The Social, Business, and Policy Environment for Green Manufacturing

2

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The world will not evolve past its current state of crisis by using the same thinking that created the situation.

Albert Einstein

Abstract

The chapter introduces readers to the pressure for change, the themes of the transitions taking place, and the steps suggested for moving forward in the social, economic, and policy environment in which green manufacturing resides. The concept of sustainability related to manufacturing with an emphasis on the metrics, standards, and best practices associated with instituting green manufacturing on the path to sustainability is defined. The drivers for change and progress and the difficulties, hurdles, and benefits associated with transitioning to green operations are discussed.

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2.1 Introduction

Manufacturing, like farming, is one of the very few means of creating wealth. It is also a crucial component of a sustainable society. Numerous items, ranging from energy collectors to medical devices, will be required to realize a world where intergenerational and intra-generational equity is promoted and everyone has access to the items necessary to foster their well-being. In recent decades, there has been a societal shift towards sustainability, or "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1]. Not everyone agrees on what these goals for a better future are—nor how to obtain them—but contemporary evidence suggests change is imperative. The Earth's climate is changing; the world is losing its biodiversity; and the existence of contemporary society is threatened.

2.1.1 Understanding the Need for Change: The Desire for a Better World[1]

In contrast to the ideal systems posited by sustainability advocates and manufacturing futurists, conventional manufacturing has negative environmental and social externalities. Manufactured products and capital for production (including infrastructure, machines, tools, and factories) tend to be created though traditional structures which are inefficient and cause negative impacts. Waste, pollution (to air, land, and sea), and large ecological footprints are all signs of this inefficiency [2]. Manufacturing practices also create significant greenhouse gas emissions.[2] Yet, adapting these practices to be more efficient is difficult because the vast majority of manufacturing operations are tied to a supply chain over which individual manufacturers have little control. Many companies have been criticized for social issues associated with their supply chain, including a lack of health and safety standards, poverty prevention strategies, and measures to support any human rights abuses that occur in the communities in which they operate. Continued impacts of poverty and climate change have been pressures for manufacturers to change their practices.

[1] This subtitle was inspired by the book, *Alternatives to Economic Globalization: A better world is possible* [3].

[2] A World Resources Report estimates that in the year 2000 global manufacturing and construction industry emissions accounted for 21% of world's greenhouse gases [4]. Additionally, the Intergovernmental Panel on Climate Change (IPCC) 2007 report states that industry made up 19.4% of the total anthropogenic GHG emissions in 2004 in CO_2 equivalents ([5], Fig. 2.1). In the US, industrial emissions accounted for 2,510 Million Metric Tons CO_2 equivalents in 2008, a quantity larger than that year's transportation, residential, or commercial emissions [6].

Due to these numerous harmful impacts, manufacturers face significant pressure to undertake quick and comprehensive change. Such transformations require movement beyond a mere awareness of green concepts to a fast and wide-ranging implementation of better practices. Despite daunting challenges of issues to address, forerunners have illustrated that appropriately transitioning to green business practices can be very lucrative; environmentally friendly and socially responsible policies can improve a firm's public image and mitigate risks resulting from inaction.

2.1.2 Values and Practices Are Changing

Because a number of societal actors have recognized these issues, and have subsequently taken action, modern manufacturers have been caught in the midst of a number of societal, corporate, and policy transitions. Because manufacturers affect numerous social and environmental issues, stakeholders are demanding more than business-as-usual practices and policy-makers are targeting manufacturers for change, relying on the specialized knowledge and ingenuity of the manufacturer to solve their concerns. Manufacturers are being pressured to help create a "better" world, where better is interpreted differently by the various stakeholders. As a result of this pressure, corporations are being forced to change to more socially aware and environmentally conscious operations and to effectively communicate this to their stakeholders and the public.

The distinct potential for manufacturers to take a leadership position and push society towards more sustainable practices is recognized at a number of governance scales. Past experience has shown that manufacturing can revolutionize systems if placed in the right environment and with the right incentives, as it did during the industrial revolution. Hargroves and Smith [7] created a diagram noting six "Waves of innovation of the first and the next industrial revolution" illustrating that innovations facilitated by manufacturers throughout the past couple of centuries, have supported major societal transitions from "steam power" to "information technology" and that the newest wave of innovation involves ideas like "renewable energy", "green chemistry" and "radical resource productivity."

2.1.3 Concept of Sustainability

People that are concerned about the sustainability of our current lifestyles are a very vocal and influential contingent searching for a "better" world. The concept of "sustainability" has been used to convey a number of meanings; however, at its most basic, sustainability implies that we as humans want our existence and or our way of life to be "maintained." Although the concept of sustainability is ambiguous and abstract, many people are striving for this goal precisely because of its pliable definition. Although the concepts of sustainability, the plethora of its associated

mechanisms, and the means of achieving it are heavily debated, it continues to be touted as a new ideal [8]. Sustainability theorists that adhere to this definition are arguing for the creation of fundamentally different societal systems based on new values. Their arguments have attracted stakeholders with various concerns to coordinate their efforts for change under the banner of "sustainable development," although these actions may be more specifically categorized under other domains such as "corporate social responsibility," "ecological design" or "industrial ecology." Because of the increasing use of the term "sustainability," a number of different conceptual frameworks have been used to focus the concept's meaning. A Venn diagram of three overlapping aspects consisting of "people, prosperity, and planet," or "equity, economy, and ecosystem" (along with a plethora of other figures) have been used to illustrate the overarching notions associated with this concept [9]. This was shown in Fig. 1.1 relative to manufacturing.

