production, its interpretation has limitations. There has also been criticism regarding the relationship between economic welfare and happiness as well as the relationship between absolute wealth or consumption versus the relationship between relative wealth or consumption.

Other limitations to this index include the exclusion of many categories of additions and deductions such as income from the underground economy, changes in working conditions and certain expenditures questionable in their contribution to economic welfare. As is the case when developing any index, certain assumptions were made, in this case regarding the estimation of quantities that are inherently immeasurable, such as the cost of natural resource depletion and long-term environmental damage.

Genuine Progress Indicator (GPI)

The concept of ISEW led to the idea of the Genuine Progress Indicator (GPI), created by Redefining Progress in 1995.[24] This concept, perhaps the most progressive indicator developed to date, is based on green and welfare economics and attempts to measure economic progress while distinguishing between worthwhile growth and economic growth that causes a decline in the quality of life. GPI was designed to indicate whether a country's growth and the increased production of goods and expanding services have actually yielded a greater well-being or not. Unlike other alternative measures of welfare, the calculation of GPI does not begin with GDP as its base but rather with the extraction from the national accounts of the transactions deemed directly relevant to human well-being.

The calculation of GPI includes the addition of the following items: 1) personal consumption expenditure, 2) services yielded by consumer durables, 3) services yielded by roads and highways, 4)services provided by volunteer work, 5) services provided by non-paid household work, as well the subtraction of the following items: 1)cost of consumer durables, 2) cost of noise pollution, 3) cost of commuting, 4) cost of crime, 5) cost of underemployment, 6) cost of lost leisure time, 7) the cost of household pollution abatement, 8) the cost of vehicle accidents, 9) the cost of family breakdown, 10) loss of

farmland, 11) cost of resource depletion, 12) cost of ozone depletion, 13) cost of air pollution, 14) cost of water pollution, 15) cost of long-term environmental damage, 16) loss of wetlands, 17) loss of old-growth forests. The following items are subtracted from the GPI: 1) index of distributional inequality, 2) net capital investment, 3) net foreign lending/borrowing. When comparing the calculation of ISEW versus GPI, the items used to arrive at the final index could be exactly the same depending on when the indexes were calculated and how each index has been updated and perfected over time.

When comparing data reflecting GDP and GPI calculations from 1950 through 2004, the trend in GDP shows a fairly steady increase in growth throughout the years, while the trend in GPI shows a peak somewhere in the 1970s with virtually no growth since. Some believe the data found using GPI is perhaps more indicative of our nation's economic state today versus in the 1970s than the data found using GDP.

Human Development Index (HDI)

Mahbub ul Haq's Human Development Index (HDI), an important alternative to GDP, consists of standard of living (GDP per capita), life expectancy at birth and knowledge (a composite measure of education, literacy and school enrollment).[25] This index is used to measure a nation's human development, which is considered to be indicative of the expansion of opportunities for people regarding education, health care, income and employment. HDI is published on an annual basis in the Human Development Reports (HDRs) through the United Nations Development Programme (UNDP).

The calculation of the knowledge component of this formula is devised by measuring adult literacy, with two-thirds weighting, and the gross enrollment rate, with one-third weighting. The standard of living component is measured using the natural logarithm of GDP per capita.

HDI has been the center of much scrutiny, mostly regarding its exclusion of any ecological factors. HDI focuses primarily on national performance and is perhaps just another index similar to GDP in that it faces much of the same criticism and issues as many others. The UN annually ranks its members and these rankings are often used to highlight national insufficiencies. Whether or not this index has actually progressed towards a model more indicative of social welfare remains to be seen but the impact of economic policies on quality of life is evident. This index has also been criticized for its focus solely on national performance rather than global development as well.

Other Measures of Welfare

Another alternative measure of welfare is Tim Jackson's *Measure of Domestic Progress* (MDP), which adjusts previous theories accounting for climate change and resource depletion. The *quality-of-life index* (PQLI), constructed by Morris David Morris in the mid 1970s, is computed by averaging basic literacy rate, infant mortality rate and life expectancy at age one (all equally weighted). Still other indexes, such as the *Human Poverty Index* which focuses explicitly on poverty, and the *Happy Planet Index* which consists of indicators such as life satisfaction, life expectancy, happy life years and ecological footprint, serve as more accurate indicators for certain countries.

SUMMARY
Ecological economics is a key discipline in what might be called the science of sustainability. Neoclassical economics is the antithetical to sustainability because it treats nature only as a factor of production and does not account for the broader role of nature in supporting life in general and quality of life for humanity. Additionally it does not acknowledge that economic growth is ultimately limited in scale and this limitation is due to the scale of the global ecosystem in which the economy is contained. Finally neoclassical economics prefers to ignore the laws of physics, particularly the Second Law of Thermodynamics, which also limits the scale of the economy. Ecological economics recognizes that the scale of the economy is a function of natural system productivity and that economic growth must have limits because of the finite size of the Earth and its ecosystems. In ecological economics, natural capital has equal importance with other forms of capital, and some natural capital is critical and must not be destroyed. Substitutability of other forms of capital for natural capital is limited and the scale of the economy is limited because some scale of natural capital must be protected to maintain the services provided by natural systems. Ecological economics requires that externalities be internalized, and that externalities be reduced to the absolute minimum. The Polluter Pays Principle is an implementation of internalization and fixes the responsibility for the parties responsible for the impacts of emissions. Similarly other principles such as the Beneficiary Pays Principle, Extended Producer Responsibility, Full Cost Accounting, and life cycle costing, provide a framework for internalization and decision making. Ecological economics also fosters alternative ways of assessing how well a country's economy is performing though the use of alternative measures of welfare such as the Happy Planet Index, GPI, and the HDI.

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ENDNOTES

[1] Robert Costanza calls ecological economics the science of sustainability in a volume he edited on the subject: *Ecological Economics: The Science and Management of Sustainability* (1991).

[2]Ecological economics could be said to have been founded in 1988 with the appearance of the Journal of Ecological Economics. A paper by Inge Røpke (2004) describes the early history of ecological economics and the influences of ecologists, economists, environmentalists, and others on its evolution.

[3] As described in a paper by Costanza et al (1997).

[4] The development of economics and the emergence of ecological economics are derived from an excellent book on ecological economics, *An Introduction to Ecological Economics*, by Robert Costanza (1997) and several colleagues, including Herman Daly, one of the key figures in the development of ecological economics.

[5] Karl Marx clarified his thinking on the value of nature in *Critique of the Gotha Programme* (1863).

[6]A discussion of the rebound effect relative to the Jevons Paradox can be found at http://www.treehugger.com/files/2008/05/beating-energy-efficiency-paradox.php

[7] These equations were first described in his book in his 1925 book, *Elements of Physical Biology*.

[8] This famous paper was presented at the Sixth Resources for the Future Forum on Environmental Quality in a Growing Economy in Washington, D.C. on March 8,1966.

[9] From *The Enemy of Nature: The End of Capitalism or the End of the World?* by Kovel (2002).

[10] The Empty World versus Full World models are described by Daly (1999).

[11] As stated in "Natural capital and sustainable development" by Robert Costanza and Herman Daly (1992).

[12] Human appropriation includes direct use of NPP for food, fuel, fiber, and timber plus reduction in potential due to ecosystem degradation caused by humans.

[13] From "Human Appropriation of the Products of Photosynthesis," by Vitousek et al. (1986).

[14] Summarized from "Human Appropriation of Available Fresh Water" by Sandra Postel, Gretchen Dailey, and Paul Ehrlich (1996).

[15] The ecological rucksack was invented by Friedrich Schmidt-Bleek of the Wuppertal Institute in Germany in the mid-1990s.

[16] An excellent description of the broader concepts associated with Hicksian Income can be found in *An Introduction to Ecological Economics* by Costanza et al (1997).

[17] As described in "Intergenerational equity and the investing of rents from exhaustible resources" by J. Hartwick (1997).

[18] In economics, externalities can have positive or negative benefits. For example, an automobile can have the positive externality of mobility for people, making them more efficient and improving their quality of life. Automobiles also have the externality of air pollution which has negative social impacts. In ecological economics, externality refers exclusively to negative impacts.

[19] European Union Directive 2000/53/EC spells out the requirements for ELV recovery and recycling. The 80% recycling rate increases to 90% in 2015.

[20] True cost accounting (TCA) is a terminology sometimes used as an alternative to full cost accounting.

[21] The EPA's full cost accounting process is described at www.epa.gov/waste/conserve/tools/fca/index.htm

[22] The rationale for the MEW is covered in Nordhaus and Tobin (1972).

[23] The design of the ISEW is described in *For the Common Good* by Daly and Cobb (1989).

[24] Lawn (2003) describes the theoretical basis for GPI and ISEW in "A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes."

[25]The HDI is described by A Sagar and A. Najam (1998) in "The human development index: a critical review."

CHAPTER 8
THE PROCESS OF DECISION MAKING

As the first chapters suggests, we are at a turning point. The modern, conventional models of economic development and business that have catapulted many nations out of agricultural subsistence and into the luxury of industrial production and consumption have also taken advantage of available resources with little regard for ecosystem limits of extraction and nutrient cycling or human rights. While we have generated an incredible variety of technologies to facilitate our life on earth, we do not have a long history of recognizing "good" technology from "bad."

No one sets out to make a "bad" decision, of course. The tobacco industry enabled many small landowners in the Appalachian foothills to scratch out a living and built themselves and their stockholders a fortune by creating a highly desirable product. The Aswan Dam held the promise of better control of Nile floodwaters for irrigation during drought. In hindsight, both cigarettes and large-scale dams have created additional, unforeseen problems that challenge their idealized image. The litany of disasters and current problems, however, suggests that we do not have a good system of vetting proposed products or taking into account both the factors that must be considered and the level of uncertainty that hides unknown consequences. And even if a few people are capable of recognizing decisions that lead to more sustainable practices, the challenges of communicating those ideas and convincing others may overwhelm their ability to steer us into a new direction.

This book defines ethics as a discipline that guides us to making good decisions. As Chapters 3-7 explain, when it comes to matters of sustainability, the practice of considering environmental, social, and economic consequences in the context of the future, other humans, and other species will make these decisions more ethical. A great many decisions fall into this broad realm, from which product should we make to what we should eat. The former represents professional decisions that will be addressed in Chapter 9 while the latter represents personal quandaries that will be the basis of Chapter 10. It may be tempting to believe that every decision is covered under this umbrella, but there are challenges we do not intend to address. Decisions that sit squarely in the realm of just one of the pillars of sustainability: environment, economic, or society, are not the concern of this book, such as which person should you ask to dinner or at which interest rate should you increase your investment in a bond fund. In many cases, however, we contend that decisions which historically belonged in only one category <u>should</u> consider the consequences to each dimension and that any issue in the environmental sphere probably has economic and societal implications if we learn to look for them.

This chapter covers the process of decision making and will use examples of both professional and personal decisions in the mental process of arriving at a decision, the challenges of making good decisions, and the strategies that should help us make better decisions.

RATIONALITY

We make decisions every day—so many that we probably do not recognize most of them as

decisions. What we wear, what we eat, which route to take to work, which supplies we order for a job, what projects we tackle first, whether we speak at a meeting, and who we hire are some examples of decisions we make in our personal and professional worlds. Common, daily decisions are often made without a great deal of attention or introspection; they are often governed by habit, personality, or previous experience. Big, special, or new decisions, however, usually require thought so the process of decision making is more obvious. Both types of decisions use basically the same process and using an example of each will illustrate how we make decisions. For simplicity's sake, consider the steps of buying cereal and the process of buying a car.

For many of us, buying cereal requires little thought or attention, which enables us to focus on the more important aspects of our grocery list. We either purchase the same tried-and-true cereal, or we venture into the unknown following the promise of an advertisement or a friend's recommendation. In either case we unconsciously list the characteristics we desire and match them to the set of cereals that conform to our expectations. If several cereals match our need for nutrition, sweetness, or crunch, for example, we begin to consider which variables are more important to us. Is the banana flavor more appealing than blueberry? Do whole grain squares offer a better resistance to milk (that sogginess factor) than nuggets? All things being equal, we tend to pick the cheapest box and move on to peanut butter. And it all happens in a blink of an eye.

This basic process is called rational decision making or rationality by economists, who use it frequently to model decisions. The theory suggests that people make choices that maximize their interests. They do this by assembling all the information about the choices, prioritizing and weighing the characteristics, and selecting the choice that scores the highest on the important features. The process can work well if the assumptions are met—if the decision maker has all the information needed about all the relevant features and if the best option can be calculated. If someone only cares about three factors in cereal, perhaps vitamin B content, whole wheat, and price per ounce, it can be a straightforward process to collect the relevant information and make a decision. Cereal boxes and grocery shelves in the United States provide this information, since many people want to know. And since everyone does not share the same priorities for ideal cereal, a variety of combinations are strategically offered to aim to please everyone.

But what happens when we make a more complicated decision, and particularly one with consequences for sustainability? For most people, a car is a significant enough purchase that it deserves careful consideration, and our transportation choices clearly have economic (quality, service, price, new or used), environmental (fuel, hybrid or traditional engine, emissions), and societal (US-based industry, labor unions) dimensions. Choosing to share a car, rent a car, or use public transportation should also be considered, of course. For those who settle on owning a personal vehicle, it takes a bit of time to read up on the current models, compare loan packages, consider mileage and fuel options, and recall the characteristics you desire or dislike about automobiles. You collect information. You compare options and figure out whether you want headroom in the backseat or a trunk that is easy to load. You think about whether you can find biodiesel fuel and how often each model needs repair. You look at your bank account and think

about the risk associated with buying a used vehicle. You then prioritize the options you care about based on what matters to you. If several options are basically the same, you pick "the best," which is probably the cheapest. And you happily drive away.

You may not have made a completely rational decision, however. The assumption of perfect information, for example, is rarely met. We do not know when the brakes will need to be replaced or the muffler will fall off. We may not have read the consumer ratings to know how the car compares to others. Critics of rationality suggest if we do not have all of the information, we must not be making a thoroughly rational decision. The fact that we still make a decision suggests there are other strategies at work.

Followers of rationality say that we calculate the probability of unknown things happening. How likely are the brakes to fail in the first 50,000 miles, and how much would it cost to replace them if we follow the manufacturer's recommendations? If a consulting firm were bidding for the design of a new project, they would certainly aim to predict every possible scenario and cost out all conceivable problems. The more complex the decision, the more factors are included. We would use a computer model and reams of historic information to improve the accuracy of our prediction. The mathematical study of rational decision making involves calculating probabilities and determining when people are successful rational actors.[1]

But to add additional variables into the equation or to compare dissimilar components (such as mileage efficiency and comfort) we have to translate them into a common measure, usually money, and decide which variables are most important. And as any decision moves from the realm of one pillar to consider other aspects of sustainability, more variables are added. Some comparisons are easier than others: What does better gas mileage cost—both in terms of the initial investment of a more efficient engine and in the increased savings while purchasing less gas for every 1000 miles driven? Which is better in the long run, a new car that is more efficient or an older, cheaper car? But what if you cannot get both a quieter ride and a smaller trunk? At some point we make a selection and convince ourselves it is just a car and does not deserve such agony. And that decision is not likely to be rational.

LIMITS OF RATIONALITY

Herbert Simon, a psychologist, was one of the first to suggest that at the individual level people do not make decisions according to this ideal rational model because they do not have the necessary information or information-processing capacities.[2] Instead, we use bounded rationality which allows people to merely do the best they can under the circumstances. As experts have since realized, people do not take the time or have the mental horsepower to calculate the probabilities of all the options, weighted by all the preferences, as in the car purchase above. We may not even recognize our deficits because some variables may appear to be more attractive or important. In addition, we do not even intuitively make the best decisions because of the cognitive shortcuts (which psychologists call "heuristics" or "rules of thumb") we use to approximate the rationality.[3] These shortcomings tend to revolve around information retrieval, probability, overconfidence, and uncertainty. And finally, there is the issue of complexity—we

tend to be better at solving simple problems and therefore tackle complex ones by simplifying or dissecting them. Because sustainability issues are generally complex and our access to complete information is limited, these cognitive shortcuts do not help us make more rational decisions. The very notion of sustainability may be so cognitively uncomfortable that we might choose to ignore the complexity and focus on the familiar realm of our favorite pillar. On the other hand, understanding and addressing our cognitive limitations may help make more clear how decisions could be approached so that we learn to overcome these limits.

Lack of Information

Perhaps the most obvious problem with rationality is the lack of information that we know we need and the lack of information that we may not know to look for. Grocery shelves rarely reveal where the food was grown, for example. Unless we have a third-party certification system, consumers may not know if the workers were really paid a fair wage as they created sneakers or bicycle seats. Making rational sustainability decisions ought to include having information about the resources and labor practices that were used to create the product.

Some available information may be misleading. Blow driers mounted in public restrooms proclaim this is a pollution-free device and we should be happy to save the trees that would have produced paper toweling. Yet electricity usually is not generated without environmental and social costs, and most of us know that. The label on the drier, however, makes it easier to avoid thinking about the reality of mountain-top removal, environmental justice, dammed rivers, acid rain, or nuclear waste repositories.

In addition, we tend to selectively recognize and process the available information that meets our expectations. We see what we expect to find, which is why having a mental picture of what you seek is a good strategy for recovering lost items. But it also means you will not see what you are not looking for. It is what Albert Einstein meant when he said, "It is quite wrong to try founding a theory on observable magnitudes alone. In reality the very opposite happens. It is the theory which decides what we can observe."[4] We also do not pay attention to what we do not need to see. If asked to describe a U.S. one dollar bill, for example, few people could get beyond George Washington, pyramid, eye, the number 1, and the words one dollar. It is not that we are unfamiliar with what a dollar bill looks like, but that we <u>are</u> familiar. We do not need to focus on every detail because a quick glimpse at George tells us what we need to know. Having a generic dollar already in our heads enables us to function because we do not have to inspect every bill we handle to know its value. As a result we may not see the organic vegetables or fair trade coffee in the grocery store unless we consciously look for these products. Similarly, if we do not ask ourselves what other factors we should consider before selecting a new product, we will continue to follow comfortable patterns of decision making.