The goals and actions associated with this idea have a large conceptual range and often conflict. For example, some business people are revaluating the purpose of business, and its ability to help those in need. Instead of producing more nonessential products, some business people are targeting the needs of the larger, less-affluent proportion of the world population because they have seen the potential to grow their customer base and help people obtain with essential goods. Others critique these actions when they take money out of the country by not supporting local manufacturing operations and skills. Still other actors tackle different systemic issues with contemporary practices. For example, some people have identified issues with the current economic model and are working to change the focus of its metrics of success in order to restructure the rules under which all businesses must operate; alternative metrics to Gross Domestic Product (GDP) have been suggested; the idea of growth has been challenged; and alternatives like a steady state economy have been proposed [2, 7, 10, 11]. Overall this transition to sustainability supports a more holistic view and dialog about what society values and wants to foster, support, or persevere. Thus, in many cases, those advocating for sustainability are advocating for a fundamental restructuring of the values of our modern societal systems where a greater focus on natural limits can yield opportunities to create a "better" world. Chapter 5 will explore what goals these domains may include at the entity scale. Although, differing in their tone, motivation, and strategy of approach, many sustainability theorists are arguing that society has to restructure itself to fit within the bounds of Earth's natural systems. Different theorists and practitioners have approached this transition towards sustainability with varying foci [9]. For example, McDonough and Braungart [12], focus their goals on the transition of industrial systems, while Elkington [13] concentrates on alternative business principles. Others emphasize the role of mechanisms and tools to incite change or facilitate the transition to a system more in line with principles which govern the natural world [11].

This chapter, and the remainder of the book, will explore the role of contemporary manufacturing in the transition towards sustainability and discuss the current social, business, and political environments in which green manufacturers are

operating. The remainder of the chapter is dedicated to a survey of the social, business, and political milieu surrounding green manufacturing, and the difficulties, hurdles, and benefits associated with these environments when attempting to transition to a green operations.

2.2 The Social Environment—Present Atmosphere and Challenges for Green Manufacturing

> Interdependence is and ought to be as much the ideal of man as self-sufficiency. Man is a social being.
>
> Mohandas Gandhi

This chapter will illustrate that manufacturers are operating in a modern social environment determined by numerous stakeholders, both internal and external to their company, each of whom has concerns about how the company functions. However, the ideal role of a manufacture in a world that is marked with entrenched disparities and is threatened by significant climate risks remains undefined. Conventions for addressing social concerns are developing, although when attempting to address these types of issues manufacturers have to deal with the ambiguous nature of sustainability and the wide range of its metrics. Choosing what considerations to address is not a straightforward exercise. With this in mind, this chapter segment examines some of the implementation issues involved in addressing social issues. Chapter 3 will discuss current implementation of social metrics.

2.2.1 Applying Principles of Sustainability

How to successfully proceed and reap the benefits of utilizing sustainable principles and addressing stakeholders concerns is no easy task. Once convinced to take the step towards a sustainable enterprise, businesses have to decide on their new goal, strategy, approach, rate of change, and speed of exposure. These and a host of other factors will influence their ability to succeed and to ensure their transition to a more environmental and socially responsible company is advantageous. There are a number of scales a company can choose to address and a number of concerns to tackle. McElhaney [14] defines the magnitude of the various interpretations of corporate responsibility, by differentiating the role of a business as a company, as part of the community, as part of the industry and as part of the world. Each of these roles, McElhaney [14] implies, provides different opportunities for businesses to contribute to their areas of influence. He suggests scaled recommendations ranging from “Give something back” to “Transform an industry.”

A variety of internal and external frameworks exist to help facilitate the transition of individual companies and their stakeholders, as well as compare those companies to others.

2.2.2 Stakeholders

The modern environment in which manufacturers operate suggests that an implementation of both internal and external provisions will be needed to support social well-being. Social concerns at the internal level are commonly addressed by companies in terms of job security, benefits, and safety. Although, external measures that extend beyond employees working within the company's bounds have become more common. These measures address the needs of a variety of stakeholders, each with unique concerns. These stakeholders include the larger manufacturing industry as well as civil society agents (consumers, families of employees, and the community at large, which is represented by nongovernmental organizations (NGOs) and media) and governments.

2.2.2.1 Internal

A company can influence the satisfaction of internal stakeholders, through rewards, pay, and job safety and health. For this discussion, the interests of shareholders are not of great interest, as it is a company's legal obligation purpose to make profits. Meanwhile what is the appropriate level of provisions for equality, safety, and support for employees remains opaque and has different interpretations amongst various companies and their stakeholders [15]. Also up for debate is how far back in the value chain a company is responsible for working conditions. This may be more of a legal definition than an engineering one.

The treatment of employees is one of the most discussed issues regarding social sustainability. Concerns about working conditions have grown out of some highly visible problematic cases. Yet, beyond gross abuses, the precise definition of what constitutes decent working conditions is highly debatable. In general, the baseline for working standards includes the prohibition of human rights violations, such as forced labor, sweatshops, child labor, and high fatality rates. There are multiple diverging views of what entities are ultimately responsible for the well-being of individuals with which a company interacts. Some researchers are of the opinion that governments should be held accountable for ensuring the quality of life for their citizenry. Others believe it is the obligation of employers to provide a minimum standard of living for their employees. Still others view it as the individual's responsibility to create their own standards of living.

Yet manufacturers are at risk of intense criticism if any aspect of their supply chain is executed under inhumane working conditions. As with direct employment, issues of what working standards should be throughout the supply chain, and who is ultimately responsible for them arise. While manufacturers only have so much control over the working conditions of their suppliers, they do have a choice in where they source their components from, and can leverage this power to influence the behavior of their suppliers. Yet, it is unclear how deep into the supply chain a specific set of working conditions should be upheld or verified. Manufacturers generally have working relationships with their direct suppliers, which can make it easier for them to negotiate adherence to particular specifications. However, the same does not necessarily hold true beyond first tier suppliers.

All of these factors leave the most appropriate social standards for the treatment of employees ambiguous. Baseline standards exist to ensure that manufacturers are at least be cognizant of the human rights standards they should maintain. Such standards can be taken from Social Accountability International's SA 8000 standard, and the UN's International Labour Organization (ILO) conventions, Universal Declaration of Human Rights, and Convention on the Rights of the Child.

However many manufacturers do not recognize that employee standards offer an opportunity to gain strategic advantage. These standards hold some importance to consumers, as evidenced by their willingness to pay for products that are created under good working conditions [16, 17], such as fair trade products. Consumers have become increasingly critical of the working conditions under which products are created. While the public may not be aware of the exact conditions under which employees work, past incidents of poor working conditions have brought bad publicity to some of the world's largest producers.

Hawken et al. [2] offer an alternative interpretation of a company's workforce as human capital, for which any investments into generally yield a return. From this viewpoint, expenditures on the welfare or development of employees results in increased productivity or efficiency. However, determining the best social improvements that will have the greatest returns can be difficult. For instance, Azapagic and Perdan [18] note that high rates of employment improve social welfare, but at an organizational level may indicate process inefficiencies.

Whatever standards are chosen, verification of compliance for working conditions is especially problematic. For example basic commodities extracted under intolerable working conditions are indistinguishable from the same material sourced elsewhere. Wehrfritz et al. [19] note that this is the case in Malaysia, where there have been instances of rubber and palm oil being harvested under forced labor.

2.2.2.2 External

Stakeholders outside of the company are also part of the social framework of sustainability. Logan et al. [20] define corporate citizenship as the activities that make an organization accountable to its stakeholders, including employees, shareholders, consumers, suppliers, and the communities in which they are located. Similarly, some define social accountability as the total contribution that a company makes to society. For instance, Azapagic [21] states that social accountability is "related to wider responsibilities that business has to communities in which it operates and to society in general, including both present and future generations." Meanwhile the environmental interest group, Business for Social Responsibility [22], considers corporate social responsibility as a way of conducting business that meets or exceeds societies' ethical, legal, commercial, and public expectations. With these differing views of the social scope of manufacturing impacts, the following section provides an overview of the external actors that play a role in a manufacturer's social sustainability. These actors include the larger industry, consumers, NGOs, media and the community.

Consumer interests in issues of sustainability, such as human health, depletion of resources, pollution, waste creation, and climate change, have grown over the years. In the context of this chapter, the primary interest is in consumer's purchasing behavior, which can be a driver of more sustainable production. Meulenberg [23] defines sustainable consumption as a process by which social responsibility and impacts on future generations are incorporated with the needs and desires of consumers. Similarly, the ethical consumer sees a direct connection between their purchases and social issues, and expresses it through their product choices [24]. Cohen [25] points out that these consumers, a demographic known as LOHAS (Lifestyles of Health and Sustainability), spends upwards of $300 billion each year in the USA. Thus, finding ways to clearly communicate aspects of sustainability with this segment can have substantial financial incentives for producers.

The most direct social impact manufacturers have on consumers is the health and safety aspects of a product. In terms of sustainability, the question that arises is whether producers should take the initiative to improve the health impacts of their products. Some producers, such as Unilever, have done so through their dedication to improving the nutritional value of their food items. Also manufacturers would be well served by keeping mindful of the potential of contaminates in sourcing, as they are seen as responsible for any product impacts, no matter where in the supply chain contamination occurred.

One of the major goals of sustainability assessments is to trace the effects of business onto the world in which they operate. In particular, various research efforts have been dedicated to calculating the sustainability impacts that entities have on communities. These typically relate to: the equity of relationships between businesses and communities, the standards of living in communities where businesses exist, and the investments businesses make to improve such standards (e.g., philanthropic giving and development of infrastructure). Each of these issues is difficult to even assess because there is rarely a direct causational relationship between any one company's actions and the living standards of the surrounding communities. Furthermore, any improvements of these issues can only be achieved through the efforts of multiple entities such as businesses, government, and the population.

Companies often include information about their philanthropic efforts in their annual report. In addition some methodologies exist at the product level to identify goods for the impacts they have on workers and communities. For instance, fair-trade products are certified to ensure that agricultural workers are provided certain working conditions, and that international farmers receive equitable trade premiums. Meanwhile, the methodology for assessing community impacts at the process level remains unclear. Very little research has been developed on possible approaches to assess the social implications of different manufacturing processes at the time of this writing.