We may not recognize when the circumstances are not familiar and we need to pay closer attention.[5] Even when we build the monitoring systems to give us important feedback, we have to learn to pay close attention to potentially important changes. For example, two papers published in 1974 predicted the erosion of the ozone layer as a function of chlorine atoms which could be traced to chlorofluorocarbons (CFCs). The papers triggered additional research on

atmospheric chemistry, defensive postures by industry, and international monitoring programs. In 1984 British scientists reported a 40% decrease in ozone over Antarctica. Although they had seen a steady decrease for 10 years, they did not believe the reports because the computer models predicted a decline of only a few percent in ozone. Their data did not conform to their expectations, so they assumed there was an error. The scientists published their findings only when they found confirming reports from a monitoring station about 1000 miles from theirs. NASA scientists were perplexed, however, since the Nimbus 7 satellite had never reported an ozone hole, and it had been taking measurements since 1978. After checking they discovered that the computers were programmed to reject very low readings since they were likely to indicate instrument error. Incorporating the rejected data into the analysis resulted in findings that paralleled the British results and mapped an enormous hole, the size of the continental U.S.[6]

In the midst of a decision, we ought to take the time to ask about our data, our assumptions, and our assumptions about the data. Unfortunately, it is more typical to be under pressure for a speedy decision or to rely upon information that is easily accepted and expected.

Cognitive Heuristics

The work of Daniel Kahneman and Amos Tversky, two psychologists who developed a series of insightful experiments to test decision-making processes, helps clarify the heuristics that affect our decision-making capacity.[7] Interestingly, Kahneman was awarded the Nobel prize in economics for his work challenging rationality in 2002. He could only share the prize with his partner in spirit, unfortunately, as Tversky died in 1996 and the award is not given posthumously. Several of their heuristics offer insights into decision-making around issues of sustainability.

Availability Heuristic

Several of Kahneman and Tversky's experiments revolve around our ability to use information stored in memory. Information is available when it is easily recalled, and the easier it is to remember, the more likely we will think it is. When faced with a question about the future likelihood or frequency of an event, for example, people tend to favor the choice that is easiest to imagine or recall.[8] The more familiar we are with one option (or the more recently it occurred), the more available this information is in our brain, and the more likely we are to believe it will happen again. This shortcut works well in cases when frequently occurring events keep happening. It causes us to err, however, when the easier to recall information is actually more rare. If we regularly drive by a home with solar panels visible on the roof, we may believe they are common, just because we see that roof every day. Similarly, we might believe that jets crash more frequently than they do because of the extensive media coverage on the relatively rare events.

The availability heuristic has a variety of applications. If we want people to recall information, we can link it to something else people find memorable. When television ads showed Meryl Streep explaining the health risk of apple products to babies, because apples are typically

sprayed with the Alar to delay ripening, and later gave testimony to Congress, there was an immediate drop in apple juice consumption. Uniroyal, the maker of Alar, removed the chemical from the U.S. market. This publicity campaign succeeded even though EPA studies and reports failed to affect the manufacturer's production of the chemical.[9]

If we can describe information in vivid, imaginable terms, we build a picture in our minds that helps us recall that information more easily. Vivid information is more easily remembered, more quickly retrieved from memory, and more meaningful. This makes such information more powerful in decision-making. To those who are able to easily imagine problems associated with mountain climbing, the adventure may seem more dangerous than it actually is. Similarly, the information we get from neighbors or friends is often more available than what we read in newspapers. In terms of making rational decisions that move us toward sustainability, if the information is not readily available in our memory or if the data are described unimaginably (as in descriptions of water-borne chemicals in parts per million), we will have a more difficult time remembering, retrieving, and using that information appropriately. As Nisbett and Ross summarize, "The problem with the use of the vividness criterion is simply stated: The vividness of information is correlated only modestly, at best, with its evidential value. By accident or by the design of the communicator, vivid information is often misleading, particularly when duller but more probative information is cast aside in its favor."[10]

Anchoring and Overconfidence

Tversky and Kahneman also demonstrated that people tend to anchor their beliefs on an initial fact and do not adjust their perceptions enough to reflect additional data. In one study, they asked respondents to estimate the answer to a factual question and then to provide a range within which they thought the correct answer would fall. Despite an opportunity to create a very large range, half of the respondents chose upper and lower estimates that did not include the true value. The ranges were anchored by their initial guess, and that first impression made it cognitively difficult to consider other possibilities. This may be a substantial component of the difficulties adversaries have in modifying their initial position during a negotiation. Once advocates have established their position and justified it with the factors they consider to be important, it may be hard to change their minds. As a result of this heuristic, people tend to be more confident of their ideas than they should be. First impressions or ideas tend to create an anchor that affects future ideas. Perhaps that is one reason why people do not readily continue to make progress toward energy efficiency and stop with their initial activities.

Problems with Probability

Our ability to use logic and probability fails us when we see patterns inappropriately. A coin, for example, has a 50% chance of landing either heads or tails every time it is thrown. But after a coin lands heads-up nine times in a row, most people will bet that the tenth toss will be tails. The fact that we think we "are due for tails" is an example of this heuristic. If we expect a random behavior and see a pattern, we think it is more likely than the logical 50/50 chance that the next occurrence will break the pattern. This heuristic may be responsible when people think a wildfire will not occur in the same vicinity twice. Indeed, if all the fuel has been burned by the first fire, the chances of another are slim. But given enough time for vegetation to return, or if the area was

not completely burned by the first fire, the conditions that led to one fire may favor a second. But people are not likely to see it that way. Neither will residents of a floodplain community expect to experience two 100-year floods in the same decade. Even though we are all exposed to chance events, humans have not learned how to use knowledge about probability effectively.

Uncertainty

The certainty heuristic suggests that people avoid probabilities and uncertainty where possible and tend to select scenarios that offer certain results. Not only do people lean toward information that promises certainty, but there are strong cognitive preferences and desires for certainty.[11] Since recognizing uncertainty makes people uncomfortable, they may deny it to reduce anxiety. While some psychologists suggest this tendency comes from a desire to have control in uncertain situations, others believe people desire opportunities to participate in meaningful ways to make a difference.[12] Both explanations would lead people to avoid circumstances where their input would be hopeless because uncertainty is great. We may want to spend our energy to work on issues where we stand a better chance of being successful. The recent responses to climate change projections demonstrate how difficult it is for people to use information that includes elements of uncertainty.

Unfortunately, most predictions of future impacts of good and bad technology involve some element of uncertainty, and this alone makes it difficult to understand and communicate with decision makers and the public. As a consequence, naysayers who wish to derail the technology employ exaggerations and fear tactics to draw attention to the possibility of calamity or focus on the lack of certainty to help the public focus attention elsewhere. Although the fear strategy and debate attract media, research suggests people rarely act on threatening messages unless adequate strategies for reducing risk are also provided.[13]

Complexity

Most people recognize mental overload. Complex problems with a large number of variables can lead people to confusion and avoidance behaviors. One reason for this response is that the information comes in to our brains through our working memory and working memory has limits. Psychologists suggest we have the capacity to handle five to seven units of different information at the same time before we start forgetting some of them.[14] People can work with larger amounts of information, of course, if similar items are chunked together. Phone numbers, for example, are ten digits, but the area code is usually remembered as a single unit. That leaves seven random digits to remember. Our information storage capacity, however, is not limited by working memory and has huge capacity. The limitation is with how much information we can work with at the once.

The limits of mental capacity are reached not just when a large number of variables are presented, but also when a large number of relationships, components, perspectives, or attitudes are considered. These complex systems are often defined by feedback loops where variables can influence each other in balancing or reinforcing relationships. Keeping track of the many elements and the consequences of employing alternative decisions can easily create an overwhelmingly complex problem. The more expertise someone has in any one area, the better

he or she is able to chunk that information, put a boundary around it, and set it aside. Then the expert's attention can focus on the pieces that are harder to understand because of a lack expertise.

We have several choices to address our inability to think about complexity. An expert can put a mental boundary around an uncomfortably weak region of her knowledge of the problem because she trusts that another expert has that piece covered, or she can begin to learn what she needs to know to gain a better understanding. Decision-making processes that engage a variety of stakeholders often begin with a lengthy process of learning what expertise others bring and developing an atmosphere that can allow people to share what they know and care about—of building trust.

Not only are a variety of experts typically involved in complex and uncertain decisions, but their areas of expertise may be so dissimilar that they have very little shared language or assumptions. Questions of sustainability automatically involve areas that experts are less familiar because they often span the distinctly different disciplines of natural science, social science, and humanities. A decision about siting a landfill should involve geologists and hydrologists, who can likely talk to each other, but can they understand the waste management experts, city administrators, haulers, neighbors, and environmental justice sociologists? New sites will involve surveys for endangered species and groundwater movement patterns, plus discussions about weight limits on roads, acceptable noise levels, and deterrents to nuisance birds and mammals. Few experts share a common language across environmental, economic, and social components, and fewer individuals have expertise that crosses these boundaries. Managing the number of variables and the huge variety of concerns make decisions about sustainability complex.

This brief summary of cognitive biases and limits to rationality illustrates some of the ways that people make predictable mistakes when retrieving information and making decisions in the context of uncertainty (see Table 8.1). In experiments, even when people are given plenty of time for calculations and rewards for correct answers, they don't do significantly better. While most of these heuristics and biases had important benefits for functioning efficiently at one point in time, they evolved in a very different environment than we live in today.

Our mental shortcuts override rational thinking which may result in making a poor decision. It is easy to see that skipping over some information and attaching greater importance to other information could result in poor decisions. Similarly, avoiding situations that are confusing or uncertain and believing that we know more than we do will also make it difficult if not impossible to accept new ideas and behaviors. We would be likely to associate an announcement about a new efficient energy technology with our expectation that the manufacturer is a for-profit (and profitable) industry that ignores environmental and social considerations, which could result in ignoring potentially worthwhile information.

In a simpler world, past experience and the stories of neighbors were excellent guides to solving problems. Problems that may have been new to an individual were likely faced by someone else, or might not have been much different from the old problems. But in today's world, where new

technologies and complex situations are generated in less than one generation, neighbors and past experience are rarely helpful for making decisions. The heuristics that helped us find food, build shelters, and care for children put us at a disadvantage when wrestling with disposing of toxic material or enabling developing nations to provide health care and education to all residents. The following discussion of risk and example make these limitations more clear.

Table 8.1: Summary of Limits to Rationality

1. Information	May not exist	Selective perception prevents us from seeing it		
2. Heuristics	Availability: Information may not be easily retrieved from our memories	Anchoring & Overconfidence: First guesses, no matter how wrong, confine future perceptions	Probability: We don't intuitively think in probabilities	Uncertainty: We avoid situations of uncertainty
3. Complexity	Limits to working memory (5-7 chunks)	Unfamiliar with the diversity of aspects of problems of sustainability	Communication challenges as we talk to people who know these diverse aspects	

Risk

Many sustainability questions that involve new technologies include some level of risk. If we are not completely certain about the future impacts and outcomes of a genetically-modified organism or the toxicology of pesticide, there is a risk to using it. That risk could involve ecosystem or human health, with some individuals at greater risk than others (usually workers, infants, and elderly). In these cases, questions of risk tend to involve two if not all three areas of sustainability. Questions that involve risk are a particularly difficult challenge because of the cognitive heuristics and problems mentioned above. By definition, risk is the product of the probability of an outcome (usually a negative outcome) and the impact of that outcome. A high probability of an event that only affects a few people could carry as large a risk as an event with a low probability of impacting an entire nation. Our discomfort with uncertainty is the first hurdle; we might rather ignore than talk about risk. Our intuitively bad approach to probability means that we have to think hard about how to weigh risks and what they mean. How the media convey information, what memories are recalled, and how the issue is framed will make a great deal of difference to how the public responds to warnings and engages in discussions. We are regularly overconfident of our knowledge and may not recognize the true frequency of relatively rare risks. These factors mean that people will not using all the information that is available when they approach a question of risk.

Experts are regularly frustrated by the public's overreaction to some minimal risks, such as of a nuclear plant meltdown, and their apparent lack of concern over greater risks, such as lightning strikes or radon contamination.[15] It is clear from the limits to rationality, however, that the public is not given information in a way that helps them overcome the biases that we all have.

How Congress chose to regulate chemical additives in food provides a window on the world of risk communication, decision making, and sustainability.[16] With the growth of the chemical industry after World War II, in 1958 the Delaney Amendment was added to the Food, Drugs and Cosmetics Act of 1938 to protect consumers from food additives "found to induce cancer in man, or, after tests, found to induce cancer in animals." One can see several assumptions behind this simple, straightforward clause: 1) a substance that causes cancer in animals will be dangerous to people, 2) there is a linear or constant relationship between a cancer-inducing substance and cancer, such that if it causes cancer at a very large level in a short-term experimental test on animals, it will cause cancer at a very small level over a lifetime in a human, and 3) that the government will be able to test every food additive for the potential to cause cancer. Congress took the moral high ground with a precautionary approach and created a zero tolerance for chemical additives. Dangerous chemicals do not belong in food. One can imagine that the food industry was not pleased, but how could anyone suggest we should allow dangerous chemicals in food?

While this clause was meant to protect human health, it had an environmental implication as well and wrecked havoc with the agricultural industry. The Federal Insecticide, Rodenticide, and Fungicide Act (FIFRA) of 1947 permits the use of pesticides on food crops. The Department of Agriculture (and later EPA) were designated under FIFRA to set levels of allowable pesticide residue in produce. Since some pesticides could cause cancer, the two bills were in conflict. To resolve this dilemma, Congress decreed that pesticides are not food additives so they would not fall under the Delaney amendment. Interestingly, the nascent organic farming movement was probably not strong enough to help question the necessity of pesticides. Had the issue been approached through a sustainability lens, however, different elements might have received greater consideration.

When raw foods are processed, however, they are concentrated. It is possible for the pesticide residue to appear in larger quantities in ketchup or apple juice, for example, than was permitted in tomatoes or applies. Despite pressure from agricultural lobbyists, Congress decided this scenario fell under the intent of the Delaney amendment and said that pesticides that caused cancer were not permitted in processed foods. Because of the increasing sensitivity of laboratory testing equipment and the inability of any test to prove zero concentration levels, the FDA set a limit for pesticide residue in processed foods of causing one cancer in one million people.

Over years of debate it became obvious that the intent of a precautionary regulation may not be appropriate after the development and distribution of a product. Precaution is best applied in the decision-making mode. Although the point where more people care about agricultural practices is when additives are present in food, the chemicals were already developed and legally used for reducing pest problems long before the food was processed. Preventing pesticides from going

into production or from being used might be a better course for regulation. Real change might not be possible until economically equivalent options are available, such as an alternative pesticide or organic strategies.

The Delaney amendment was quietly retired when Congress passed the Food Quality Protection Act of 1996. Its disappearance marked a victory for the industry, which cannot supply huge quantities of food without leaving chemicals in it. Its history marks the idealistic attempt to protect human health from the hazards of chemicals and the difficult nature of decisions about toxicity and technology. It has become possible to detect tiny amounts of chemicals in food, but we do not have adequate knowledge of the risk of ingesting that chemical. This is a problem of inadequate knowledge, probability, and uncertainty.

Although people should not assume their food supply is safe, without the ability to monitor and regulate the industry, it is difficult for the public to know which chemicals are problematic and which foods contain them. People are involuntarily exposed to pesticides and other food additives because they partake in mass produced food rather than grow their own or buy at the farmer's market. The growth of the organic food movement may be in reaction to this uncertainty; at least some people now have a strategy to make some synthetic chemical additive consumption voluntary.

These challenges to rationality make it more important to carefully communicate information about risk, probability, and uncertainty to the public. Yet on issues where the risk is involuntary (as with the public food supply) and the issue can generate great sympathy to the less fortunate (e.g., infants), there are emotional overtones and powerful media messages that exacerbate attempts to employ rationality. Perhaps there is another way to approach difficult decisions that play health against economic and environmental welfare.

STRATEGIES TO ADDRESS LIMITS TO RATIONALITY

Many people have explored strategies for making good decisions in the face of limits to rationality. Four strategies are discussed here.

Small Wins

Given how people respond to overwhelmingly complex and uncertain problems, Karl Weick suggests that it is psychologically more appealing and infinitely more practical to define tasks as small, winnable challenges rather than huge, intractable problems. Rather than changing how a culture views homosexuality, for example, the Task Force on Gay Liberation took on the more readily achievable task of changing the way the Library of Congress classified books on homosexuality. Prior to 1972, these books were assigned numbers alongside books on sexual crimes and perversions. The new classification moved the books to the shelf with varieties of sexual life.[17] Similarly, the first administrator of the US Environmental Protection Agency (EPA), William Ruckelshaus, launched the new agency with five major lawsuits against big cities over water pollution. He did not choose the most important or the most visible task; he chose the most winnable challenge, from which he generated additional success. Even if the win

is predictable, the resulting success empowers people to continue to another challenge.

Reasonable Person Model

Rather than looking at ways to change the problem, we might also consider how the environment and information stymie or support the people involved in making a decision. From their years of work on human preference and cognitive capacity, Rachel and Steve Kaplan have developed such a model to suggest the situations and environments that help people solve problems by being "reasonable," assuming that will be a more realistic goal than asking people to become rational. Situations in which people are not reasonable include those where people are confused, overwhelmed, hopeless, and often helpless.[18] A variety of circumstances can contribute to these situations—not having good information or not understanding the information that is available, having too much information, not having the skills to take actions or not knowing what can be done, not having an idea of how others have solved the problem, or not having the ability to make a difference. People do not enjoy being in these situations, so they resist, remove themselves, or react angrily. As a result they can defend their position without listening to other perspectives, they can ignore controversy or avoid confrontation, or they can simply abdicate responsibility and let someone else solve the problem. If making more sustainable decisions involves engaging more people and more varieties of expertise, then finding ways to appropriately engage them in a process that uses and respects their contributions will be essential. There are three basic interdependent elements to promoting situations in which people can become more reasonable (figure 1).

Build a shared understanding

People need to understand the problem or situation. If a group of people are working to solve a problem, then they must have a common understanding of the situation. If experts are talking to decision makers, they also need to have a similar mental conception of what they are talking about. Where knowledge is a necessary ingredient to decision-making, shared knowledge enables communication which builds understanding. Enabling people to have a shared understanding is more complicated than passing out a brochure, however, as it depends greatly on what they already know and care about. People have to be motivated to explore the information, make sense of it, and see what possibilities it creates for them. Detailed imagery helps to convey information if people do not a high degree of familiarity with the problem, in part because its vividness enables us to remember and retrieve information. Misconceptions and other basic differences in how people perceive the issue must be acknowledged and addressed so that there is the possibility of productive communication. In sum, helpful information and the motivation to use it build a common understanding that will help create reasonable people.