In general, community-based social impacts are the most subjective and hardest to determine of all social impacts. Beyond the complexities of measuring how any particular organization contributes to social conditions, assessing what these conditions are is complex. Many efforts to measure social conditions have been at the geographic level (e.g., national and city). For instance at the national level the

following sustainability assessments factor in social aspects: the Genuine Progress Indicator/Sustainable Economic Welfare [26], Human Well-Being Assessment (Well-Being Index) [27], The Human Development Index [28], and Indicators of Sustainable Development [29]. Many of these assessments attempt to adjust to replace the measure of GDP to include some social measures on issues like the population's health and education. At the urban level, Shane and Graedel [30] and the UN Centre for Human Settlements [31] have proposed methodologies to assess the sustainability of cities.

The way that one company treats its various stakeholders can influence others within the industry. Manufacturers often participate in industry level coalitions or voluntary agreements in order to build support to either drive an industry forward or to maintain the status quo. Through these associations, members can more easily influence acceptable standards for others within the industry. Some industries are notoriously associated with specific social problems, or munificently thought of and creating social benefits. By becoming more sustainable, industries have the potential to improve or maintain their impacts long term. Several methodologies have been proposed to assess the sustainability of an industry [21, 32]. These assessments not only calculate the economic, social, and environmental impacts of a given industry, but also help decision makers guide national development in a more sustainable way, through policies and subsidies.

Later in this chapter the role that government plays in affecting change from manufacturers through their policy is discussed. In addition, nongovernmental organizations push producers to improve their sustainability by working with them or fighting against them. Labor groups, such as unions, USAS, UN ILO, and Social Accountability International are well established organizations that have been challenging businesses to improve working conditions for a long time. Social rights advocacy groups such as the UN, MADRE, CorpWatch, and Global Exchange also work towards improving the impacts that manufacturers have on their internal and external stakeholders. More recently, environmental groups have been advocating for changes in production to address a multitude of issues. Media is also an important contributor to the proliferation of sustainability, as it is a means to expose consumers and the public at large to relevant issues. It can also be a gauge of the importance of any issue, because to be successful it must resonate with the public. These entities can expose abuses to employees or the environment, and the problematic nature of a product or certain types of products. However, with a growing number of alternative media sources, it is more difficult than ever for manufacturers to control their image.

2.2.3 Moving Forward

The social environment in which manufacturers operate is ambiguous, shifting, and volatile. Yet, the concerns of indecisive stakeholders can impact the image and operations of a manufacturer. Thus, an understanding of stakeholder concerns, as

well as influential concepts such as sustainability, and their associated metrics are all crucial elements for helping to insulate a company from future risk. Integrating that understanding into company operations can be done at a variety of levels; perhaps most important is demonstrating an understanding of the issues and what is at stake, the intent to do something about it, and a willingness to accept suggestions. This can be done in a variety of methods: by dedicating company resources to communicating about public concerns, by accepting the help of an independent NGO consultant, or by becoming involved in progressive policy creation.

> Regardless of the stakes, at this nascent state of change, it is difficult to fault those that seek advice, and either implement it with less than optimal results or reject it based on valid counterarguments. A new business operating ethic is emerging, where many manufacturers and consumers have begun to recognize that in order to make a sustainable society everyone will have to look inward, and consider if they have truly attempted to minimize their hypocrisy. Under this new raison d'être, an individual's adherence to these intentions can be tested with the "red face test," that is, can they be confronted with questions and scrutiny without turning red from naivety or lack of effort.[3]

2.3 The Business Environment: Present Atmosphere and Challenges

> Industry is a key partner for sustainable development. We rely on industry, not only for reducing the environmental impacts of the products and services it provides us with, we also increasingly depend upon industry for the innovative and entrepreneurial skills that are needed to help meet sustainability challenges.
>
> Former UNEP Executive Director Klaus Toepfer [5]

Understanding the varied desires of their stakeholders and the new focus on sustainability, a number of businesses have begun to reexamine their goals and practices to adapt them to better meet contemporary and future needs. Some have focused on expanding their markets to include the populations of developing countries by creating desirable and durable goods for the "bottom billion," while others have focused their redesign actions on internal operations and processes [34, 35]. An international coalition of 180 companies [36] states:

> We believe that the leading global companies of 2020 will be those that provide goods and services and reach new customers in ways that address the world's major challenges—including poverty, climate change, resource depletion, globalization, and demographic shifts (p. 4).

While certain types of these efforts are sometimes critiqued by anti-globalization activists and those who would prefer initiatives focused more on local self-sufficiency, a wide variety of social entrepreneurship activities have been touted under the ever-

[3] This comment was prompted by a conversation with Tony Kingsbury, SPS, Haas School of Business at Berkeley, where he discussed the usefulness of "a red face test."

expanding scope of corporate social responsibility [37]. These issues extend beyond social causes to environmental concerns, and addressing these matters has caused companies to reexamine their priorities and opportunities for profit.

2.3.1 Components of the Next Transition

In attempting to address these issues manufacturers have made use of sustainability principles. Increased awareness of social and environmental concerns has incited action in business, societal, and legal domains and the influence of sustainability principles can be seen in manufacturers' attempts to address these concerns. This can best be seen by three major manufacturing trends: the design of circular product systems to replace linear product systems; the provision of services to improve the design of product systems; and the construction of information rich management systems to supplement existing information pathways.