Increase people's confidence

People must feel competent to be part of a decision making process. This requires having some idea of how these decisions have been made and problems solved in other circumstances, as well as feeling that they have a grasp of the problem itself (which is part of having a shared understanding, of course). The requisite degree of ability, capacity, agency, efficacy, or perceived control (to use a variety of similar terms) may depend on reducing the complexity of the decision (see Small Wins, above) and by practicing the skills needed to explore facets of the

issue. Imagery, success stories, and case studies can be quite empowering and can help overcome the notions of hopelessness and despair.[19] Conducting simulations or trials can build confidence and give people insights into their abilities.

Provide opportunities to engage people
In some circumstances, asking someone to help enables them to join. Providing a doable task and inviting assistance could change people from grouchy, complaining onlookers to helpful colleagues who are working toward a common goal. People generally want to help solve problems, make their community a better place, and engage in solutions.[20] This requires that the scale of actions be appropriate and that they have the knowledge and to do so successfully (which come from shared understanding and confidence). Examples, case studies, simulations, and practice opportunities help here as well. Providing a chance for citizens to express their ideas to decision makers can be empowering for people who recognize the limits of their expertise and would not attend a city commission meeting to speak, but appreciate an opportunity to influence the outcome of their decision.[21] Strategies to enable participation can also help overcome the frustrations of hopelessness and helplessness which often combine to derail decision-making.

Reasonable people, with the ability to understand and communicate their perspectives, and with the confidence and hopefulness to engage in meaningful actions, are in a much better position to review information, use the judgment heuristics that they have derived from their experience in the world, and make decisions that balance the represented interests. They may not be rational, but, after all, they are human.

Multiple Criteria Decision Making
As the complexity and challenges of making decisions have increased, so too have the formulas and procedures for selecting appropriate decisions. The field of engineering, for example, has generated a number of theories and shelves of reference books about decision making in complex situations.[22] Many of these theories fall under the general term "multiple criteria decision making," referring to decisions made in situations that have a variety of objectives, variables, constraints, alternatives, stakeholders, and perspectives. Each of these elements generate criteria that can be considered as part of the decision-making process. Since people have limitations in their mental processing, computers are programmed to reduce the problem, identify probabilities, and help the decision maker think systematically about the situation.

The careful comparison of attributes and criteria is helpful because one usually cannot maximize all of the important variables. Improving the safety features on a car tends to make it more expensive. Hybrid vehicles or ones that burn bio-diesel may also cost more to purchase than traditional combustion engines. Unless price is not a factor, it will be a challenge to make a decision that enables one to meet all of these criteria successfully.

The very process of identifying the data for the computer may help stakeholders and decision makers reflect on the variety of components that deserve consideration. The interactions and conversations that are required to diagnose the situation, identify the program, pinpoint objectives, imagine the alternatives, specify the advantages and disadvantages associated with

each, and compare and rank all of the relevant criteria still occur with people. In many companies, these people share the same disciplinary training (i.e., engineering) and may, by virtue of their expertise, be prone to missing some of the aspects of sustainability that they are less familiar with. With appropriate inputs, however, these models can be a tool to better decision making because they reduce the comparisons to mathematical relationships and give decision makers quantifiable results to use in their deliberations.

As engineers and other technicians make decisions in the realm of sustainability, it is clear that more variables will be considered and maximized, making multiple criteria decision making strategies important to use along with other strategies for seeing and understanding the information and perspectives in these less familiar domains.

Adaptive Management

Given that we usually have imperfect and incomplete information and are not very good at making decisions about complex, uncertain, and risky situations, it would be helpful to have a management process that allows us to take small steps, check for evidence to see how things are going, and revise our plan if necessary. Ecosystem managers call this adaptive management.[23] When addressing watershed, wildlife, or forest management, for example, it may be more desirable to take small, purposeful management actions and engage in continual monitoring and analysis of their impacts than to assume that everything will work out as the model suggests. By reviewing monitoring data at regular intervals, managers can assess the appropriateness of their original plan and make changes as necessary. Adaptive management enables managers to acknowledge that the system may be more complex than they understand and allows them to explore and learn as they proceed with a course of action. It also allows them to more carefully consider future and current impacts to the very components of the system that may be most challenging to measure and predict—global changes, social justice, economic developments, and other ethical dimensions. This strategy can be taken one step further by inviting diverse stakeholders to the design and monitoring process, an activity often called Adaptive Collaborative Management. Doing so enables managers to more appropriately evaluate the multiple social, environmental and economic aspects that affect the sustainability of the intervention.

SYSTEMS THINKING

> *We can't solve problems by using the same kind of thinking we used when we created them.*
>
> *Albert Einstein*

The limitations of the human brain, the overwhelming extent of information that could be relevant to any decision, and the increased complexity of every problem might lead us to conclude that the best way to approach a decision would be to divide the problem into small, manageable pieces and consider each component separately. Indeed, our education system has divided the world into separate subjects (e.g., language arts, mathematics, and physical science)

and departments (e.g., religion, political science, and economics), and therefore our training and expertise. Unfortunately, very few decisions can be made in isolation. Most issues cross disciplinary boundaries, and by definition, decisions about sustainability must include the previously disparate worlds of economics and development, environment, and social justice.

It may be impossible, however, for anyone to become an expert in every relevant component of a decision. The amount of information is overwhelming and people don't juggle a lot of information at once. Such an expectation may guarantee failure. We could expect, however, that everyone develop an appreciation of a decision at a systems level and recognize the need to engage a variety of experts to improve the discussion and ultimate decision. Expanding the boundaries of a problem to include additional influences and consequences might help us consider impacts of each decision more adequately. Thinking in systems helps us ask different questions about a decision, helps us anticipate consequences differently, and will likely enable us to make decisions that increase their sustainability. Indeed, systems thinking might very well provide a common language that will enable experts from different disciplines to communicate. By helping us identifying common pitfalls and strategies for avoiding them, systems thinking can also help us make better decisions.

Key Elements of Systems Thinking

Using bounded rational thinking as best as possible, engineers, architects, or foresters, for example, typically approach a decision by assessing the costs and benefits of saying yes or no. The act of identifying the costs and benefits defines the system they are considering. A systems perspective suggests that those original boundaries should be expanded to include the resources that go in to the technology, the structure, or the forest; the products that come out (both desired and waste products); and the ways these components interact. It will always be necessary to define boundaries of some sort as considering the entire world is not helpful. Using systems language should help establish the appropriate level of boundaries that enable decision makers to include the environment, economy, and society in the decision. One strategy to decide whether the boundaries are appropriately placed might be to consider whether all the key stakeholders will be included in the decision. This is the first step: defining the right system.[24]

If we consider the development of a genetically-modified rice that provides additional Vitamin A, for example, the development company will focus on the genetic possibilities, the cost, the licensing agreements, and potential for recovering their research investment. The new technology would be at the center of the systems model, with inputs including research capital and outputs of healthier people and profit. In their world, the system is their company and their product is the thing they focus on, their stock. A broader and more sustainable view of systems thinking might encourage us to consider other dimensions of the problem, wonder about the farmers, and ask if anything will change in the way they grow rice if they use the modified seed. If the health of the rice consumers might be at the center of that system instead of the rice, we might ask ourselves what created the Vitamin A deficiency to begin with. Does providing new rice hide other problems that will continue to affect this population? While some genetic engineers might claim it is not their job to consider all the components that would be included in

the expanded system, one could suggest that the decision to use golden rice can not be made ethically without the broader perspective. Making ethical decisions about sustainability, rather than about product success, demands that we consider a system than includes societal welfare, ecosystem resilience, along with economic development.

A system has interrelated parts such that the removal of one affects the function of the whole. A football team is a system and so is a university and a house. The quarterback, the religion department, and a window are parts of each system that make it function. Take any of these away and the system will not be the same as it once was. It might even fail to function at all. The problem is, we don't often recognize everything that is part of the system of interest, so along with a better understanding of the boundaries of the right system comes a carefully accounting and identification of its components.

The second step is to identify the system stock – the things you can see and count that are at the heart of the system. Stocks accumulate and are depleted based on levels of production and consumption. One key feature of a system is that there are two ways to increase a stock; raise input and reduce output. In the example of golden rice, the stock is the genetically modified rice. Systems with only one stock are easier to think about, but many inputs are stocks in other systems (such as the funding for the research and distribution of golden rice and the petroleum that transports rice to farmers and their product to market). Where to draw the boundary of the system becomes a difficult question to answer!

The next step in understanding the system is to find the feedback loops. These loops make systems function by allowing the system to respond to changes in stocks. Balancing loops make a system stable and resilient. Populations, for example, are often reduced by limits in food supply or disease. The population is the stock. A growing population eats more food and reduces the food supply. The limited food supply increases the death rate and reduces the population. Balancing loops would keep a stable stock of golden rice, as well. If there is a need for rice and no other limiting factors, more farmers will plant it. Too much rice could trigger a price reduction, which increases consumption, which reduces the supply.

A reinforcing feedback loop allows the stock to continue to change without such controls. If it is money in an interest-bearing savings account, where more money enables you to collect more interest, which gives you more money to collect more interest, the reinforcing loop seems like a good thing. Soil eroding from a streambank loosens the roots and topples the plants on the edge of the stream, causing fewer roots to hold the soil in place and increasing soil erosion. In time the stream will shift its course. If golden rice reduces malnutrition which enables population growth, more people will be around to eat more golden rice. If the resources that went into developing and distributing golden rice take away resources that previously supported local farming, fewer farmers will be able to farm. Reinforcing loops can create vicious cycles of destruction, or wonderful patterns of growth, as long as we recognize which variables are limiting factors and which consequences are most likely.

When reinforcing loops are acting on a stock that has the ability to reproduce (any plant or

animal) or can grow due to influence from a reproducing population (demand for automobiles is influenced by the human population size) the stock will grow exponentially. Exponential growth is important because we are continually surprised by how quickly things change. If a population of water lilies will cover a pond in 30 days by doubling their population every day, it will take 27 days to cover 12.5% of the pond. That does not seem to be much of a threat. But in only three more days the pond will be completely covered with lilies. While that may be good if you want to grow lilies for economic benefit, it is bad if you want to swim or maintain any other organisms in the system

Reinforcing loops can be held in check by balancing loops and both loops are commonly found together in many systems. A population grows exponentially because offspring reproduce, making more offspring that reproduce (a reinforcing loop). When the population hits a limiting factor (a balancing loop), deaths increase or births decrease, bringing the population down to a point that the system can maintain. Delays in information about the level of the stock can be disastrous in a system. As automobile drivers from winter climates can attest, anything that hides or delays feedback about vehicle speed and road conditions can result in braking too late and skidding off the road. If the feedback from the balancing loop did not act quickly enough, as in reindeer reproducing on a predator-free island, they can remove their food source (lichen) and starve to death. The feedback will eventually reduce the population. If the delay in feedback is lengthy, the soils could erode before the lichen can recover, and the system may be unable to restore itself.

We often look at a portion of a system and believe that something causes something else. Events are often to blame for dramatic changes in stocks, such as the impact of Hurricane Katrina on the dikes in New Orleans or an unattended campfire on the ensuing wildfires. It is painfully obvious that without the hurricane the dike would still stand; without the campfire the wildfire would not have started. But a systems perspective would suggest that each system was already a disaster awaiting a trigger. Building a city below sea level in a hurricane zone and not strengthening dikes created a system that was prone to fail. In a system, the original plan of New Orleans caused the disaster as much as the trigger of the hurricane. A build-up of vegetation from years of fire suppression can weaken the resilience of a forest. An outbreak of insect pests can kill susceptible trees. The increase in dead trees can fuel a fire that becomes catastrophic. Thus forest management decisions can contribute to forest fires as much as the campfire spark. In a system there is rarely a linear cause and effect. The effect may actually influence the cause because of those feedback loops.

Using Systems Thinking to Analyze Decisions

From this brief introduction to systems we can point out ways to use systems thinking in the context of making decisions about sustainability and to explain why we otherwise will have difficulty achieving sustainability.[25]

1. Define a system with boundaries big enough to include all aspects of the sustainability framework. We cannot begin to ascertain how a technology affects rich and poor people differently if that information is not in the system we are analyzing. Our economics system has

ignored environmental externalities for decades, and most people now agree that practice has made it difficult to understand and pay for the effects of pollution.

2. Look for feedback loops that keep the system in check and make choices that respect those loops. Too often policies try to enforce growth in a system that is hitting limits or create stability at a level that is not sustainable. Shipping food to refugees helps bridge a gap in an emergency situation and is not usually thought of as a bad policy because of humanitarian principles. Increasing agricultural efficiency may be a better long term strategy as it helps a nation generate its own food, if this can be done within environmental limits.

3. Develop strategies to detect exponential growth. It has a habit of creeping up on us faster than we expect. A careful look at population doubling rates will reveal that to maintain the current quality of life in a county with a 5% population growth rate means doubling the number of police cars, houses, hospital beds, and school classrooms every 14 years.

4. Recognize that linear and exponential growth are not the only patterns for system changes. Sometimes the relationship between the change in an input and the level of the stock, for example, includes an unexpected point beyond which the system behaves in a completely different way. A few centimeters of soil can erode every year causing a small decline in soil fertility, until the depth of topsoil equals the root zone. During the next few years an equally small loss of topsoil can result in enormous crop losses or complete failure. Until we know more about the system, there is really no reason to assume a linear relationship, especially with regard to to toxicology (how much of a carcinogen is allowable?) or endangered species recovery. Some ornithologists suggest that passenger pigeons' reproductive success was tied to large roosting colonies. When the density of birds dropped beyond a magical point, they stopped breeding. Such a relationship between population and reproduction would cause extinction long before it would be expected.[26]

5. Include time and space when considering systems, particularly when listing inputs and outputs. The definition of sustainable development asks us to consider the impacts into the future. If our system boundaries only include the present, our deliberations will be based on false assumptions and a lack of information. Life cycle analysis is a tool that begins to quantify and consider the inputs and outputs for each product. Doing so enables us to make choices in products, and also in production systems to reduce extractive impacts and waste generation (See chapter x). Germany's Packaging Ordinance, adopted in 1991 and effective since 1998, shifts the responsibility of waste disposal to the producing industry. The disposal or recycling cost of each package is incorporated into the product price. This version of the "polluter pays" principle creates an incentive for industry to develop products and packages that recycle more easily, that break less often, and that use recycled materials.[27]

6. Look for strategies to increase information flows such as identifying indicators of positive and negative change patterns. Delays in providing information can slow the system's response to changes, which can cause negative consequences. Make sure all of the concerned parties are getting feedback information so they can adjust their behavior, too.

7. Rather than blaming an event for a calamity, look at the system. How many other ways was the system affected, in addition to the trigger. National debates often turn on this question—does our foreign policy reduce or increase terrorism? The answer is probably buried in the intertwined feedback loops and flows of weapons, goodwill, money, drugs, and products that link our global economy.

Another Look at the Delaney Amendment

History tells us that the Delaney amendment, however noble, was not realistic or functional. What would good food safety regulations look like and how should we make these decisions? If we use the suggestions above, we could fashion a hypothetical set of process and considerations to illustrate these concepts.

If food safety is the goal, the system of study must include agriculture, food preservation and processing, as well as marketing and distribution. Considering sustainability will encourage the addition of human health and environmental health experts to the system. A set of meetings will be necessary for them to learn how to talk to each other and to better understand issues, the responsibility, and the power they have. It may be useful to begin the process by focusing on an additive that is less complicated.

If recommendations are focusing on one piece of the system, such as artificial sweeteners, it is important to consider the consequences of removing them from the U.S. market to those who might be most affected (diabetics and dieting people). The feedback loops that affect this stock are one way to explore these consequences.

The process of approving new additives might be different from that of screening existing additives. New chemicals that bring an acknowledged risk may be rejected on the basis of precaution. How often should a chemical be reviewed? What types and levels of feedback should trigger additional investigation? What type of test result would enable the manufacture to agree to remove the chemicals from the market? As the number of additives skyrockets, a government lab cannot be expected to perform all the approval tests, and the maker might not have the best interest of the consumers at heart. Who should provide this service? Who should pay for that research? Who will increase their revenue as a result of approving the additive? An adaptive collaborative management strategy could be designed with the input from the chemical manufacturers, the human health experts, the social justice advocates, and the environmental community to establish a system of trigger points that could launch additional tests for the chemicals more likely to generate problems, based on a historic review of similar chemicals.

What are the ultimate goals of this group, and can agreement on a vision help remove the differences they will stumble over as they protect their interests? What is their duty toward the most vulnerable populations? Perhaps the group could agree to establish different food quality limits for items most typically consumed by infants and elderly, or employ the use of warning labels for foods that are a greater risk to pregnant women. To what extent should known mutagens that could change the genetic makeup of future generations be regulated differently than additives that are toxic to pesticide applicators?

Do we have the technological ability to know the consequences of these food additives? How do we balance uncertain, risk, and the promise of a new product? If epidemiology tests on mice are not generalizable to people, and we are not comfortable testing additives on people, does precaution win, or do we establish agreements that will trigger screening at five year intervals? Can we ever know the impact of a single chemical given the combination of additives we consume regularly? Recognizing the difficulty that we have in understanding probability and uncertainty should help our hypothetical team develop better analogies to explain the test results to each other, the media, and the public.

SUMMARY

Limits in human mental capacity, decision heuristics, and experience or expertise conspire to reduce our ability to make wise decisions in the face of complexity and uncertainty which would include most decisions about sustainability. Making decisions may require that people work together, each bringing different expertise to the system. It may also require a common language so that these experts can function effectively as a group.

Since using information is essential to the decision making process, how the information is provided can make a significant difference in how people perceive, remember, and use the information. All information is not created equal! As Kahneman, Tversky, and others have suggested, the way options are defined may influence how much we prefer them, what analogies are included will change what we remember and how we retrieve it, who provides the information may change whether we believe it, and any strategy that offers certainty is likely to be favored. Since our ability to be rational is predictably limited it means we can attempt to compensate for our failings by reducing uncertainty, framing scenarios similarly, and addressing complexity, for starters.

Designing the environments or programs that allow people to make decisions may be possible by using a framework called the Reasonable Person Model. It suggests that decision makers need to share a similar understanding of the problem, or at least recognize what others know and developed a way to talk about it, know how to be effective, and have realistic opportunities to use their skills to make a difference. Experts involved in making business decisions probably already possess some of these skills. Making decisions in the public sphere often requires experts to engage with decision makers and the public, and these situations will necessitate attention to shared understanding, competence, and helplessness.

Computer models and systems thinking may be helpful to predict how a decision could play out over time, as long as the model includes the relevant components—if the system's boundaries are set appropriately and all the parts are present. Since models by definition only proximate reality, it is important to recognize their limitations. Adaptive management techniques may allow groups to cautiously establish monitoring protocols and future scenarios for tracking important changes where uncertainty and risk still exist.

If people are not using rationality to make decisions, what are they doing? They are probably

using a form of bounded rationality that enables them to do the best they can. They will assemble what information they can find and comprehend, and they will interpret that information through the lens of their own experience. They will not calculate probability, but they will lean on some intuitive rules about frequency, risk, and likelihood.

So how should we make better decisions? The basic process is still viable, but since none of the assumptions of rationality can be met, we must make some significant changes to the original formula. If we want people to do a better job of making decisions, they need to be taught specific skills:

1. Broaden the boundaries of the problem to include environment, social concerns, and economic development. Establish a common understanding of the system that will enable the decision-makers to explore the dimensions of time and space that are helpful to the question at hand. Framing, and reframing the problem could give us new ways to understand it and communicate with others (see Chapter 3).

2. Appreciate the many dimensions of the issue and identify others who bring complementary perspectives and expertise. Work to increase communication and understanding of the problem.

3, Keep a record of the exploration, the presentations, and the decisions so that people perceive forward movement in the decision process and that the final outcomes will be transparent and understandable.

4. Reduce the complexity of the expanded problem with systems thinking that suggests what to look for (inputs and outputs in stocks, balancing and reinforcing loops, relationships between variables).

5. Identify what is known and agreed upon, what is uncertain, and what is unknown. Identify priorities and those populations or limiting factors that must be protected or respected. Where there is uncertainty or unknowns, discuss how to gain more information through adaptive management and targeting monitoring. Select the outcome that appears to offer the most advantages with the fewest disadvantages while following the principles and limitations that were originally established.

This process may begin with a core of rationality, but when we add a systems perspective, opportunities to create reasonable decision makers, and adaptive management strategies for coping with uncertainty and risk, we have a lengthy process that engages a variety of people in exploring how to negotiate a more adequate decision.

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http://www.msha.gov/stats/charts/coalbystate.asp. Accessed May 21, 2009, US Department of Labor, Mine Safety and Health Administration; average of annual fatalities from 1996 to 2008.

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[1] Peterson and Beach, 1967
[2] A variety of discussions of the limits of rationality exist, particularly in Kaplan and Kaplan (1982) pages 160-163 and Gardner and Stern (1996) pages 227-234. More in Simon's original contributions can be found in Simon 1956 and Simon 1959.
[3] Gardner and Stern, 1996
[4] Nisbett and Ross, 1980, page 65
[5] Nisbett and Ross, 1980
[6] Meadows Meadows and Randers 1992. See Chapter xx
[7] Slovic, Fischhoff and Lichtenstein, 1977
[8] Tversky and Kahneman, 1974.
[9] Published in PR Watch, Second Quarter 1997, Volume 4, No. 2 at http://www.prwatch.org/prwissues/1997Q2/alar.html on Oct 18 2009. "One Bad Apple? Facts and Myths Behind the 'Alar Scare'" Center for Media and Democracy and Hrab, 2004.
[10] Nisbett and Ross, 1980, page 60
[11] Gardner and Stern page 234, Kaplan and Kaplan 1982, page 163, and Tversky and Kahneman 1981
[12] Kaplan 2000
[13] Jacobson, McDuff, and Monroe 2006
[14] Kaplan and Kaplan 1982, citing Mandler 1975a and 1975b
[15] Slovic 1987
[16] Based on Meadows 96 and Rifkin
[17] Weick 1984
[18] Kaplan and Kaplan 2008a, 2008b
[19] Bardwell 1991, Monroe and Kaplan 1988
[20] Kaplan 2000, De Young 2000
[21] Monroe et al. 2009
[22] See, for example, the Technical Briefing from the Institute of Electrical and Electonics Engineers published in 1997 and written by Mansooreh Mollaghasemi and Julia Pet-Edwards, *Making Multiple-Objective Decisions* and reference materials such as: Keeney, R. L. and H. Raiffa. 1976. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs*. NY: Wiley; Chankong, V. and Y. Y. Haimes. 1983. *Multiobjective Decision Making: Theory and Methodology*, NY: Elsevier/North Holland; Zeleny, M. 1982. *Multiple Criteria Decision Making*. NY: McGraw-

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[23] Murray and Marmorek 2003, Walker and Salt 2006

[24] Donella Meadows has been one of the leaders of several efforts to understand systems and one of the few to make systems accessible to the general public. Her biweekly syndicated column, The Global Citizen, was picked up by newspapers across the country, and used to explain systems thinking in the context of the national debt, current political debates, or gardening (Meadows 1991 and http://www.pcdf.org/meadows/). Her book, Thinking in Systems (Meadows 2008), provides an excellent introduction to systems language and the applications of a systems perspective. This section is taken from her work.

[25] (for more information, see Meadows 2008).

[26] Personal conversation with David Blockstein of the National Council for the Institute of the Environment ?? in 1997.

[27] Halpert

CHAPTER 9
TURNING ETHICAL DECISIONS INTO PROFESSIONAL PRACTICES

The previous chapters explored aspects of sustainable and ethical decisions that imply change. Because many of our activities in the workplace have not, as a rule, championed sustainability, one might wonder how an individual could use this information to make a difference. Given that businesses, industries, organizations, and communities have rather set patterns for decision-making, how does one employee engage in sustainability through his or her work?

As the examples in previous chapters have suggested, a number of people, organizations, and communities are providing leadership in making these changes. Companies such as Clif Bar, Patagonia, Ben and Jerry's Ice Cream, and Interface, Inc. (the carpet company) were relatively early leaders in promoting sustainability through their products and practices. Today even Walmart and Ford are accepting best practices that establish guidelines for ethical agreements, reduced waste, recycled products, and other responsible practices, often known as Corporate Social Responsibility (see chapter 1). New business graduates from the Thunderbird School of Global Management voluntarily sign an oath of honor to contribute to implementing sustainability.[1]

Not every employee works in a business or industry, of course. The "workplace" also refers to public agencies, municipality offices, universities, and NGOs. This chapter will incorporate examples from both the private and public sectors as their employees consider adopting practices that lead toward sustainability. Also, innovations leading toward sustainability are not just about what we decide to do, but also how we decide. Notions of transparency and broader participation in decision-making are at the heart of more ethical and more sustainable procedures.

As Chapter 8 outlined, sustainability practices often begin with an individual making an ethical decision that leads to greater sustainability. While that chapter is limited to understanding the complexities of thinking about sustainability, this chapter focuses on carrying that idea through to a decision on the job. Except for the self-employed and extremely wealthy, implementing decisions will always involve other people. Every good idea must be approved by someone before it goes forward. In fact, the process of arriving at a good idea often comes from a group, as recent attention to quality circles, team building, and multi-stakeholder processes in leading organizations would suggest. Furthermore, good workplace practices, such as new strategies to reduce waste or purchase certified products, may not be successful until a large number of people agree to adopt them. And if the good idea is a product, its success depends on consumers making a decision to buy it which is influenced by advertisement, packaging, price, and other aspects of a business. All four of these situations involve persuasive strategies, team effort, or group deliberations. This chapter addresses the process of obtaining agreement, spreading new ideas to others, and working successfully within groups.

At the core of effective communication with individuals and groups is an understanding of what motivates individuals change their behavior. When a colleague agrees to join a group, he or she makes a conscious effort to adopt a new behavior—group meeting

attendance. When a supervisor approves a new concept, the behavior is the actual decision, and additional behaviors may come soon after, such as authorizing a new team and altering the budget accordingly. When we employ clever strategies to appeal to key motives to change behavior, we do so with some sense of what is important to people and what will support this new action. In all these situations the beginning of behavior change lies with the individual. The extent to which the individual controls that decision, however, is very much a product of their social and physical environment.

DIMENSIONS OF INDIVIDUAL CHANGE

What determines whether individuals accept and put into practice a new idea? Psychologists have wrestled with this question for decades. We'll use three commonly used theories of behavior change to answer the following questions and then explore how they could help us adopt sustainable practices at work: 1) what determines behavior, 2) who changes first, and 3) what process do we go through to make a change.

What determines behavior?

One critical element of adopting a new practice is information. People need to know what, how, and sometimes why before they can make a change. Information enables people to form beliefs about behaviors, the process of conducting a behavior, and the consequences of their actions. But having beliefs about the consequences of their behavior doesn't always mean people will act appropriately (as demonstrated by the still numerous environmentalists who fly to annual conferences) and beliefs that prompt action may not be based on current information (such as those who shun aerosol cans because they believe they contain CFCs). Thus information is not the only important variable in forming beliefs, and beliefs are not the only component of behavior.

Researchers hunting for the ultimate answer to the question of what changes behavior then turned to attitudes. Attitudes have two elements: a positive or negative emotional response coupled to a belief. An attitude predisposes someone toward or away from an action. A behavior often includes several attitudes, each a combination of a belief and affective element. They need not be equal. A conference attendee could acknowledge the negative consequences of flying and feel bad about her behavior, but hold a stronger positive attitude about the benefit of attending the conference for her work. Indeed, how people feel about the information and the behavior often have some bearing on whether they adopt the new practice, but the combination of attitudes an individual holds, such as for health, status, job security, or family well-being may not all support the same behavior, and as a result we either tolerate the dissonance or convince ourselves that some factors are not very important.

Martin Fishbein and Izak Ajzen's Theory of Planned Behavior[2] suggests that attitudes are one important factor that help determine our actions. There are two other factors, subjective norms and perceived control, and taken together, these three elements do a fairly good job of predicting whether people will adopt or change a behavior.

Subjective norm is one of the determinants of behavior because people care about what other people think. This social influence is not awarded to everyone, but rather to those

whom the individual chooses to care about. When a company president releases a statement about the ethics of sustainability, for example, those who care about winning the president's approval may be motivated to value sustainability. If the janitorial staff do not care about the president's new-fangled ideas nor see how it affects them, they will forget it. So this second element is a product of what a person whose opinion matters to me thinks about me adopting the behavior and the degree I care about how that person will feel. An employer who wishes to use this element to sway someone's behavior may not leave an interpretation of his desires to chance. Instead of a blanket message about the value of sustainability, a savvy leader might say, "This company will lead our competitors in sustainability and I will be paying attention to where the best ideas are generated." For employees who care about how their supervisor perceives their work, there would be no doubt what the supervisor values.

The third component is perceived control. The best information, most positive attitudes, and most supportive subjective norm will not change behavior if people believe they are not able to perform the behavior. Some environments are simply not conducive to installing solar technology. Some stores do not carry fair trade chocolate. Wanting to adopt these behaviors will not be enough to make it happen. Even when the behavior is possible, if an individual does not have the confidence in his or her ability to perform the action, the lack of perceived control may prevent the behavior from occurring. If previous experience with suggesting a new idea results in an individual feeling foolish, an employee may stifle new ideas or may route them through individuals who are more likely to be applauded for their innovative ideas. The latter would be a case of having enough perceived control to understand who would be a better conveyor of the idea. In the personal realm, if commuters believe bicycling to work is more strenuous than it actually is, being supported to try a behavior may enable them to build enough confidence in their own abilities to overcome their original perception.

Who changes first?

Although the Theory of Planned Behavior suggests that these three components play a role in decisions to change behavior, some individuals are more likely to adopt new ideas quickly and others will take a much longer period of time to believe the change is worth doing. This variation among people, according to Everett Rogers[3], occurs in every collection of people—from the day shift factory workers to county employees, teachers in an elementary school, or members of a church. Each social system is made up of the following five types of people:

Those who don't need much time to decide at all are called *innovators*. The presentation of an idea may be all it takes for them to snap their fingers and say, "I'm on it; let's go." They are accustomed to wild new ideas; they are not afraid to try untested waters. They tend to have enough financial and social capital that new ventures do not entail substantial personal risk. While Rogers believes every community or group has some innovators, there are not very many around, and they may not interact well with "regular" folks. They can, however, help experimenters understand how a new technology might function. In some circles, innovators could also be inventors. In either case, these people are often not too good at helping others understand their infatuation with the new idea.

When an innovation is marketed to an audience, it tends to go through familiar channels. Some people are more attuned to these channels than others. Among farmers, those who live closer to big cities and use the Internet may be the ones to receive new information first. For engineers it may be those who are active members of their professional association. *Early adopters* are those people who get this information and are able to take advantage of it. They are often well respected and well integrated members of their community or association. They can be trend-setters. If they try a new idea and like it, others are more likely to follow in their footsteps. These are the people you first saw driving a hybrid vehicle. (The innovators were driving an earlier model, but not in places we frequent, such as Aspen, CO or Hilton Head, SC!)

The *early majority* are the folks who follow the early adopters. They interact with early adopters and others in their network, but are less likely to be in leadership positions. They require someone else to set the example before they make their decision, but they will adopt a new behavior slightly ahead of the vast majority. Because urban dwellers are more likely to see more hybrids on the road than rural dwellers, the early majority in a city will adopt hybrid cars faster than their small town-brethren. Some policies (e.g., cash for clunkers) may be designed to attract the early majority, especially when political and economic factors are considerations in decisions to make a change. Along about here in the adoption process, the innovation might change to something more appealing to the majority. Many new ideas are in a constant process of adaptation, and thoughtful users are often the best people make changes and create slightly different ideas of products.

The *late majority* tend to be skeptical of change. They are more likely to respond to peer pressure—they need an overwhelming response before they feel comfortable adopting the change. In their case, more adopters may not be the only criteria pushing them toward change. They may need more evidence as well. They may be waiting for the price of gas to stay high, or for service reports on hybrid batteries. They are still driving their gas-efficient small car but are paying attention and saving their pennies for a switch someday.

The last to adopt any innovation are the *laggards*. They are traditional, suspicious, and resistant to change. These characteristics also protect them from risk; those who survive at the margin cannot afford to try something new. They are not even contemplating something as different as a hybrid vehicle. There is no reason to change a good thing, and gasoline-powered transportation is completely dependable.

Interestingly, these labels are applied to people in specific contexts, not in every context, so that an urban minister may be an early adopter when he encourages his flock to retrofit a nearby homeless shelter to conserve energy and also a laggard when he refuses to own a cell phone because it distracts him from work. The Amish are typically labeled laggards because of their rejection of electricity and automobile ownership, but are at the forefront of wise, economical farming practices in Ohio's rolling hills where tractors are less efficient than horses. As problems are discovered with technology such as synthetic pesticides, those die-hard laggards who rejected the Green Revolution have become innovators of organic farming. Although Rogers' categories may sound too flexible, are

very helpful when analyzing how innovations spread through a community and determining how to speed the process.

The S-curve described in Chapter 2 that charts the adoption of a technology over time is actually a map of these five groups choosing a new idea. In each case, Rogers estimates that the innovators are about 2.5% of any community; early adopters total 13.5%; early and late majority each contain 34%; and the laggards complete the total at 16%. They form a normal bell curve (Figure 1). When this bell shape is converted to the number of adopters over time, it is the familiar S-curve (Figure 2). Some innovations sweep through a community (like cell phones) and with a steep slope, while others take a long time to become popular. Fax machines, for example, were invented in 1843 and took 144 years to sell one million per year.[4] Cell phones, in contrast, sold 13 million in the first ten years of existence in the U.S.[5] While both technologies speed communication and enhance sustainability by increasing access and requiring fewer resources, a fax was only useful once they were common, where cell phones could be functional when calling a land lines. Fax machines were limited to use in offices, where cell phones could be seen in public as people walked to work or waited in restaurants. The differences in these innovations led to a faster adoption rate for a cell phone because, in part, the early and late majorities were able to see the early adopters use their phones and realize the advantages for themselves. Given these data, we could hypothesize that visible innovations will be more likely to be adopted quickly than hidden ones (such as solar panels vs. in-ground heat pumps) and that innovations that can be used in concert with existing technology will be more easily adopted than those that require their own unique system.

By knowing something about the determinants that motivate people to consider new actions and the characteristics of the people who are likely to lead such efforts, we can be more effective at suggesting new strategies to our colleagues, targeting people to champion a new activity, or realizing why an apparently good idea never took off.

But not all new good ideas are popular. The diffusion curve depends on whether the "right" people are supportive. Bicycle riding has long been the mode of transportation for students and homeless; until people who are perceived as community leaders start riding regularly, the majority will stick to their cars—hybrids and clunkers alike. *Opinion leaders* are these community leaders. They are the folks to whom others look for advice and leadership. They may hold this influential position because of their job (rabbi or mayor) or their personality (the newspaper gossip columnist). If the cultural norm leads people to disregard a new idea because it is trivial or backward, an opinion leader could draw new attention to the concept.

Opinion leaders can be found in each of the five categories and can help to sway others in their category toward their point of view. Jim Dearing, one of Rogers' students, claims that Rogers was disappointed that his theory was most commonly used to target early adopters—those people who could kick-start the adoption process, and not the opinion leaders of the late majority and laggards—those people who could help the less fortunate gain the advantages of an innovation sooner.[6] Since many of the predictors of early adoption are characteristics that are difficult to affect, like exposure to information,

formal education, socio-economic status, travel, and social networks, Rogers felt it should be our duty to use these theories to overcome the barriers that constrain whole demographic groups. In this way diffusion theory can be used to promote sustainability innovations with those who would otherwise be the last to gain the advantage, as do ethical decisions that favor the less fortunate.

What process do we go through to make a change?