2.3.1.1 Environmental Pressures Suggest a Transition from Linear to Circular Systems of Production

Recent decades have been marked by stresses on ecosystems, an increase in resource scarcity, growth in waste, and a change of the Earth's climate. Because manufacturing systems contribute to these issues, theorists who care about manufacturing's impact on the environment have explicated the need to convert the linear systems of manufacturing to circular systems; researchers have suggested the need for more demonstration projects to further these theories; and governments have implemented zero waste policies, attempting to scale action.

Illustrative practitioners who call for a need of a more circular system are the authors McDonough and Braungart [12]. Their concept of "cradle to cradle" extends the responsibilities of manufacturers to all phases of a product's life cycle. To design a system of industry drastically different from that encased in our most recent industrial revolution, McDonough and Braungart [12] and Hawken et al. [2] suggest that the wasteful ineffectiveness of the current industrial system could be optimized if it was redesigned to have few harmful inputs or outputs and used resources judiciously. Natural systems have been used as inspiration for these redesigns. Benyus [38] advocates integrating nature as a "model and mentor."

In an ideal "cradle to cradle" cycle products and industrial byproducts are harmlessly reintegrated into the natural ecosystem or act as food for the next industrial process. McDonough and Braungart [12] have termed these systems as ones where "waste = food." Accomplishing this feat would require production facilities to be appropriately aligned with other participants within industrial parks or cooperative industrial networks [2, 12]. Hawken et al. [2] and those interested in a larger concept of waste also suggest that our industrial systems could be redesigned to concentrate on better allocating our human resources, in other words, not wasting lives. Hawken et al. [2] suggest that increased jobs can also be brought about by a closed loop system, because 75% of labor is associated with the production phase.

Regardless of ecological inspiration, companies have shown that what they previously considered trash can have value. The minimization of waste from processes, or reduction of the raw materials needed for manufacturing—through recycling, design for the environment, disassembly, or provision of increased maintenance—are strategies that can all have positive impacts on a company's bottom line. These actions are associated with a general shift towards including traditional externalities into decision making at all levels of production. Momentum for continued, more systemic action has been building: the UN has established initiatives on sustainable consumption and production; conventional corporations like Walmart have adopted a zero waste policy; and "green" pledges or actions, have become vogue.

Despite this inspiring vision and the (albeit sparse) examples of successful synergies, there are many barriers to the design of, transition to, and maintenance of a successful circular system. Change requires effort, knowledge of alternatives, and difficult decisions. The lack of control manufacturers have over their supply chain continues to impede these possibilities; at present it is difficult to coordinate, much less reimagine, the network of these upstream and downstream entities.

2.3.1.2 The Need for Greater Influence or Control Over the Company's Resources Suggests a Transition from Product Production to Service Provision

A different approach to managing one's product is needed due to the supply chain limitations manufacturer's face. Either a symbiotic network of different companies has to be engineered so that the value of the product and its waste are increased, or individual companies can transition to a service-oriented business model, rather than simply a product-based one. Ayers [39] enumerates three existing models for inter-firm cooperation, but it seems likely that more will be needed to make substantial changes.

Certain companies have illustrated that providing a continuous service, rather than solely a product, allows them to have better control over the lifecycle of their products because they must consider the value in taking back and reusing materials. Interface, Inc. is a company that has successfully refocused its vision on the service it provides, rather than the product. After Interface's founder and Chairman Ray Anderson provided a top-down mandate that inspired and incited bottom-up action, Interface began to rapidly implement changes. While the company still provided products, modular carpeting, they are designed with a service perspective [40]. For example, rather than requiring the customer to replace an entire carpet if they ruin a small portion of it, Interface's modular carpeting design created a system where small portions can easily be replaced. This strategy has worked to both improve sales and decrease costs.

Reexamining traditional product-oriented business practices requires a different perspective amongst all of the various stakeholders on the value proposition that companies provide for customers. For example, the ideals of industrialized societies stress the importance of ownership of "things." Companies, like Interface, that have successfully challenged this concept and have discovered that consumers can be satisfied in other ways while still meeting their needs. Gertsakis, Morelli, and Ryan

[41] cite a few examples of companies who add value to their products by implementing services that support a more circular industrial system. Xerox, Herman Miller Inc., and Appliance Recycling Centers of America Inc. (ARCA) focus on fostering the "value of utilization" via company initiated take-back programs, support of secondary industries, and models of product creation and maintenance that focus on the service that the product provides [41].

The refocusing of one's operation on the service value of a product is gaining more attention as people concentrate on ways to simultaneously improve the economic, ecological, and social requirements of sustainable development. The numerous benefits of green jobs, or "blue-collar employment that has been upgraded to better respect the environment and family-supporting, career-track, vocational, or trade-level employment in environmentally friendly field" [42] have been touted as a potential component of this transition. In addition to helping the environment, people suggest that these green careers also improve domestic employment rates because they are difficult to outsource; the installation and maintenance of solar panels, insulation, or other infrastructural retrofits, are all jobs which rely on manufactured goods and must be done on location [41].

The appropriate management of the physical flows of materials is important for enabling a transition to a more sustainable state. Closed loop systems of industrial symbiosis, eco-industrial parks, and industrial networks are some of the solutions that have been proposed to help our society reach this goal. However, enabling these physical systems at a number of scales will require novel management strategies.