The last of our three theories about behavior change refers to the process that people go through when they decide to adopt a new behavior. While several psychologists have developed models about the process of change, those that refer to addictive behaviors have less relevance to sustainability. Rogers favors the following five steps, recognizing that individuals may spend varying amounts of time in each phase, and may return to repeat a previous phase:

1. **Knowledge**: Initially people must become aware of the potential action, behavior technology, or idea. It helps if people understand the problems that this innovation solves or prevents. While presenting information about problems can be depressing, linking that with information about the solution can be powerful. Because we attend to things we care about, and often miss information that appears to be irrelevant, awareness and concern are important precursors to knowledge. This predisposition often affects how the information is received. Mass media is often used to create awareness, as it does not depend on targeting the information for distinct audience groups. In addition to awareness, however, facts and figures, pros and cons, and detailed information about the behavior and how to perform it are needed.
2. **Persuasion**: Once people are informed, the next step is for them to form a positive or negative attitude about the innovation. Interest can be piqued by presenting the innovation in a relevant and meaningful context, which often means this information might be tweaked and adapted for different audiences. Providing culturally sensitive information, showing examples of how others who are similar to the target audience have used the product, and helping people believe this could be for them will help enhance this phase. Because it is helpful to understand how the action is performed, what the behavior looks like, and how others feel about having participated, the most valuable information may come from personal contacts, friends, and workshops, not from mass media. Even a presentation that helps participants realize a problem and develop their own reason for change is an effective form of persuasion—especially if participants believe they came up with the idea themselves! If individuals take the time to thoroughly evaluate the consequences and outcomes of each aspect of the innovation (understanding the information and how they feel about it), a great deal of effort can be spent in phases 1 and 2.
3. **Decision**: After people perceive the change to be good or bad, they decide whether they wish to adopt or reject the change. Some innovations lend themselves to a trial phase, and this opportunity enables people to test an innovation for a limited time. Farmers, for example, are often given free samples of seeds to plant in one field prior to agreeing to a complete conversion of the farm. Simply adding, “You can always quit the group if you don’t think the

project is working," might enable more people to join. A test-run is extremely important for innovations that carry a risk of catastrophic failure. If a pilot test is impractical (such as a space walk or plane landing), simulations are typically created to enable potential users to develop needed skills and "experience" the intended outcome. For some people and some innovations, "trial-by-others" is sufficient to help push the adoption decision. Extension agents use demonstration areas to show homeowners how native plants can be maintained without synthetic fertilizer and pesticides, and ranchers can see what a silvopasture[7] will look like. Of course, a decision to adopt is based not only on information, attitudes, but also an ability to perform the behavior. Not having access to the requisite equipment for participating in a webinar or funds to attend a conference will limit one's ability to engage in professional development, regardless of the strength of the attitudes.

4. **Implementation**: This is the stage where an individual engages in the innovation. The process is no longer something they think about, but a real activity. Because this is the first time the person is conducting the action, he or she may have questions or need support. Procedural information is critical that this stage to prevent frustration and backsliding. This is also the stage where individuals may determine that a slightly different strategy will work better. A re-invention activity can physically alter the innovation or how the innovation is used. As good ideas spread across a community, it is often necessary that adopters understand that adaptation is possible and even welcomed.
5. **Confirmation**: While the implementation-reinvention stage represents the end of the process for some innovations, others include a fifth stage in which the individual seeks additional information to confirm the decision is right. Supportive messages may be helpful, particularly those that provide feedback about how the change is being adopted or how the environment is changing. Large thermometers that track donations to charity help reinforce decisions to give and prompt those who have not yet opened their wallets. For the former, this is a confirming "feel-good" message, and for the latter it is a persuading reminder.

Considering Theories on Individual Change

The elements from the Theory of Planned Behavior and the stages of adopting a new behavior are similar and complementary. Beliefs are formed during the knowledge stage, and attitudes are shaped in the persuasion phase. How important others feel about adopting the new idea or product (subjective norm) may be important information that can be provided in the decision stage. Perceived control, or believing that the user can indeed manage the innovation and it will be successful, is exactly the outcome of the implementation phase, and feedback from this may be helpful if a confirmation is sought.

All three of these theories can be used to help convince colleagues and supervisors to consider a new idea, to work together on a project, to approve a new and more sustainable practice. Here are suggestions that arise directly from these theories. They can be applied to a variety of situations in the workplace to help move people toward change:

- Provide information about the advantages and disadvantages in all three realms of sustainability, with emphasis on the realm that the audience cares the most about.

In the private sector, this might be the profit, though the public relations arm of the company might be interested in community service. In the public sector the environment and social dimensions may become the major effort, but balancing the budget will not be far behind.

- Offer stories, case studies, or example of others who have done similar work. If the topic is controversial, examples where decisions were made against the change may be just as helpful as those of adoptions. Demonstrations and models can be helpful to enable people to see the difference the decision might make.
- If perceived control is a barrier to adoption, organize training sessions to build skills or provide tools and equipment for people to borrow. Then allow them to practice these new skills in a safe environment before they need to perform for real.
- Offer to provide a consultant to take over a particularly challenging aspect of the program, or contracting with someone else to take that element.
- Identify the opinion leaders of the audience you are reaching and meet with them before your presentation. Allow them to ask questions and help you refine your approach. If they approve, ask them to say so in front of others.
- Remind people that options to move toward sustainability will ultimately serve everyone's best interests.
- Critique the innovation and determine if it is likely to be adopted easily, or if it can be modified to make it more adoptable. Visibility while in use, borrowing other people's, and fitting in well with the current culture are characteristics that can make an innovation more likely to be successfully adopted.
- Identify the early adopters in your office and make sure they are likely to try the new idea, that they like the new idea, and that they are happy to share their success with their networks.

A recent survey of US Forest Service employees about their environmental behaviors at the workplace reinforces many of these ideas. Respondents revealed that a commitment from the leadership was important for employees, and those who perceived their leaders were strongly supportive of certain practices were three times more likely to perform the action than those who believed their supervisor was not supportive. Support in the form of social norms and expectations from coworkers and the public were also important for those who conducted and maintained environmental actions. These respondents had positive attitudes toward the behaviors, knew about and how to perform the actions, and reported that supportive policies and procedures were important to the successful implementation of the environmental actions. They reported that workplace reminders and incentives influenced their behaviors and recommended that rewards be used to engage others.[8]

Knowing what is important to entice or encourage someone to pay attention to the issue and behavior is the first step. Since most work place decisions occur in teams and groups, however, the real action is when these motivated individuals come together

CREATING CHANGE WITH GROUPS

Many ideas about sustainability will be born in groups simply because the disparate

dimensions of economics, environment, and equity often require expertise from several people (see chapter 8). If they all are not working together from the initial conception, new ideas or technologies may require selection or modification by representatives from the missing dimensions. In the world of policy implementation and resource management, a number of agencies and organizations are adopting stakeholder groups to better explore problems, understand issues, and jointly recommend actions. These stakeholders usually represent as many view points as possible, and are likely to include economic, justice, and environmental interests. Some groups are expected to ease communication challenges by having everyone together to hear the same information. Other groups are asked to review options and make recommendations. In some cases, stakeholder groups are used to solve problems.

Social Learning

In all of these cases the process of interacting with and learning from others, called social learning, is a critical component of implementing decisions about sustainability. Peter Senge, author of *The Fifth Discipline* has popularized these ideas in the business world, where terms like mental models and shared vision refer to disciplines that bring different perspectives together and motivate individuals to work truthfully, creatively and with integrity, creating learning organizations.

Social learning in this context is the process of sharing and reflecting on experiences and ideas with people and groups as they collectively strive to implement more sustainable practices.[9] Although educators have been aware of the value of learning from others for years (e.g., vicarious learning, cooperative learning, group learning), business leaders and natural resources managers have recently begun to use this term to draw attention to the importance of facilitating group interaction. Some experts consider social learning to occur only when people who hold diverse views interact and everyone learns something from each other. In these cases the groups are designed to build trust among individuals and are facilitated to enable people to realize that their ideas are changing. A continuous process of questioning the assumptions that each person brings and reflecting on the similarities and differences among them helps to create social learning.

By definition, leaders of sustainability initiatives should carefully consider social learning as well. For many individuals, the chance to share their ideas about a concept is the best way for them to learn.[10] Although we often provide information to individuals, the opportunity to discuss the ideas with others can alter the way we understand that information. And interestingly, whether the group discussion occurs before or after the individual receives information can influence how they perceive new ideas about change. A recent study at Columbia University suggests that doing one's homework before a group meeting and reading about a controversial investment in wind energy tends to result in people bringing their own perspective to the group discussion. If the first time they hear of the controversy, however, is in a group discussion where someone expresses a different perspective than their own, people may be more likely to consider those ideas more strongly than if they formed their own opinion first. [11]

Social learning is a very useful tool when there is no widespread agreement on how to

move forward. Many issues can be used as relevant examples. Should we use wood for energy if that requires land to be taken out of agricultural production? Should we export technologies to developing countries if there is no vocational program that can train workers to manage or repair these systems? Do we have the right to create genetically modified trees to enhance their conversion to products we desire? Which is more important—an incinerator to burn municipal waste from an urban area or the health of the neighbors and ambience of the rural region? Employees involved in contentious issues should not employ persuasive communication strategies to sell their solution. Instead, they might find more productive a social learning approach with a variety of stakeholders to better explore the problem from all perspectives. Such a group can be asked to develop solutions that meet the various needs of those involved, as well as the needs of the future and distant citizens who may not be present to speak for themselves. As we develop more creative avenues for addressing economic, environmental, and equity considerations it may be increasingly difficult to assume that any solution will be easily accepted by team members, colleagues, supervisors, or stakeholders. In the context of sustainability, social learning may be a very useful tool.

Multi-Stakeholder Processes

These diverse groups of stakeholders and the activity of working together is a called multi-stakeholder process (MSP). A variety of resources and techniques are available to facilitators and organizers to think about the goals for the group, to win the trust and cooperation of group members, and to develop a process of critical reflection that results in a new idea for which there is broad agreement.[12]

Not only is social learning a key aspect of successful MSPs, an experienced facilitator with the skills to recognize how to engage more discussion, when to move forward with a decision, and how to help the group critically think about their deliberations is essential. As mentioned before, reaching a shared understanding and common language will enable the group to function, and a systems approach will help the group consider a variety of variables, problems, and consequences as they sort through their task.

Indeed, a growing number of industries and agencies use these strategies to engage stakeholders in decision making, believing that (1) better strategies will grow out of the varied perspectives that will be brought to the table, and (2) broader ownership of the recommendations will lead to quicker implementation and fewer subsequent law suits. From citizen advisory boards to stakeholder panels and adaptive collaborative management, social learning processes enable groups of experts and the public to share perspectives, learn together, build trust, and recommend solutions that are likely to be sustainable.[13] By representing economic interests, social groups, and ecosystems, these discussions have the potential to revolve around recommendations that maximize all three components of sustainability.

These are typically long-term groups that convene for years to identify needs, sponsor joint fact-finding and research, listen to every perspective that comes forward, establish strategies to make decisions that respect all parties, and make recommendations. They build skills in perspective taking and communication as well as build understanding in environmental science, monitoring processes, economic costs and benefits, legal

procedures and political pressure, and social justice.

While each MSP is different, they tend to include four phases: initiation; adaptive planning; collaborative action; and, reflexive monitoring.[14] The beginning, initiation phase involves the establishment of the group, the development of appropriate expectations and common purpose, an orientation to the situation, and the development of a leadership group. The adaptive planning phase enables the group to build trust as they learn about each other's interests and perspectives. This is often accomplished through future visioning exercises or scenario planning. Such an exercise may reveal where significant disagreement occurs or where serious gaps in knowledge exist. The group may have the resources to request research proposals and select a team to collect information that will guide their decisions. The collaborative action component enables the group to implement their decisions, inform stakeholders of their progress, and make changes as necessary. During reflexive monitoring, the group will set up strategies to track change, identify those components that require further investigation, and welcome critical reflection on their process and decisions.

The conflict around the expansion of the Frankfort airport in Germany represents an impressive case of a successful MSP.[15] Neglecting to balance economic growth with the negative impacts on residents and the environment resulted in public outcry when a third runway was proposed in 1984. The movement ended when snipers killed two policemen in 1987 at a mass rally. When a fourth runway was proposed in 1998 the state government initiated a mediation process with 21 stakeholders who were asked to balance economic growth with environmental and public health concerns. After two years of deliberation, they recommended the new runway be built if the airport eliminated night flights, took steps to reduce noise, and implemented a Regional Dialogue Forum (RFD) to continue to build understanding and explore solutions. Shortly after the mediation process's recommendations were received, the RFD was established with four different objectives: to build understanding, to conduct research, to provide counsel on formal procedures, and to protect the mediation process. The Forum established a leadership group of 34 stakeholders which held hearings to explore issues and the need for further research. They established 5 subgroups which had open membership. Over the course of the Forum the teams held over 200 sessions and attracted over 130 additional interested participants. Close to 2000 students took part in a mediation simulation program, the media were regularly invited to report on developments, and open meetings were held for the public to share what the teams were learning.

The night flight ban, flight routes, and approach and departure procedures, for example, were highly technical components that required answers to legal questions and additional research to document noise levels and significant negotiation among stakeholders on what will be monitored. The questions and possible outcomes changed with alterations in German legislation and European agreements. Interestingly, such important aspects of the operations of an international airport had never been considered with the social and environmental costs of doing business. An elaborate process of research was established with the Forum and project team inviting researchable questions, a team of experts formulating the call for proposals and reviewing submissions, the Forum selecting a

winning proposal and asking the runner-up to serve as a monitor of the quality of the research conducted. The results and recommendations were considered and approved by the project team, quality safeguard, and Forum before their release to the public. The process helped build faith in the data, reduce the notion of unsubstantiated claims by opposition groups, and created a framework that was cited and referenced in future negotiations.

The process of deliberative and social learning helped convert a divisive conflict into an opportunity for a win-win negotiation. As the process began to reach closure in 2007, even the most critical opponents wished to see a similar process continue to provide a forum for exploration and understanding. The MSP was deemed by stakeholders to be a good strategy for creating solutions that everyone could live with.

Challenges to Multi-Stakeholder Processes

A number of challenges arise in pursuit of this goal, however, which facilitators of social learning strategies work hard to avoid or resolve. Merely being at the table, for example, does not mean all members speak, are heard, or are included in deliberations as equals. Particularly if the issue involves a looming lawsuit, some representatives will not wish to reveal all their interests and considerations. Also, if the issue involves passionate pleas or traditional knowledge, these justifications may not be given the same weight as scientifically valid data. Clearly, the selection of members should be given considerable thought for a healthy mix of personalities who can help create an atmosphere that welcomes different opinions and who can listen respectfully. In addition, if the members are expected to represent others, they must be legitimate representatives who will carry information between the group and their constituents and help convince both sides of the value of the others' perspectives. Facilitators often work to build trust among members, provide room for less talkative members to voice opinions, watch interactions to nip destructive comments early, and help integrate information into shared understanding.

Although much is implied about the importance of democratic participation and the empowerment of all participants, there is often a power imbalance in multi-stakeholder groups. For example, the industry or agency in question may hold the ultimate decision-making power if the MSP is created with only the ability to make a recommendation. Some stakeholder groups may represent thousands of citizens given them the perception of greater power. Some interest groups may subscribe to the same perceptions or mind sets, making their position harder to change. The composition of a group may try to take these factors into account, allowing for a certain number of seats at the table for each perspective.

Multi-Stakeholder Process and Systems

Since the topic of most MSPs will involve sustainability, Chapter 8 suggests that using a systems perspective will help enable the group to consider all perspectives of the issue. Using the group to build a model of the system in which their concept operates, identify areas where their collective knowledge is weak or uncertain, and embark upon strategies for collecting data or building knowledge can be powerful tools for social learning. This process, when applied to natural resource management, is often described as adaptive

management (see chapter 8).[16] When local residents and other stakeholders are included in the decisions and the group intentionally works collaboratively, the term adaptive collaborative management (ACM) may be more appropriate.[17] In such opportunities, a focus on systems thinking and social learning should enable the group to be most productive. Again, when the management question involves an economic dimension, an adaptive collaborative management process will be working toward sustainability.

Examples of these collaborative MSPs with a systems perspective span the globe:

The New Zealand Land Care Trust[18] is an organization that uses community involvement to create sustainable land management practices. Working with over 150 local land care groups, they organize landowners, often farmers with a vested interest in economic survival, around common problems and help provide a platform for seeking information, developing research projects, and exploring solutions. Groups bring in experts who can help provide information or design experiments that will result in relevant, needed new knowledge. Building trust among those with conflicting views is an essential part of their activities and comes with the territory of increasing biodiversity and water quality in an agricultural region. These conflicts make the work of developing a common understanding and agreement for creating informed decisions all the more essential.

On the other side of the planet, in southeastern Sweden, the people of Kristianstad came to realize that centuries of farming, channeling water, dredging canals, and fertilizer use had significantly altered the shallow lakes and wetlands near their city. They hoped that international recognition for their local wetland would bring about important changes, but after ten years were disappointed with the continuing decline in environmental quality. Their frustration fueled a new process that enabled agency staff and citizen groups to work together to map the region, explore possible solutions to restore the wetlands, and report their results to the public. They worked with local farmers to understand that different grazers (cows and horses) create different surfaces (tussocks and smooth) on the flooded meadows that attract different species of birds. Restoring traditional forms of agriculture to the wetlands was a vital step in maintaining the ecosystem, but also led to conflict. Cranes, for example, damage crops but attract bird watchers. Through a stakeholder work group the farmers agreed to sacrifice some of their land to the cranes in exchange for compensation for their loss.[19] Bringing together various stakeholders enabled this coalition to build trust, engage in discussions, share responsibility, explore possibilities, and establish consensus on decisions that reflect economic, environmental, and social goals.

Learning how to work together, establishing trust, collecting needed data together, wisely incorporating disparate ideas and perspectives, and working toward a shared goal or vision helped the participants in these examples succeed. Social learning, systems thinking, working with diverse stakeholders, and collaborative management may be essential features of every successful workplace innovation that features sustainability. The practice of these skills and strategies could help define an ethic of sustainability in the work place. Decisions about which product to make, which budget to cut, or which problem to solve might be best answered by considering who do we need to hear from, what consequences have we not considered, what additional expertise can help, and how

can we learn our way forward, together?

Building shared understanding

One challenge to working in groups is the problem of communicating with people who do not share the same expertise or perceptions. Poor communication can be the result of purposeful omissions or unavoidable confusion due to assumptions that stem from different experiences. This is common when scientists and policy makers work with the public, but is also a concern when working with colleagues in other departments or supervisors. Knowing how to listen for misconceptions and the source of confusion can help immensely. In the case of perceptions about risk, however, there are clear differences in how non-experts understand and value hazards.

Developing a shared understanding of the problem and the consequences of any solution is a key step toward implementing new ideas that carry the promise of sustainability. It features prominently in the Reasonable Person Model (see Chapter 8) as a basic requirement for engaging people in solving problems. It is also one of the five disciplines that Senge identifies for learning organizations (see next section). And of course, it is one outcome of social learning. As a result, a closer look at the problems associated with the simple step of communicating ideas within a varied group may be useful. Below are three specific concerns that can arise in stakeholder groups and workplace teams.

1. When pieces of truth do not convey the whole truth.

When team members assemble, they bring not only different perceptions of the problem, but also different assumptions and experiences that can be so tightly woven into their ideas that it is difficult to recognize where opinions differ from facts. It is easy to see these communication challenges between opposing advocacy groups who traditionally call each other derogatory names, but more subtle variations of the same problem can be found everywhere. The advocacy groups tend to carefully select bits of facts that support their perspective. Over time it is easy to rely on the message as representing the whole truth, when in fact it is just a part of the truth. That message will be utterly and unavoidably true from the originator's perspective, and equally and totally false from the other.