2.3.1.3 The Need for Greater Transparency and Control Over Operations Suggests a Transition to a Highly Integrated, Information-Rich Communication System

Entities attempting to reimagine their practices are faced with intricate supply chains and complex internal and external governance requirements. Information rich management environments offer the opportunity to better achieve the management of sophisticated coordination feats and a new level of basic transparency to improve a company's accountability. Gersakis et al. [41] suggest that managing information about production processes and controlling the distribution of information to others along the supply chain are key requirements for existing models of closed loop systems to be successful. Additionally, they note that that the creation of symbiotic networks will require two forms of integration: "vertical," between companies in different, but related, supply chain sectors, and "horizontal," between similar companies that cooperate to gain a spatial or scale advantage [41]. Transparent operations help improve accountability and better illuminate the actions of the company to those who can react accordingly. Such information sharing could also facilitate cooperation and innovation among industries. Regardless of the strategy used, numerous theorists have lauded the implications of communication between internal and external company stakeholders. For example, Allenby [43] and other industrial ecologists encourage cooperation between manufacturers and their supply chain, even though he notes that a number of new legal challenges will arise out of the massive changes taking place. For example, certain types of

such attempts could put actors at risk of violating laws regarding the formation of trusts [43]. Yet, information intensive strategies could be used to support these logistical feats.

However, there is a lack of implemented tools that extend beyond company bounds to coordinate with other stakeholders striving for sustainable development. Implementing information intensive operations will require dealing with siloed processes, production, and information that have never before been made transparent. Although Strebel and Posch [44] note that there are lessons to be learned about sustainable resource management from existing recycling networks, existing tools, such as Environmental Management Systems (EMSs), may not be sufficient to facilitate this transition to an information rich environment. Additionally, scaling any changes will be challenging. Given the uniqueness of each industrial ecosystem, resulting from its specific actors, inherent values, chosen criteria, and interaction with other systems, the support devices that have been found to be successful for one industrial ecosystem cannot necessarily be easily replicated, nor appropriately adapted. Standardization of tools, processing languages, or the use of open standards may help to encourage innovative monitoring.

2.3.2 Moving Forward

Certain companies are discovering their ability to benefit from practices that address appropriate social, environmental, and economic concerns. People have realized that manufacturers, specifically, have the potential to be true leaders and innovative problem solvers, responsibly building products that meet world needs. Indeed, the past industrial revolution shows us that manufacturing can revolutionize systems if placed in the right environment with appropriate incentives. The benefits of implementing socially responsible practices and environmental standards have been extensively noted for both internal and external stakeholders. For example, a progressive and responsible company stance may improve the company's internal and external reputation, helping to retain employees and please consumers, translating into industry advantages and greater profits. Decreasing wasteful practices can also provide opportunities to save money, while improving a company's environmental performance. Additionally, actions to preempt legislation have allowed green businesses to mitigate risk and reduce insurance costs. In sum, business which have begun to think of the meeting of environmental, social, and economic objectives as opportunities, rather than constraints, have reaped rewards [2, 45, 46]. Yet, despite these potential benefits, not all industries are transitioning. The United Nations has formed broad and negative conclusions about industry progression towards sustainable development. Their conclusions note insufficient progress, hindered by a lack of partnerships, dialog, commitments and aid and the need for changes and action at all scales [33, 47].

Thus, there is a lot for manufacturers to do and a lot for them to gain. Whether attacking our systems of "stuff," "shelter," "cities," "community," "business," "politics" or "planet," there is a lot to be done and a lot of ideas [48]. Indeed, the

list of required changes is so extensive that it seems prudent to remain skeptical. Not everyone is going to be on board in what Elkington [13] calls the future "Chrysalis Economy." Although many companies have begun to transition their operations, Elkington [13] posits that the future of the corporate world will be formed by four very different types of companies, each requiring very different policy mechanisms to support or deter their tendencies. He predicts industry associations, government bodies, and public entities will all have a role to play in influencing their future paths and that the use of policy to facilitate the actions of forerunners and push latecomers will be necessary [13].

2.4 The Policy Environment—Present Atmosphere and Challenges for Green Manufacturing

> We now live in interesting times. ... Clearly government, the private sector, and civil society all have power and responsibility here. In this tripartite world, they all therefore have a part to play in solving the challenges of sustainable development.
>
> Hunter Lovins [7]

Because of its global reach, extensive product variety and large number of stakeholders, the manufacturing industry is seemingly caught in a mire of regulatory actions. These actions, or even the threat of such actions influence the way manufacturers do business, and while most are meant to facilitate a transition to a better state (whether promoting transparency mechanisms or attempting to level the competitive playing field socially, economically, or environmentally) their targeted actions can often have unintended consequences. It is no surprise, therefore, that stakeholders often see the role of policy as a carrot (reward) or a stick (punishment) [49]. Some argue that the need for regulation meant their business argument for green has failed [50]; others argue that, when properly implemented, it is tool to encourage change and make sure the social and environmental externalities are included in society's actions. Because of these varied ideas, a number of policy analysts, organize the wide realm of policy in a variety of ways. For example, Beder [51] condenses these influences on environmental and social policy into to six principles: "the sustainability principle," "the polluter pays principle," "the precautionary principle," "the equity principle," "human rights principles," and "the participation principle," but other academics parse up the domain differently. Yet, regardless of one's view, a better knowledge of the policy realm may help companies mitigate risk.

2.4.1 Changing Policy Trends

As the problems being tackled by stakeholders become more complex, the policies used to address these issues has become more reliant on the ingenuity of the businesses targeted. Some companies, understanding their need to mitigate risk, also seem to be more aware and open to mitigative or precompliance action.

This practice represents a change from past strategies. Traditionally, environmental legislation has mandated specific targets involving infrastructure, chemicals, or emissions [52, 53]. However, it is often the case that modern problems faced by manufacturers can no longer simply be fixed with specific and uniform solutions, but instead requires creative and customized redesigns. For example, instead of utilizing a straightforward technological solution to one specific issue, companies are now looking at redesigning their overall processes to avoid those negative impacts. A redesign of operations could result in byproducts that would not be harmful to the environment or could be used in different production cycles. Thus, as entities have begun to tackle the more holistic redesign issues associated with sustainability, environmental policy affecting stakeholders has also shifted, emphasizing the need to solve these issues through cooperation between businesses and those concerned about the businesses' impacts (stakeholders, regulators, etc.). There now exist multiple actors which rely on cooperation to set realistic industry goals. Of course, command and control strategies and regulation are still required, but in recent years the forces of some environmental policies have also relied on the use of regulations focused on specific goals and market mechanisms to incentivize companies to take action prior to formal legal mandates [43, 52, 54–56]. More specifically, since early 1990s, policies have begun to focus more on products because of their increasing presence in the waste stream and the impact of certain products' use stages [53, 57–59].

2.4.2 Fostering Cooperation

As the number of stakeholder concerns has multiplied, and the issues involved require more holistic design solutions, certain actors have begun to understand the need to work together to create solutions to existing problems. This idea of different actor roles and the idea of governance, rather than a focus on government as a lone actor responsible for environmental policy, has become more recognized as more stakeholders flex their influence [43, 59]. Indeed, many have recognized the need for government, NGOs, academia, the public, and corporations to cooperate in order to effectively "race" towards sustainable development [60].

Each of these actors can take a number of actions to support environmental action. Government can make and enforce legal agreements, support a market environment favorable to green innovation, and fund investments necessary to facilitate large-scale industrial changes (e.g., education, infrastructure, and research). NGOs and academics can help to inform the direction of the transition and provide other actors with guidelines and standards for consumption and action. The public can be responsible and educated consumers and buy items and services that match their values; their uses of dollars are votes for or against toxicity, human rights, and habitat preservation. Companies can also take a proactive stance to make sure they help to define the industrial transitions others desire to take place; indeed, they have the great power to both clean up their operations and create items that matter and influence their overall industry [7, 57].

This is not to say that everyone will cooperate and strive for these goals willingly—it is likely that certain existing power dynamics will require significant pressure and the maintenance of a contemporary regulatory system to change; however, a totally confrontational stance by all parties may not always be necessary. All of these actors have roles to play in defining and making the transition to a green economy [7, 55, 57]. Additionally, communication between internal and external company stakeholders will be crucial to aiding this transition. For this to occur, access to the quality information, at appropriate times, and in effective formats will be crucial for the success of entities exchanging information at multiple scales and new levels of complexity [61].

2.4.3 Moving Forward

Because of the large number of stakeholders, the policy environment in which the manufacturing industry operates is both challenging to understand and maneuver through. This suggests that it is important for manufacturers to understand the potential desires of their consumers and the broader frameworks emerging in certain critiques. For example, many criticisms of action are associated with the idea of sustainability and its common interpretations (e.g., social, environmental, and economic pillars). These understandings can be integrated into a company's operations through priorities and action in order to both mitigate risk and make a difference to those goals.

Taking action can involve a number of strategies. At the most basic level, education on priority issues and a public acknowledgment of what a company can improve is a crucial step to mitigate risk and to fostering an intelligent relationship with one's buyers. These types of open and well-meaning practices, if appropriately planned, can help to both ease tensions with potential opponents and illuminate a company's priorities for a larger audience. It can also help a company find innovative solutions to their most challenging problems. Promoting a culture of sincerity, honesty, and transparency is crucial to foster cooperation rather than scathing critiques from a potential adversary.

Because of their specialized expertise, it makes sense that manufacturers will want a say in creating policies to facilitate changes in their industries. A number of ways exist for manufacturers to influence policies. They can utilize tools to facilitate dialog on policies, or they can implement voluntary action to stave off formal policy. There are often opportunities for interested stakeholders to participate in calls for industry participation. Indeed, certain organizations are required to solicit industry or general stakeholder opinions [43, 57, 62]. Although informational tools are helpful for keeping up to date on the most pertinent issues and ensuring one's company conforms to the status quo of upcoming regulatory action, as a company and as a person, it seems more likely that one would be approached by policy makers and other stakeholders, if it is apparent that one is interested in these issues and is willing to work with others who may have different views. A variety of

resources exist to guide interested companies in the general direction towards a sustainable entity, but reaching the majority of benchmarks will require a significant amount of education and dedication.

Despite the critiques made of manufacturers, some believe that society simply cannot move at the rate of change required without the ingenuity, specialized knowledge, and resources of business. One can wear as many tee shirts or bumper stickers stating, "'You must be the change you wish to see in the world'—Mahatma Gandhi or 'Never doubt that a small, group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.'—Margaret Mead," but it is the manufacturers of those tee shirts, bumper stickers, laundry machines, cleaning products, and cars that have the greater ability to make such change happen.