For example, environmentalists have long sounded an alarm that landfills are reaching their limits and we should reduce, reuse, and recycle rather than burying our waste. A plastics industry representative was heard to respond by saying such statements are bold lies: we are not nor will be in danger of running out of landfill space. It is easy to see how such a war of words can escalate into mudslinging. What both sides omitted from their "truth" is location, cost, and justice. Cities in New Jersey may not have abundant local landfill sites, while those in Nevada, have sites in abundance. If east coast residents paid enough, they could find a landowner willing to bury their garbage, at least for a while. What does this mean for people in New Jersey (and their environment) who don't have the discretionary income to ship their garbage across the continent? Will the wealthy residents of Nevada also be accepting waste from the East, or only those in need of cash? Complete information is needed to convey information that all parties would find truthful, and this exchange may allow a one-dimensional environmental issue to become

a three-dimensional sustainability concern. But this degree of thoroughness may be seen as unnecessary by those who agree with the statement, by journalists who want short sound bites, and by editors who want to reduce complexity. As a result, interest groups trumpet their limited views and feel justified in accusing their opponents of lying. And the public, caught in the whirlwind of confusion, stops trying to make sense of the controversy and lets someone else decide what to do. The intentional and accidental omission of facts make it difficult for people to resolve and understand conflicting opinions. It also keeps issues one dimensional when the full complement of concerns would be useful to work toward a practical and sustainable resolution.

Sometimes omitting facts can be justified because people would otherwise ignore a potential problem. Melting Arctic icecaps are altering polar bear habitat; the image of gaunt, starving polar bears has become global climate change's canary in the coal mine. But wildlife biologists note that polar bear populations are at an all time high based on recent records; in the normal course of dynamic population changes, more bears are likely to starve now than ever before.[20] Bear populations will most assuredly fall in the near future, but not as a consequence of climate change. Those who wish to see change come to American habits of consumption and energy use, however, aren't likely to challenge the popular conception that polar bears are starving because of climate change. The end, in their mind, justifies the means of misleading information, and their emotional defense of polar bears helps make the point that this species is an effective way to attract attention, even if the evidence doesn't completely line up.

Successfully incorporating advocates into stakeholder groups will require exposing these assumptions and omissions and challenging long-held dogmas about how the world works. That is not easily done, but is vitally necessary.

2. When new information does not make any sense.
When people cannot accept the information, it may be because the explanations they built from their experiences and observations are rooted in fundamentally different ways of understanding the world (often called naïve conceptions or misconceptions in children). Their different mental model can make it nearly impossible to have a productive conversation. If an explanation doesn't make sense, the listener is likely to proclaim the information is false or biased, and the speaker does not know of what they speak. Experts in the conversion of wood to energy, for example, are quick to point out that the wood-fired power plants emit so few air pollutants that they rarely need emission controls to pass air quality standards. Audience members who are prone to skepticism will not accept this as fact, particularly if they have experienced campfire smoke or a wildfire. Their first-hand experience with stinging eyes, massive amounts of smoke and ash, and choking coughs from burning wood suggest to them this expert must be crazy. Furthermore, this must be another trick for the energy companies to make a fast buck off the environment. Mistrust creates the perception of bias and destroys the opportunity for learning.

A more careful presenter would acknowledge the accuracy of the audience's experience with wood smoke and explain that the smoke they have seen comes from using a variety of fuels at various moisture levels and the relatively low and uneven temperatures in a

campfire. In other words, she starts her explanation with what the audience knows and believes. Then she would explain that incomplete combustion from damp wood and big chunks mixed in with twigs and leaves creates tiny particles of unburned wood and gases that rise with the hot air. In a power plant the wood is chipped to a regulation size, dried, and burned at extremely high temperatures in a controlled environment. The boiler is able to burn the fuel evenly and completely, which reduces the amount of particulates in the smoke. She might also be careful to explain that wood has fewer air emission problems than coal. When wood is compared to a zero-emission energy source, it is not so clean, but in comparison to a fuel we currently use, it brings some measurable benefits to air quality. The simple soundbite promise of a cleaner fuel has now turned into a rather detailed explanation to help build understanding and begin to change recalcitrant mental models.

Misunderstandings in communication are often the result of undetected basic differences in how people explain the world that arise from a lifetime of experiences. They are common, and require listening skills and time to engage people in a conversation to explore these differences. Questions such as "what makes you say that?" or "where have you seen that" might open the door to improved understanding. Groups working on issues of sustainability will by definition bring a variety of expertise to the discussion. Misunderstandings are likely to be the norm. Building a sense of trust to enable communication that explores and understands differences in perception will be essential.

3. When new information involves risk.
Communication about proposals that involve risk tend to lead to extreme degrees of mistrust, misunderstanding, and downright outrage. These communication challenges between experts and the public have led to a number of studies that reveal basic differences in mental models. The difference: engineers and other experts tend to calculate risk based on the probability of human fatalities. This makes nuclear power dramatically safer than coal power, since the United States averages 33 coal mine fatalities each year.[21] But the public includes in their calculations of risk a number of other factors, such as the degree of disagreement in the scientific community, the possibility of catastrophic problems, the risks to future generations, the controllability and voluntary nature of the risk, and the degree to which the risk is observable, known and immediate.[22] "In other words, the general public appears to use a broader and more complex definition of risk and acceptability than does the technical community. [They] are 'speaking different languages' and therefore speaking past each other."[23]

There are some patterns in risk perception, however. A number of variables cluster around "dread" and make these risks appear worse than experts think they are: uncontrollable, globally catastrophic, fatal, not equitable, high risk to future generations, not easily reduced, involuntary, and increasing. Nuclear power fits this scenario. The opposite set of variables tends to be perceived as less dangerous; caffeine, tobacco, or skateboards are controllable, voluntary risks that are not likely to lead to catastrophic or unequal problems since they are individually chosen. Interestingly, experts agree that the risks are defined by these variables, but because they have defined risk narrowly as fatalities, they do not judge the outcome the same as the public. The public perceives a

second factor in risk, defined by variables such as not observable, unknown effects, delayed effects, and uncertainties. This explains why chemical additives or electric fields might be perceived to have great risk, while fireworks and automobiles appear to be less risky. A third factor involves the extent of the consequences of the potential problem.[24]

These patterns of risk perception make it impossible for experts to credibly speak to the public unless they understand and base their discussion on the factors the public considers important. They suggest that risk comparisons (which are the typical way risk is discussed) that equate the annual risk of a nuclear accident to riding an extra three miles in an automobile, for example, are meaningless. And they suggest that both experts and the public have important perspectives to contribute to discussions about the acceptable risks of a new technology.

These communication challenges surface regularly in the many groups and gatherings where different perspectives should be included to enhance learning, understanding, problem solving, and decision making as people consider sustainability. Merely wanting to solve the problem will not remove communication challenges, but it will likely provide the requisite vision that will help people be patient with each other, ask questions when they become confused, and work harder to communicate. The information and perspectives that each individual brings to the meeting are important to uncover, as their perspectives are the lenses through which all new information is perceived.

Communication challenges can be avoided when people trust each other enough to interrupt to say, "Wait, I don't understand." Such levels of comfort are rare in stakeholder groups that meet only twice a year, unless they are carefully facilitated and opportunities are created for questions to be asked. Speakers may find it helpful to engage the group in discussions and to facilitate the development of their understanding by walking through questions, observations, and realizations. When a group represents a great many different types of expertise, however, this too is a challenge because everyone starts with a different set of experiences and assumptions. An audience assessment is one way to learn about the various perceptions that a group brings and may help a presenter think about how to share new information with analogies that will resonate with subgroups of the audience.

Such challenges are common in the professional world of sustainability. Fortunately, there are changes afoot that will enable workplaces to more easily adopt work teams and practices that reveal and share mental models. Many are becoming learning organizations.

Creating learning organizations

There is little more motivating than a crisis. We are hard-wired to bolt at initial signs of potential danger— an inclination passed on by the ancestors who didn't became lunch for a lion. While our abilities to leap to conclusions (that snapping twig might be a beast) and act (run without a backward glance) have clearly saved our lives for eons, the current sources of trouble are not so easily escaped. And in fact, our intuitive reactions may be exactly the opposite of what is needed.

In the *Fifth Discipline*[25], Senge uses the recent experience of multi-national corporations and businesses to develop his suggestions of the skills that are needed to move ourselves and our organizations toward sustainability. These skills are not easily acquired by the fight or flight responders. These are skills that must be learned and practiced over time, and they enable people to explore, dig deeply, and learn about problems and solutions together. Those who practice these skills talk about pausing, talking to each other, thinking together, and reflecting, a far cry from the snap decisions made in an emergency. When businesses, industries, and organizations value and nurture these skills, they evolve to become *learning organizations*. They share the following five disciplines:

1. **Systems Thinking**—Rather than dividing a problem into parts, seeing a problem in the whole, and using systems thinking to understand the situation and see potential solutions.
2. **Personal Mastery**—Becoming proficient at learning. This involves mastering the techniques of creating a vision, being patient, focusing energy, committing to a goal, and seeking truth. Where youthful optimism and idealism contributes greatly to this discipline, a seasoned workforce tends to be disgruntled and may lack the desire for mastery.
3. **Mental Models**—Becoming skilled at understanding personal assumptions and rationale, i.e., one's mental model, articulating that to others, and helping them understanding their mental models so that a shared model can be jointly constructed. These conversations involve balancing statements of advocacy with inquiry—promoting one's views and thoughts in such a way that different perspectives, faults, and contradictions are surfaced and explored.
4. **Shared Vision**—Creating and sharing a powerful ideal of where the organization is moving, and energizing commitment toward that vision that is not coerced but desired.
5. **Team Building**—Building productive teams so that joint dialogue reflects exploration and learning. "Teams, not individuals, are the fundamental learning unit in modern organizations... Unless teams can learn, the organization cannot learn."[26]

The process of achieving change in the workplace, then, is a process of creating a learning organization—one where a systems perspective is used to understand important problems and situations, where teams of stakeholders work together toward a common vision or to resolve disputes, and where mental models are explored and challenged in an atmosphere of trust and acceptance. Good communication skills are vital for the development of shared visions and mental models. An understanding of behavior change, diffusion, misconceptions, and the role of advocacy can help the teams function more efficiently, honestly, and truthfully. This does not happen overnight. Becoming a learning organization is a change in culture. A commitment by leadership to change and to learning is often needed, as well as the ability to commit to change over time. After several years on this path, the Harley-Davison President Jeff Bluestein was asked what was different in his company. He admitted it wasn't a massive change, but he thought it was significant. "I hear more and more people say, 'This is the way I am seeing things' rather than 'This is the way things are.'[27]

One need not be a CEO to build the skills of a learning organization, though some level of support from leadership may be helpful. Within small units and offices, for example, these good practices can help people communicate clearly, address problems more effectively, and ask questions about the broader system. Taking the time to ask people for their opinions, establishing working groups and committees that investigate problems and make recommendations, and modeling and encouraging employees to work with stakeholders who share different views are ways we can move the office environment toward the practice of making more ethical decisions.

Another characteristic seems to be common to the people who work to shift the culture in their organization toward one of learning—they value and respect people. They know that people need and thrive on meaningful work, and finding meaning is more possible when people develop the skills associated with learning organizations. Supervisors who support creative new ideas, even when they don't work, help people grow, and human growth is a noble goal. These are the supervisors and companies more likely to tackle and succeed in moving into the unknown—sustainability.

Senge's work has been adopted by corporations and organizations in many different sectors. Staff at Unilever have created more meaningful work by gaining leadership skills in working with people and integrating more experiences in problem solving. Because their business uses relies upon fish, they have become involved in policies and the development of sustainable fisheries.[28] Several years ago Intel was developing a new facility for a new microprocessor. The leader of this large, stressful effort suffered a heart attack and returned to work with a new commitment to limit his work life to a more reasonable 50 hours a week and be home to eat dinner with his family. He also made it clear that he expected the rest of the work force to join him. They used this opportunity to shift their culture to taking the time to work better, not harder. They become more engaged, and even happier people. The new facility opened earlier than expected, eclipsing the original, demanding target.[29] These and other businesses find that the work of their agency or industry is improved by valuing and respecting their employees—they solve problems and tackle unknowns with greater success. This bodes well for organizations that wish to move toward sustainability, as the issues are challenging and unknowns abound. We will need to create space to find joy in the many difficult trials that are ahead. The attributes of a learning organization suggest that these groups will be able to respond more adequately when the planet's warning lights start blinking.

APPLYING THESE IDEAS – AN INTERNATIONAL PROCESS TO ASSESS GMOS

The concepts of social learning, multi-stakeholder process, and the development of learning organizations to improve understanding and solve problems that encompass technology, environment, society, development, and ethics can be illustrated in the following case. Rapid advances in genetic engineering have created opportunities for technology to address a wide range of agricultural challenges with genetically modified organisms (GMO). Nutrient-rich rice, corn that has greater resistance to pests, and fish that mature faster are among the new GMOs that have been created by inserting genes

from one organism into another. The advantages of GMOs could greatly enhance our ability to feed, clothe, and heal people around the world.

Because the GMOs are new and involve complicated technology, few people are well-versed in their advantages and disadvantages. There is substantial uncertainty about the potential consequences of planting a new organism in open fields, for example, where pollinators may spread designer genes to wild cousins or across international borders to nations which have refused to allow these crops. There is controversy about the traditional practice of saving seeds for next year's planting if the seeds themselves are licensed genetic material. The science is difficult to understand, the advocates on both sides use compelling tactics, and nations are faced with important challenges as they consider whether to allow each GMO into their agricultural systems.

In 2000, the nations who signed the Convention on Biological Diversity authored the Cartagena Protocol on Biosafety—an agreement designed to use the precautionary approach to help protect people and the environment from the uncertainties associated with widespread use of GMOs. As of October 2007, 143 nations had signed on the protocol. The suggested process of assessing a potential GMO should include scientific information and expertise to explore the proposed benefits and possible interactions that could arise with the environment and society, an opportunity for those who will be most affected by a decision to contribute to the decision, and a process to guide efficient deliberation.[30]

Public sector scientists associated with universities and government agencies tackled the challenge of developing a risk assessment process that any nation could use to make decisions about GMOs through the GMO ERA Project. An environmental risk assessment (ERA) is a logical tool to accomplish some of the analysis associated with GMOs, but it also has limitations.[31] Most ERA models focus on science and ecosystem risk and do not address societal impacts, particularly social acceptance, economic factors, political influences, and ethical issues. Since most GMOs are solutions to a problem, it makes sense for the process to be grounded in a problem formulation process with reflection on alternatives that achieve similar goals. The project team recommends multi-stakeholder participation that engages the people most affected by the GMO decision in a deliberative process that integrates information and careful, reflective discussion about the problem and potential solutions.[32] This process, known as the Problem Formulation and Options Assessment (PFOA) would become part of the standard ERA activity.

In their pilot test of the process in Brazil, Kenya, Malaysia, and Vietnam, project scientists learned that the process enabled a blend of expert and public voices to be heard and included in the discussion. Participants learned from and with each other as they moved through the process, and as a result, participants reshaped their views as they learned. Focusing on the problem they faced kept the group discussion on the realities of their context, and considering each alternative in a transparent process allowed interest groups to understand both the process and the recommendations the group made. The process is not simple or easy, however, and questions still confront the project organizers

about how nations can develop the capacity to orchestrate the process and create recommendations that their regulatory bodies will accept.

Clearly, the multi-stakeholder process is essential to understand the problem and the possible consequences of each option the group considers. The effectiveness of a process that includes people representing many different (and opposing) interests and experiences (from research scientist to farmer) will depend on developing trust and openness, practicing good listening and communication skills, building shared understanding, careful consideration and reflection—in other words, social learning and the skills of learning organizations. Understanding how to present information, how to convince people to attend meetings, and how to facilitate discussion requires understanding the motives and interests that encourage or discourage the stakeholders from engaging in different practices. Finally, the selection of participants for the process should target the opinion leaders who can represent the member groups effectively, and acknowledge their likelihood for accepting innovations.

CONCLUSION

It may be challenging for a scientifically minded professional to bypass a solution that appears to be technologically sustainable in favor of a process that considers values, ethics, justice, future generations, and the perspectives of naysayers who advocate for the demise of your industry. But as the examples of the Frankfort airport and the international GMO approval suggest, technological decisions are not sustainable in the long term if they do not consider the varying perspectives of the environmentalists, the rural poor, the neighbors, the unborn, and the non-human creatures on the planet. Considering all those elements requires groups of stakeholders and representatives who are probably not working for the same employer.

Implementing practices that lead toward sustainability in industries, businesses, government agencies, municipal offices, and schools will take a process of working together. Senge describes this as the process of developing a learning organization. The Kaplans refer to the Reasonable Person Model (chapter 8) to guide the development of situations and environments that enable people to flourish and use their creativity to solve problems. Social learning is one description of the strategy that is engaged, and multi-stakeholder processes are one method for facilitating social learning where complexity and diverse perspectives are the rule.

These groups will engage people with different experience and expertise who may not share the same vocabulary or biases. Communication within such groups begins with an agreement to try, a shared vision of the purpose and goal, and a trust that working together will result in something better than if everyone worked alone. As the world faces greater challenges in balancing environmental limits with economic necessity and social justice, it will not be hard to justify the importance of group efforts to design more sustainable products and practices.

The groups that focus on sustainability will include the questions raised in chapters 4-7 of this book. Perspectives on ethics can help people sort through the issues and weigh and

compare various options. In some cases, we are missing alternative perceptions and need to challenge ourselves to always test assumptions and look for new considerations. We need to shed old ways of knowing and thinking in order to perceive options for sustainability. Is any outcome irreversible? Will future generations have the same resources and options we enjoy? Are all those who are affected by this technology or decision involved in the conversation? Are the costs of negative impacts included in the price? The process of discussing, debating, and deciding is not easy, but is made more effective when groups deliberately use the strategies of social learning and learning organizations.

Convincing supervisors, colleagues, and laggards to adopt recommendations and new ideas, however, may be more difficult. The skills of communication rest upon a foundation of understanding the motives and determinants of behavior and the ways in which ideas move through a group. While these ideas have been perfected in the world of advertising and marketing, they are currently being used to affect health and conservation behaviors. It is only logical that they will be used to make behavior more sustainable as well, as the next chapter will explore.

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CHAPTER 10
PERSONAL AND PLANETARY SUSTAINABILITY

Introduction

This book has emphasized, so far, the ways the ethics of sustainability can be applied in professional activities in science and technology. This chapter addresses the ways that professionals can understand and integrate the ethics of sustainability into other aspects of their lives. Thinking about sustainability in this more integrated fashion is important because, as we have noted before, sustainability itself is a holistic goal. It not only brings together social, economic, and environmental concerns in a coherent way but also applies those concerns to a wide range of activities. These activities require different tools and modes of analysis, as well as varied practical responses, but they share an integrated set of ethical principles and goals.

Thus one of the most important messages of this book is that sustainability cannot be achieved in a compartmentalized manner but will emerge only as the result of careful decision-making that takes into account a wide range of factors. Further, decisions for sustainability are not limited to professional, scientific, or policy settings, but should be considered and applied in a wide range of contexts. Sustainable decision-making, in other words, must be expansive both in the factors it considers and in the settings in which it is implemented. This is true for societies and also for individuals, including scientists and other professionals who aim for greater sustainability in their work lives. In this chapter, we discuss ways that professional might begin to recognize and take advantage of opportunities to enhance both personal and planetary sustainability.

Enhancing Personal and Planetary Sustainability

Scientists, engineers, and technology professionals are also citizens, parents, neighbors, and recreationists. These other aspects of their lives, no less than their professional activities, offer opportunities to enact an ethics of sustainability. Seeking sustainability in our personal lives is no less complex or challenging, however, than efforts to achieve sustainability in research and other professional activities. In both cases, solid information about environmental, social, economic, and ethical dimensions of sustainability – can help build a foundation for effective action. Knowledge alone is not enough to create a more sustainable society, but it is an essential first step.

Measuring Consumption and Sustainability

In academic literature on sustainability, more information is readily available about sustainability's environmental dimensions than about its social and economic aspects, especially in relation to consumption and other daily activities. Resources from economics, business, and related fields can be vital to help integrate the social, economic, and environmental dimensions of sustainability in personal as well as professional settings. Understanding the environmental dimensions of sustainability in our personal lives can begin with information about the environmental impact of ordinary activities. This impact can be measured, at least in part, by calculations of one's **ecological**

footprint, a concept introduced earlier. [Add note giving reference for chapter that introduces this concept.] The ecological footprint provides a measure of the environmental impact of a person's daily activities, including energy expenditure in the home and transportation and the impact of food consumption, among other factors. The "footprint" refers to the approximate area of land that a person uses through resource extraction, waste absorption, pollution, and other forms of environmental consumption. Various organizations have produced calculators, which individuals can use by entering information about their food, home energy use, and transportation, among other indicators. Some footprints include additional items, such as the sources of energy used in a community and other macro-structural factors which are beyond the control of individuals yet which affect the environmental impact of every individual's environmental impact. Using the information an individual enters into the calculator and national assumptions and databases, the ecological footprint program will indicate how much that person uses of the earth's land, water, and resources, usually measured in hectares. Most footprint calculators indicate how many planets would be needed if everyone consumed at the same level as the individual entering the information. (ENDNOTE to be created later: Examples of calculators can be found at http://www.myfootprint.org/ , http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/ and http://www.ecologicalfootprint.org/Global%20Footprint%20Calculator/GFPCalc.html, among others.] Ecological footprint calculators vary in the amount of detail and the specific questions they ask, and thus results for the same person will vary depending on the particular indicators used.)

The ecological footprint has become a widely used estimate of human impact on the Earth's land, water, and other natural resources. There is at least one variation, the **carbon footprint**, which measures the amount of greenhouse gas emissions produced by daily activities. The great advantage of the footprint model is that it provides, quickly, a vivid and easily comprehensible snapshot of personal ecological impact. Most calculators also permit users to see how their footprint would change were they to modify certain factors, for example by eliminating meat from their diets or switching from a private car to public transportation. However, the footprint model has received criticisms for failing to account for differences among social groups within nations, as well as for simplifying the complex processes by which humans use and degrade nature.

Similar criticisms are made of Paul Ehlich's IPAT equation, discussed in Chapter 2. The IPAT equation, first introduced in the early 1970s, suggests that environmental impact as the result of a combination of social and technological factors. The formula proposes that ecological impact (I) is the product of population (P), affluence (A) and technology (T). IPAT was valuable as one of the first efforts to think systematically about the ways that technology, social factors (especially wealth), and population combine to affect ecological processes and natural resources. This attempt at integration makes IPAT an important piece of the history of sustainable decision-making. However, the formula has been criticized for a variety of shortcomings, including that it is over-general and

addresses only limited impacts on limited resources. Certainly the equation is not especially helpful for individuals, households, or even businesses that hope to implement more sustainable decisions and practices.

However, the IPAT equation does highlight a fact that is vital for thinking about sustainability: environmental impact is tied to wealth, for both individuals and societies. Per capita resource usage tends to increase as affluence and technology grow. This is true because greater wealth usually leads to more use of private cars (and to larger cars, driven more often), more meat consumption, larger homes, more garbage production, and so forth. Thus residents of wealthier nations generally consumer more and have larger footprints than those in poorer nations. Even within the same country, more affluent residents generally consume more than poorer ones. However, the link between affluence and environmental impact is not always straightforward. The IPAT formula includes technology as an important dimension. For example, some wealthier nations use fewer resources than others, reflecting factors such as greater energy efficiency in housing, greater use of alternative energy, better public transportation, and lower consumption of meat and highly processed foods, among others. For example, most European nations have much lower per capita resource consumption than the United States. This is true even for some nations that have better quality of life indicators (such as life expectancy, infant mortality, and education) than the U.S. In addition, resource consumption and ecological footprints of some developing nations, notably China and India, have expanded very rapidly in recent years.

The links among quality of life indicators, environmental impact, technology, and affluence are crucial for thinking about sustainability. As an integral measure of social, economic, and environmental factors, sustainability cannot simply be measured by environmental impact. Unfortunately, measures of social and economic impacts are not as widely available as are the ecological footprint calculators. While they are not measures or calculators, there are marketing programs that provide some indication of social goods and costs, such as those reflecting the use of Fair Trade practices, which certify that a product has been made without exploitative labor practices. Union labels also reflect a generally higher degree of employee compensation and benefit and thus of social goods. These indicators, however, are partial and are available on a limited array of goods. It is impossible, at present, to calculate the overall social impact of a product or activity in a way akin to the ecological footprint. Similarly, it is difficult or impossible to measure economic goods such as efficiency, productivity, or durability. The distortion of market mechanisms by factors such as advertising and government subsidies means that the law of supply and demand does not consistently weed out poor quality products or inefficient production processes. The calculation of sustainability's economic and social dimensions, in other words, is much more difficult than the calculation of ecological impact – which itself is complicated enough.

Nonetheless, people seeking sustainability in their work or their personal lives must try to weigh ecological, social, and economic factors in relation to each other. This entails

questions that are difficult to answer at collective levels, such as whether greater use of natural resources corresponds with higher levels of social goods such as education, employment, or life expectancy. If so, can resources be used more efficiently without reducing important social goods? Which benefits are essential and which might be reduced or eliminated? Will people be willing (and able) to pay more for some environmental or social goods? These questions are still challenging but perhaps more manageable for individuals and families. Obviously science and technology play an important role in answering these questions, as does public policy and corporate responsibility. However, individual choices can also have a significant impact on the ability of a community or entire nation to achieve greater sustainability.

Information, Knowledge, and Sustainable Decisions

The discussion of ecological footprints and other ways to measure environmental, social, and economic goods reflects the importance of accurate information. Before we take action, it is important to know, as well as possible, what the likely outcome will be. This is especially true for consequentialist (goal-oriented) approaches to ethical decision making, such as utilitarianism, but even in other ethical frameworks, it is usually important to calculate both the feasibility and the likely results of a course of action.

Research and accurate information can help answer questions that are crucial first steps before we act to achieve sustainability. Because sustainability is an integral concept that encompasses so many factors, it can be difficult even to frame the important questions, let alone answer them accurately and fully. Individuals may be overwhelmed by questions such as these: Will the higher-priced hybrid car really reduce my ecological impact? Does paying more for fair trade certified coffee really improve the lot of agricultural workers in Colombia? Does the extra time spent taking the bus instead of driving really improve my community's air quality? If I vote for higher taxes, will my local government use those funds for projects that improve social goods for residents? What will be the long-term impact of my present choices on my children's attitudes, practices, and quality of life?

Such questions cannot be answered without accurate information, scientific and other. Such knowledge is a crucial first step in the effort to make more sustainable decisions. People need to know about the costs and likely consequences of acting on principles, including the principles of sustainability. However, accurate information is not, by itself, a guarantee that people will act on their ethical commitments. Even when people have accurate knowledge about the costs, benefits, and likely results of an event, their decisions hinge on a host of other factors. This conclusion is reinforced by research about conservation behavior and environmental education, among other topics. People know that driving increases greenhouse gases, but even people who are worried about global warming rarely reduce their driving or purchase more efficient vehicles solely on the basis of environmental concern. The gap between values and practices is well illustrated in surveys of environmental concern, although it extends to other moral issues also. Studies consistently show that around 80 per cent of Americans regularly express strong environmental concern, a much smaller proportion translate their environmental

concern into concrete changes in their everyday practices. Fewer than 20 per cent regularly participate in environmentally responsible behavior, e.g., recycling, reducing consumption, or activism. Political behavior also remains largely unaffected by expressed environmental values. In an October 2005 poll, 79% of respondents favored stronger environmental standards but only 22% said environmental issues play a major role in determining their votes (Duke Poll 2005, see also Kempton, Boster, and Hartley 1995). In sum, most people worry about the environment and say they care about it, but very few take effective steps to help it. Similar conclusions can be drawn by expressed concern for social goods such as public education, help for needy children, and so forth. Even people who value these goods sometimes hesitate to vote for higher taxes to fund them. Similarly, even parents who know that excessive television-watching or junk food is bad for their children may find it difficult to enact strict limits on these activities. Knowledge, in sum, may be necessary but is far from sufficient for long-term behavioral change.

This is because decisions about how to act, including decisions about something as complex as acting on the basis of an ethic of sustainability, are influenced by multiple and complex factors. These include personal commitments and loyalties, peer support and criticism, and good examples, among others.

* Martha, is this where you want to add a short summary or mention of the theories of Planned Behavior and Diffusion of Innvovation, with reference also to the discussion on these in Ch. 9?

Such interpersonal and emotional considerations are often more important than calculations of cost and benefit. Further, both interpersonal and rational factors must be embedded in social networks and structures that encourage and support principled action. This is evident from studies of conservation behavior, which show that ease of access is especially important (McKenzie-Mohr and Smith 1999). Similar results have been found in studies of parenting, which suggest that it does indeed "take a village," or at least strong and enduring social networks, to succeed in following many child-rearing recommendations. People can have all the information and desire in the world, but if they do not have accessible ways to enact their values they will be unable to do so. Sustainable behavior by individuals depends, sometimes in very large part, on large scale factors such as urban and regional planning, tax structures, food production and distribution systems, and educational policies.

Problems of Distancing and Individualization

The complexity of the relations among different scales is one of the most important complicating factors in sustainable decision-making. Sustainability is more than the sum of its parts, not only because it integrates environmental, social, and economic goods but also because it is affected by and implemented on different scales. Sustainability is a collective, social goal, which is influenced by individual choices but not solely determined by them. People who aim to act on the ethics of sustainability find that there

is no easy way to understand the impact or significance of specific individual choices in larger contexts. This is true in part because of the complex relationship among the different scales at which sustainable decisions and actions take place. These decisions and actions range from individual about, for example, what to eat for breakfast, to global processes over which individuals have little power. These different levels are interrelated and influence each other, although they do so in unequal ways.

One way into thinking about how the different scales are related and how they affect each other is through the environmental, economic, and social consequences of consumption. Consumption is an important piece of sustainability in itself, and it is also a good model for understanding the relations among different scales in relation to other goods, including economic and social values. Specifically, consumption helps highlight two issues that are central in the relationship between different scales of action.

The first is the problem of **distancing**, in which people do not directly experience the harmful effects of their behavior [Princen cite]. Distancing is the process of externalizing or misrepresenting costs through production processes and consumption decisions (Princen 2002: 126). Distancing results from consumers' lack of information about and sometimes their lack of interest in the ecological (and social and economic) effects of production and consumption. Often, people distance themselves from the problems caused by production and consumption processes because they are (or perceive themselves to be) "upstream" from the effects of their actions. This involves a temporal as well as spatial horizon. One can be upstream literally and physically, insofar as the harmful effects of one's actions materialize far away. The classic example of this phenomenon is the factory that dumps pollutants into a river flowing away from it, so that only the water downstream is contaminated. It is also possible to be upstream metaphorically and temporally, insofar as the harmful effects of one's actions are felt much later, beyond the life span of the actor. When people distance themselves, temporally and spatially, they are unlikely to act with the care required, for example, by the Precautionary or Reversibility principles. More generally, when people distance themselves from the damaging environmental effects of their consumption, they do not think about the likely consequences of their actions – and vice-versa. Distancing, in other words, both stems from a failure to understand the relations among scales, both temporal and geographic, and makes it impossible to think clearly about these relations.

The danger of distancing, as Thomas Princen summarizes, is that "When critical resource decisions are made by those who will not or can not incur the costs of their decisions, accountability will be low and what gets counted is likely to be financial capital, not social and natural capital" (Princen 2002: 129). When people with power do not experience the negative effects of their choices, in other words, they are unlikely to make changes that would reduce these effects, which are usually felt by people without power and by the natural world.

Distancing has been discussed primarily in relation to environmental problems, but the concept can also be helpful in reflections on the social and economic elements of sustainability. It is possible, in other words, to distance ourselves from the negative social and economic results of our actions just as it is from their ecological consequences. Our consumption and purchasing decisions, for example, may support industries that use unfair labor practices or that damage local communities, e.g., by shifting production and jobs to nations with fewer regulations and lower wages. However, few consumers feel their effects, other than those who work for the business or live in the company town. Most of us live upstream from the negative effects of our decisions to buy the cheapest possible product or shop at the most convenient store.

For people who want to live according to an ethic of sustainability, addressing the problem of distancing can be challenging. In a global economy, in which goods and services routinely travel thousands of miles, how can we reduce the distance between ourselves and the products we consume? One effort to reduce the social, economic, and environmental harm that can be caused by "distanced" consumption is the movement to buy food and other products locally. "Buy Local" advocates argue that buying locally-produced goods, direct from the producers or through farmers' markets or locally-owned businesses, increases accountability, fairness, and environmental stewardship. While these movements consist of many diverse elements, their centerpiece are farmers' markets and community-supported agriculture (CSA).

The CSA movement aims close the gap between consumers and farmers, by connecting them in a direct relationship that is social, environmental, and economic. Members buy annual or seasonal shares that entitle them to a weekly bag or box of seasonal produce and sometimes also herbs, flowers, eggs, or dairy products. More than 100,000 CSA members currently buy shares from over 1,000 farms in North America, most of which produce organic or otherwise sustainably produced products. CSAs eliminate the middlemen required for conventional marketing and thus make it possible for farmers to receive better returns. Because members share risks and production costs, farmers are less vulnerable to economic and natural crises. Finally, CSAs link consumers directly to local food producers and increases their knowledge of the local "foodshed."

The CSA movement reinforces all three main goals of sustainability – economic, social, and environmental – by reducing the distance, both literal and metaphorical, between consumers and producers. However, buying locally is far from a complete solution to the environmental, social, or economic challenges of sustainability. It is important to note, for example, that when people in the U.S. and other wealthy nations buy more locally-produced goods, the markets for fair-trade, organic, and similar products produced in the Global South may diminish.

Many of the consumers and farmers who participate in CSAs are also involved in farmers markets, an old institution that has found new life in recent years as increasing numbers of people want to buy locally produced food directly from producers. The number of

farmers markets has increased rapidly throughout the U.S., in small towns and large urban areas, with 4,385 markets operating weekly in 2008, according to the U.S. Department of Agriculture (USDA) (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5072472&acct=frmrdirmkt). That figure has grown 6.8 percent since 2006 and more than doubled since 1994. Further, the USDA probably substantially under-reports the actual number of markets around the country, many of which are not officially registered.

As farmers markets and CSAs have grown, so has infrastructure and movements to support these and other local food programs. A number of certification and marketing programs promote locally grown and harvested food and help consumers find farmers, markets, and stores. (A good example is "Buy Local Florida" (http://www.buylocalflorida.net/.) Related movements include those that assist people who want to grow their own food, either in traditional backyard gardens or with "edible landscapes" that incorporate fruit and nut trees, berries, herbs, and vegetables as both landscape elements and sources of food. For people who do not have garden space in their homes, there are urban and community garden movements. This can be a family as well as community activity, bringing parents and children together to learn and have fun as well as build social networks – all while producing healthy and tasty food. A number of private and public schools have also begun vegetable and herb gardens that educate children about food and gardening, beautify campuses, offer opportunities for exercise, and provide food for school lunches. The "100 Mile Diet" (http://100milediet.org/) encourages people to eat food grown and produced near their homes. An umbrella term for these various movements, "locavore," was selected by the *Oxford American Dictionary* as the word of the year for 2007, reflecting the increasing popular as well as scholarly significance of localist movements.

The Slow Food movement, which originated in Italy in the late 1980s and has since spread to over 130 countries, also promotes eating locally and seasonally. Slow Food "was founded in 1989 to counteract fast food and fast life, the disappearance of local food traditions and people's dwindling interest in the food they eat, where it comes from, how it tastes and how our food choices affect the rest of the world. To do that, Slow Food brings together pleasure and responsibility, and makes them inseparable" (www.slowfood.com). The relevance to sustainability is evident, insofar as Slow Food advocates see their approach to eating as strengthening local community and family structures, supporting local economies, and reducing the ecological impact of food production and distribution. Slow Food's philosophy is supported by research on, for example, the importance of family meals for children, especially during adolescence. Children who regularly eat dinners with their families tend to do better in school and have less risk of destructive activities such as drug or alcohol abuse. These positive behaviors are good not only for children and parents but also for schools and local communities. Stronger families, schools, and communities, in turn, are important foundations for the social and economic dimensions of sustainability.

Practical efforts such as the work of Slow Food and community garden advocates have been informed and celebrated by a number of recent books, including Gary Paul Nabhan's book *Coming Home to Eat* (2001) and Barbara Kingsolver's more recent bestseller, *Animal, Vegetable, Miracle* (2008), both of which document the authors' efforts to eat only locally-produced food for a full year. Prominent environmental author Bill McKibben also spent a year trying to eat only local food. Many guides to local eating and locally and seasonally-oriented cookbooks have also been successful, as have those informed by the Slow Food movement.