2.5 Conclusion

> They must often change, who would be constant in happiness or wisdom.
>
> Confucius

Perhaps the question is not who wants to be a green manufacturer, but rather who does not. If being part of the next industrial revolution implies greater profits and positive impacts, while remaining static endangers one's business and our society's greater survival, it seems prudent to strive for goals of a healthy ecosystem, economy, and society [2]. Yet, the state of our world is far from this aim. Manufacturing is caught in a transition where social measures are vague and difficult to prioritize, and where the dominant business model is having its validity challenged. Not only do the frameworks to guide business forward vary in depth, breadth, and proof of application, but our system of governance is complex and difficult to navigate, much less create or uphold an appropriate level of coordination and order. Despite these inherent difficulties, perhaps the most important trait of this predicament is that it does include everyone. All of society is bound to suffer from a lack of change [63–66]. Indeed, many people already are. This means society has a greater reason than ever before to not only hope that change of the needed magnitude at the required speed is possible, but to take the needed action to make it happen. Manufacturers, more than most, are uniquely positioned to contribute to this transition and reap its potential rewards. This is recognized by business people and the public alike. Indeed, when Shellenberger and Nordhaus [67] placed the Chinese ideogram for "crisis" on the cover of their essay, *The Death of Environmentalism*, they noted on the next page that this was made up of two characters, "danger" and "opportunity."

As part of this transition, a number of people are advocating that society needs to transition from a largely detrimental system of production to one that is environmentally benign. This system also must promote a healthy workplace and economy. However, at times, these goals are in conflict with our contemporary practices and dominant systems of production. Hawken et al. [2] note: "For all their power and vitality, markets are only tools. They make a good servant but a bad master and a worse religion." (p. 261). Although businesses are situated in a changing

environment, filled with critiques regarding the best course of action; there are still profitable and ethical paths down which to proceed. Indeed, what Willard [46] calls a "perfect storm" of drivers for the next sustainability wave is present here and now. Impacts of climate change and globalization are made relevant to contemporary business dealings with the pressure from internal and external company stakeholders, who, although motivated by different criteria, are all concerned with the risks associated with these pressures. Because of the wide spectrum of issues to be addressed, and the speed at which change is required, the next wave of action will have to be more inclusive. We all will have a role to play.

The large number stakeholders involved in manufacturing are demanding change and require a new level of transparency, analysis, and action. Manufacturers have to be aware of the concerns of their stakeholders in order to mitigate their future risks and help build an acceptable future for all. Yet, stakeholders have to help facilitate such action.

With the ever-increasing plethora of products entering our waste stream, some might argue that we have progressed from craft to crap production; yet, this view is unjust, especially from the viewpoint of producers. Manufacturers excel at creating products to meet demand within the constraints of a larger economic system, and modern society's demands have been diverse, short-term oriented, and plentiful. Stakeholders have a role to play in helping manufacturers meet their demands, either by voting with their dollars or advocating that the government help green solutions compete.

In the future, a number of new trends will shape the role of the manufacturers. They may have to help address the needs of those suffering from lack of income and material disparities or those requiring tools to transform their society into an eco-efficient entity. People need practical means to reach their aspirations (although what those aspirations are may be an issue) and manufacturing may be able to help provide a type of this aid. These types of requests will require increased information management requirements, and increased cooperation between corporations, the public, and the governance agencies.

An examination of the policy environment in which manufacturers operate has also illustrated that government alone is no longer in charge of governance. The modern policy environment is complex and difficult to keep up to date on, much less be involved in. Yet, working towards understanding the goals of one's stakeholders and making strives to not only conform but push the boundaries of new actions towards being a sustainable company can help turn potential critics into innovation partners. Indeed it seems as though the new environment could be characterized by cooperation among forerunners, after all, we all have something at stake.

To make our transition towards a better system, we also need input from a variety of academic disciplines as well as business leaders and governance agencies who can implement the suggested changes. We are beyond a point where one solution could fix all our problems; instead, we require action on the part of all affected participants [7, 57]. Whether they include top-down guidance or freedom to incite bottom-up action, new multichannel communication will be crucial to

this forward progression. This will require horizontal and vertical means to communicate as well as cooperation between disciplines to quickly adapt good ideas to unique circumstances [41].

Antoine de Saint-Exupéry posited the following strategy:

> If you want to build a ship, don't herd people together to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.

Yet, longing for sustainable processes and a world where each person's dreamed version of social justice, a flourishing ecosystem and a healthy economy exists will not simply emerge from imagining this dynamic view. To reach this utopia, society needs a certain amount of utilitarianism. Despite this necessary motivation, manufacturers need actual steps on which to take action.

This chapter has attempted to introduce readers to the pressure for change, the themes of the transitions taking place, and the steps suggested for moving forward in the social, economic, and policy environment in which green manufacturing resides. Neither nuanced analysis of issues nor critical documentation of solutions can be accomplished in a sole book chapter, and, certainly, these authors do not have sufficient answers. Yet, there is something to be said for taking action, however slight, at a time when we all face significant pressure for deep and widespread change.

Sustainability is not solely what the societies of the world are looking for; when thinking about the future, most people are looking for something better. As Braungart [68] notes, a happy couple would not define their relationship as merely "sustainable" and in this same vein, those looking to improve the world at this time of crisis, are looking to capture the tenacity and creatively of people in need and truly reinvent the world. Unlike many actors, manufacturers have done this before. The industrial revolution dramatically changed society; our lifestyles, our environment and our economy and our embedded values. The next industrial paradigm shift will likely have to do no less [2].

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