Although food received very little scholarly attention until recently, it is now one of the most widely discussed issues in environmental studies. While most advocates of local food highlight its social and economic as well as ecological benefits, academic work on "sustainable food" generally focuses on environmental issues. Thus, for example, scholars have researched the environmental benefits of alternative approaches to food consumption, including locavore efforts to reduce the distance between producers and consumers. They have not, however, paid much attention to the other aspects of sustainability. However, it is not difficult – and can be very illuminating – to apply categories of analysis taken from environmental studies to other dimensions of sustainability. This is true for the concept of distancing, as noted earlier. The distance that production and consumption systems puts between us and the consequences of our actions can lead to social and economic, as well as environmental, harm.

Another helpful category from environmental studies scholarship on consumption is **individualization**, which refers to the tendency to think of social problems, including environmental harm, as essentially individual in both their causes and potential solution (Princen, Maniates, and Conca, 2002b: 15). Individualization means, in practical terms, that people often believe that small scale actions – such as planting a tree or riding a bike – can make enough difference to "save the world" (Maniates 2002: 43). When we individualize responsibility for environmental problems, we ignore the ways that large-scale patterns and institutions, including economic systems and the nature and exercise of political power affect individual consumption patterns (Maniates 2002: 45). We think that the decision about, for example, whether or not to drive to work alone reflects only private factors, such as personal preferences, family lifestyle, and economic circumstances. Further analysis, however, quickly reveals that such decisions are also heavily influenced by structural factors such as the availability of public transportation, the safety and accessibility of pedestrian and bicycle routes, and the location of businesses and other public and private facilities.

The failure to take seriously the larger social forces that shape purchasers' decisions often leads to wrong diagnoses of causes and ineffective efforts at solutions. We may think that educating people about the consequences of a particular action is all that is necessary to achieve lasting change. This is wrong for at least two reasons. First, individual behavior is heavily shaped by social and institutional factors, including ease of access, peer support and pressure, and the presence of good examples. Individual factors

such as the amount of information or education that a person receives, or even personal values and convictions, do not by themselves motivate changed behavior (McKenzie-Mohr and Smith 1999). When we individualize responsibility, in other words, we misunderstand what motivates, facilitates, and sometimes obstructs practices.

Further, and perhaps more important, even when individual behavior does change, the scale is not adequate to address the major environmental (or social or economic) problems that we face. Thus in addition to changed individual behaviors, such as using public transportation or eating locally, environmental and social problems require changes in regional and national policies and institutions. Such changes might include increased miles per gallon standards for cars, greater funding for public transportation, and an end to the perverse subsidies that encourage environmentally damaging agricultural production, among many others. This is not to say that individual behavioral changes are not necessary and important – they are, as we will discuss at more length later in this chapter. However, we cannot make our personal practices matter unless we understand them in larger contexts.

Like distancing, individualization is a problem not only in relation to the environmental impacts of consumption but also for sustainability more broadly. There are no purely individual solutions to social problems such as racial and gender inequality or homelessness, nor to economic problems, including the banking, housing, and employment crises that appeared in 2008. While individual practices can contribute to these problems or to their solutions, individuals as individuals can neither cause them nor end them. This is true for all the social, economic, and environmental dimensions of sustainability, which is a collective goal that can be achieved only by collective efforts. Such efforts must include large-scale changes in public policy, infrastructure, land use, and economic institutions, among other factors. If we think about these problems as distant from us, or as merely personal issues, we fail to understand their causes and potential solutions.

While we should not think about individual actions in isolation, individual and personal practices are important and necessary in order to support institutional changes, in the marketplace, in community and civic organizations, and in government from local to national levels. They can also be valuable in a host of other, perhaps less tangible ways, including setting examples, showing possibilities, and creating community. Again, seeking sustainability is always a multi-faceted and challenging task. It involves thinking about environmental, social, and economic issues. It requires thinking about different geographic scales, from the local to the global. It entails thinking about individual actions as well as their systemic and structural contexts. Perhaps most of all, understanding and seeking sustainability demands that we think about the relations among these various dimensions, scales, and levels.

Making Personal Sustainable Choices Easier

Even though people cannot solve problems of sustainability at individual level, they do have opportunities to be more or less sustainable at every level. Our personal actions, no less than our professional ones, can contribute to the social, environmental, and economic goals of an ethic of sustainability or detract from them. As noted in Chapter Nine, sustainable decision-making in professional contexts is a complex, multi-layered process. Many of the issues that arise in professional settings also appear in personal and civic spheres of our lives. In this section, we outline some of the obstacles and facilitators of more sustainable behavior, in order to help people achieve greater sustainability in their domestic as well as professional lives and understand some of the common threads that connect the two spheres of action.

Obstacles to Sustainable Behavior

As suggested above, the obstacles to sustainable behavior are both individual and structural. Individual factors include lack of knowledge, lack of time, financial limitations, and personal preferences and desires. Theories about environmental and social behavior discussed in the previous chapter, including the Theory of Planned Behavior and the Theory of Diffusion of Innovation, can help to organize and understand these factors and their interactions. These factors often combine, even in a single example. Food provides an illuminating case study. First, many people lack knowledge about where to buy more sustainably produced foods, or even what foods are more sustainable. Even if they do know which foods are produced in more environmentally and socially responsible ways, they may lack the time to get to the farmers' market between 4 and 7 p.m. on Wednesdays, for example. Financial limitations may enter into the decision as well, since many products that would be considered more sustainable in social and environmental ways, including organic, free-range, and fair trade goods, can cost significantly more than the conventionally (and unsustainably) produced alternatives. Last, personal preferences are a powerful factor particularly in the case of food. People often prefer food that is familiar and find it difficult to make radical changes, especially when the kinds of changes that are more sustainable diet – eating less meat and more seasonal foods – require learning different cooking styles and developing new tastes. It is possible to make a similar analysis of obstacles for many other aspects of our lives – how we get ourselves to and from work, how we wash and dry our laundry, heat and cool our homes, and so forth. In each case, making changes toward more sustainable practices requires personal conviction and perseverance and also, in many cases, social and institutional support.

Individual factors interact with structural obstacles to sustainable behavior. It is difficult to stop driving single-passenger vehicles, for example, when roads are not safe to walk or bicycle on, public transportation is inadequate, or regional planning has placed living, shopping, and working places far from each other. Poor or nonexistent park and recreation facilities prevent people from developing knowledge and desire for outdoor recreation and limit the development of social networks. Conventional agricultural production and distribution systems also reinforce unsustainable choices, by making less sustainable (and less healthy) food much more accessible and affordable than better

choices. Political structures, including government at local and larger levels, also influence the ways people can enact more sustainable practices in their everyday lives.

Between the structural and personal levels are community and interpersonal networks, which if strong can do a great deal to facilitate and support sustainable practices. If such networks are not in place – if people feel isolated or powerless – then it is much harder to act in a positive way. This has been the topic of much debate in recent years, especially around the concept of "social capital." As defined by political scientist Robert Putnam, social capital is "connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them" (Putnam 2000: 19). Social capital is both a private and a public good. Strong connections to other people improve individuals' quality of life and also enrich the larger community in which they live. Social capital is also vital for robust democratic politics. Healthy public institutions – which are crucial for the achievement of greater environmental, social, and economic sustainability – require widespread participation in the networks of civic engagement that embody social capital [ADD endnote acknowledging work of Sam Snyder on social capital section.]

Putnam argues that social capital "has eroded steadily and sometimes dramatically over the past two generations" (Putnam 2000: 287). Other evidence supports his claim, including a 2006 study which concluded that not only have informal and formal networks declined, as Putnam notes, but close personal ties have also diminished in recent years. Declines in social networks and increases in social isolation are important for efforts to achieve greater sustainability for several reasons. Organizations and movement for sustainability, as for other kinds of social change, cannot succeed without both informal and formal social capital – the connections among participants that keep the organization together and effective. Social capital can significantly increase community involvement in local sustainability initiatives (Selman 2001). In addition, declining social networks make democratic processes less effective, so that sustainability advocates will not be able to change laws, policies, and institutions. Third, and perhaps most important, people who are socially isolated and lack deep and meaningful connections with others are less likely to act on their values – because they lack peer pressure, moral support, good examples, and social structures that facilitate environmentally and socially responsible behavior.

Facilitators of Sustainable Behavior

Like the obstacles, the facilitators of sustainable behavior are both personal and structural. If the primary personal obstacles to sustainable practices in the U.S. are lack of information, time, and financial resources, then it is reasonable to expect that more of these qualities would help people be more sustainable. More information about the environmental impact of different consumption choices, for example, can help people make better choices. Fortunately, excellent resources are available for this purpose. Among the best is *The Consumer's Guide to Effective Environmental Choices*, by Michael Brower and Warren Leon (1999), which outlines better choices in food,

transportation, and home energy use, the three areas of consumption that have the biggest effect on people's ecological footprint. Unfortunately, similar information and tools for the social and economic dimensions of sustainability are harder to find, although some fair trade and other market certification programs are helpful.

Again, simply possessing more accurate or complete information, however, is no guarantee of changed behavior. Additional factors are needed, including time and money to research the available options and to follow through on them. For example, well-researched books and articles can inform people that buying a high-efficiency dryer or refrigerator will lead to a major reduction in their environmental impact, but obviously people cannot act on this information without the necessary financial resources. Similarly, learning that bicycling is the most efficient way to transport oneself will make a difference in actual resource consumption only if they live reasonably near work, school, and shopping. (And what "reasonably near" means varies, of course, for different people – some commuters regularly bicycle ten or fifteen miles each way to work, while others consider a mile too far.) Similar considerations hold true for other changes toward more sustainable behavior – it might be hard to purchase fair trade or union-made goods, for example, without traveling a long distance or paying an untenable premium.

While time, money, and knowledge are important, it turns out that they are not adequate or even necessary to change personal practices or even personal preferences. Social support, peer pressure, religious and moral convictions, habit, and structural factors are probably more important in helping people act in more sustainable ways. Research has shown that accessibility is especially important – people will change to more sustainable practices when doing so does not require major changes in their daily routines. They are much more likely to recycle when they can do so by simply dropping cans or papers into a household bin for curbside pickup, for example, rather than having to carry recyclables to a central location. Similarly, people are more likely to donate money to a good cause when they can do so by checking a box on their tax or payroll forms, or to purchase fair trade goods when they are available at the same store where they regularly shop. This holds lessons for sustainability professionals: in order to make better behavior more widespread and more lasting, we need to make that behavior easier. Curbside recycling is an excellent example of how this can happen. In the past couple of decades, almost every community in the United States has combined recycling pickup with garbage services, leading to great increases in the amount of goods that are recycled. While valuable, however, recycling must be complemented with other ways to reduce resource consumption – and those cannot all be accomplished with changes that are as simple and easy as curbside recycling.

Many sustainable practices, including some with the biggest potential impact, require more deliberate and sometimes costly or inconvenient behavioral changes. Rather than choosing the organic carrots located directly next to the conventionally grown ones, for example, a much more significant and difficult change is to get people to the carrot section to begin with, which may require persuading them to make radical reductions in

their consumption of meat and processed foods. Such changes requires changes in individual preference and habit that are facilitated not only by self-discipline but also by peer support, community leadership, good examples, and also time to experience the more positive consequences of some changes, such as the health benefits of eating food that is less processed and lower on the food chain.

Sustainability professionals often have expert knowledge about these issues, but that does not make them exempt from the pressures and inclinations that affect other people's behavior. Even when we know a great deal about the environmental or social impact of certain choices, in other words, we are still subject to limitations on our time and financial resources, to personal preference and habit, and to the demands of family members, among many other factors that shape our behavior. Similar complications often enter into the professional decisions that we have to make, when costs and benefits must be weighed, or when the interests of various people must be taken into account, or when social and environmental goals conflict. In all such cases, the most sustainable and responsible option is not to throw up our hands because the situation is overwhelming, but rather to gather as much information as possible, to evaluate the options carefully, and to make the best decision possible in the circumstances – learning, in the process, how future decisions might be made easier.

Sustainable Practices

There are countless ways to explore and define sustainable practices, in personal as well as professional aspects of our lives. One informative starting point, especially with regards to environmental impact, is *The Consumer's Guide to Effective Environmental Choices*, mentioned earlier. The authors acknowledge that learning about the ecological impact of our daily practices and seeking to reduce this impact can be bewildering and suggest that instead of trying to fix everything, consumers focus on a few areas of consumer behavior in which specific changes can make a real difference. These areas are food, transportation, and home energy use. Other behavioral changes, such as recycling, using cloth diapers, and choosing paper bags at the supermarket, simply do not have the kind of impact, the authors contend, and thus overwhelmed consumers should focus their time and energy on changes that will really matter.

In regards to food, people can reduce their ecological impact first and probably most importantly by eating less meat. Meat production requires large amounts of resources, including water, land, and fossil fuels, per calorie. The production of beef has led to the deforestation of many regions, including the Amazonian rainforest. Factory farms (known as "confined animal feeding operations," or CAFOs) raising chickens, pigs, and cattle cause severe air and water pollution in the U.S., including major responsibility for the "dead zone" in the Gulf of Mexico. Other dietary changes that can reduce ecological impact include eating more locally- and organically-grown food, eating food that is in season, and reducing consumption of highly processed food, both in fast food restaurants and from grocery stores.

In regards to transportation, the authors of *The Consumer's Guide* recommend both driving a more fuel-efficient vehicle and reducing the amount of driving that one does. They make familiar suggestions, including car-pooling, bicycling, walking, taking public transportation, and combining trips to reduce miles traveled. They acknowledge that some of these changes may be difficult, requiring infrastructural changes such as the construction of bicycle lanes or the extension of bus and train routes. With home energy use, the obstacle is frequently cost. Insulation, energy-efficient windows and appliances, and solar water heaters can be expensive. Policy changes to subsidize conservation and alternative energy will be necessary to make these options available to many consumers.

Each of these aspects of our lives is connected to the social and economic, as well as environmental, dimensions of sustainability. As noted in the discussion of local food movements earlier in this chapter, food choices (and the agricultural implications thereof) provide an excellent way to think about social, economic, and environmental aspects of sustainability together. Most simply, our environmental impact is lowered by eating more food that is locally grown and processed, that is plant-based, and that is organically produced. Happily for people seeking more sustainable choices, many of the more environmentally friendly food options are also more socially and economically sustainable. Locally grown and processed food, for example, is good for the local economies as well as for the natural environment. Eating less meat leaves more acreage available to grow grains and beans that could help reduce malnutrition nationally and internationally. Organically produced food helps reduce our dependence upon fossil fuels, which is economically as well as environmentally devastating. In addition, social and economic facets of sustainability can be addressed by seeking out goods, such as coffee and chocolate, that are produced and traded according to fair trade principles, and by avoiding foods that have been produced with unfair labor practices.

In regards to transportation, sometimes social and economic dimensions of sustainability are related to both production and consumption. For example, some automobile manufacturers have found that their economic health is related to production of more fuel-efficient cars. And sometimes social community is strengthened when people come together to discuss and share their interests in, for example, hybrid or biodiesel technology. The connections among dimensions of sustainability are even more readily apparent when we think about transportation beyond personal automobiles. For example, traveling by bicycle, foot, bus, or train can build social capital and networks in a way that long, solitary commutes in private cars never do. When we get out of our cars, we are more likely to notice and interact with other people. Many informal interactions – waving to neighbors as one walks to the bus stop, chatting with other cyclists stopped at the same light, exchanging news with fellow bus or train commuters – can build knowledge, trust, and concern that are the foundations of civic engagement. In a longer-term perspective, communities that are not designed around private automobile travel are more socially and economically sustainable in a number of ways. Pedestrian malls, greenways, and bicycle paths all increase social interactions as well as reducing energy use.

The kind of insulation or appliances we have in our homes may seem to have little effect on the larger social and economic dimensions of sustainability, but choices about where to buy as well as what kinds of products to buy can strengthen economic and social sustainability. Further, some housing choices can make a difference in these areas. For example, residents of urban areas can choose to live in close-in neighborhoods rather than distant suburbs, which can reduce commute time, leaving time for formal and informal activities that build social capital and civic engagement. Some kinds of neighborhoods – with front porches, sidewalks, and green spaces like parks and community gardens – facilitate social interactions much better than other kinds. People can choose places with such amenities or work to create them. The benefits are often multiple, as community gardens can provide locally-produced food, while sidewalks can make it more pleasant and safe for residents to walk to school, work, or shops. Social capital and engagement are also strengthened when people organize neighborhood projects such as clean-ups of parks or schools, child care cooperatives, or tool libraries, among many options. Informal activities such as these can provide training and encouragement for people to become engaged in more structured ways, such as participating in local government or boards.

Many of these practices can be carried over, in some ways, at workplaces. Many science and technology professionals may think about sustainability in relation to their professional activities, such as creating more energy-efficient buildings or researching better agricultural methods. However, both work activities and workplaces can become more sustainable also by following some of the recommendations discussed here in regards to household activities. For example, workplaces can be located on train or bus lines, offices and laboratories can be made more energy efficient, and workers can be encouraged and rewarded for involvement in local communities.

Conclusions

Sustainability is always an integrated process with multiple loops and synergies. Just as the social, environmental, and economic dimensions of sustainability can reinforce each other, so can sustainable practices at work and at home. Professionals, as citizens, family members, and consumers, can reinforce the values of sustainability on multiple fronts, by first educating themselves about the choices that will make a difference and then seeking changes – personal and structural – that can enable those choices to take root. We cannot transform our society if we isolate sustainability in one aspect of our lives. Instead, we must see and seek out connections among diverse activities at work, at home, at school, and in the community.

While individual activities are not, by themselves, sufficient to create a more sustainable society, they are invaluable. Individual practices can help initiate and reinforce structural changes. For example, increasing consumer demand for locally- and organically-produced food encourages producers and distributors to make it available. Large-scale policy changes are necessary to transform the national food production and distribution

system, but such changes may never get a start, even at a local level, without the pressure of individual choices. Such choices not only build support for policy changes but also provide good examples that inspire other individuals to undertake more sustainable practices. For example, watching a neighbor bicycle to work or walk her children to school can inspire others to try the same, whereas without that personal connection these changes might not seem possible or desirable. Personal connections also make sustainable activities more enjoyable and thus more likely to continue. Planting a garden or cleaning up a school can feel like work when done alone but fun when done in congenial company.

Glossary terms
Carbon footprint
Consumerism
Distancing
Ecological footprint
Individualization
IPAT
Locavore

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