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Fitting together the building blocks for sustainability: a revised model for integrating ecological, social, and financial factors into business decision-making

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Abstract

Companies committed to integrating sustainability concerns into product decisions are confronted with the daunting task of assessing hundreds, or thousands, of materials and goods. Further complicating efforts have been the rapid growth of environmental and social assessment principles, strategies, actions, and tools. The lack of clarity on how existing approaches are complementary or distinct has resulted in ambiguities about pathways forward for companies. This current state of the field highlights the need to draw out interconnections between the wide range of current work on integrating environmental and social issues into material, product, and other business decisions.

This article—developed through collaboration among several environmental, social, and sustainability-oriented researchers and practitioners—addresses this need through building upon pre-existing work [J. Cleaner Prod. 10(3) (2002) 197; J. Cleaner Prod. 8(3) (2000) 243]. It proposes adaptations on a framework for organizing the assessment field, including development of exemplary sustainable product characteristics and their inclusion in a ''strategic sustainable development'' decision-making model and process [J. Cleaner Prod. 10(3) (2002) 197]. The article also argues for an expansion of analytical approaches within this previously developed framework in order to highlight social aspects of sustainability and landscape-level issues. Finally, the article puts these elements together to describe a pathway forward for companies. In the conclusion, areas for future research are highlighted.

Keywords: Sustainability; Materials; Products; Principles; Assessment

1. Introduction

Consider a large retail business with thousands of products. Each product is comprised of a broad range of materials. Wooden chairs are held together with metal nails, protected by chemical varnishes, and completed with foam and fabric seats. Lawnmowers and garden tools are made of metals and plastics, requiring oil or fossil fuels to operate. Clothing is made from natural and/or synthetic fibers, sewn together with natural or synthetic threads, dyed, and often finished with an array of chemical treatments. Most of these products

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are sourced from, and manufactured in, numerous locations around the globe, which are connected through complex transport systems.

Within this context, imagine retail company mangers who are told to integrate sustainability factors into all product decision-making. Taking action on this corporate policy immediately raises a number of questions, such as:

- How do I apply sustainability concepts to the current retail context?
- Is there a process to follow?
- Are there overarching principles to guide this process?
- What strategies, actions, and tools are suggested?
- How do approaches and tools inter-relate? Which ones should be used in what contexts? Why?
- Are there criteria, and/or characteristics, used to distinguish, and request, more sustainable products?

This article provides a basis from which to begin answering these questions. It is the result of a two-day dialogue, convened in the spring of 2002, that included over 30 specialists from academia, environmental and sustainability NGOs, and businesses.[1] With representatives from sub-fields spanning from Life Cycle Assessments (LCAs), sustainable forestry (Forest Stewardship Council), through green energy (Green-e), participants reviewed ongoing work on related sustainability, material and product issues. The premise of the gathering was that there is a need for clarity on how businesses can begin considering products in relation to sustainability and what pathways exist for decision-makers to move toward use of more sustainable materials, products, and enterprises. This article builds on pre-existing work to highlight one process for businesses to follow in moving toward more sustainable practices.

Section 1 describes pre-existing work that synthesizes the sustainability, materials, products and services decision-making fields—developed through a similar dialogue process in Europe [1,2]—and suggests refinements to this approach. Section 2 argues for highlighting a set of high-level criteria and characteristics—that are distilled from the range of existing tools and approaches—for informing decisions. Section 3 suggests further detail to the "strategic sustainable development" decision-making approach with regard to social aspects of sustainability. Section 4 discusses the importance of landscape-level issues—including ecosystem structure and function, eco-regional variations, and cumulative effects—and offers several ways to consider these factors in decision-making processes. Section 5 lays out the process for moving toward more sustainability-focused decision-making within businesses. Finally, the article highlights future research needs.

[1] The full participant list included representatives from: the Forest Stewardship Council; Scientific Certification Systems; the Chemical Strategies Partnership; the Center for Maximum Potential Building Systems; Seigel & Strain Architects; the Clean Production Network; the Center for Resource Solutions; Rocky Mountain Institute; the Alliance for Environmental Innovation; the Center for Clean Products and Clean Technology at the University of Tennessee, Knoxville; the Lowell Center for Sustainable Production at the University of Massachusetts, Lowell; the International Institute for Applied Systems Analysis; the World Resources Institute; the Environment and Society Group, Battelle Seattle Research Center; the US Environmental Protection Agency; Ecotrust; Green Seal; and the Natural Step. A few business people also attended, including people from: Ben & Jerry's; Interface Carpets; Michael S. Brown and Associates; IDEO; Cargill Dow; CH2M Hill; and Hewlett Packard. For more information on the dialogue, please see: http://www.naturalstep.org/learn/docs/events/sus_prod_mat/index.php.

2. Current state of the sustainability assessment field

There has been a proliferation of macro-level principles (e.g., United Nations Declaration on Human Rights, The Natural Step System Conditions), strategies (e.g., Cleaner Production, Natural Capitalism), as well as issue- and industry-specific criteria and guidelines (e.g., Forest Stewardship Council certification, Green-energy certification, and a variety of eco-labels). For many business decision-makers it is unclear what connections (if any) exist between these approaches and how to begin systematic application to products (as well as the enterprise as a whole). Overall, it is also not immediately evident what questions should be asked—of designers, vendors, and others within business systems—in seeking more sustainable materials and products. These issues have been one, of many, factors hindering forward movement on integrating sustainability into material, product, and broader business decision-making processes.

The need to highlight inter-relationships between existing sustainability assessment approaches was initially addressed by an international group of eight environmental and sustainability experts [1] through the development of a hierarchical "map" of the environmental and integrated sustainability assessment field. The hierarchy is premised on the authors' argument that sustainability efforts necessitate assessing specific decisions both in terms of focused tools as well as broader, system-based sustainability principles (see Table 1 for adapted detailed version). In other words, the authors argue that detailed analyses should be "nested" and interpreted within broader assessments. In this sense, the context in which to understand the findings of each assessment is provided by the next level up. For example, "clean production" is a strategy for addressing issues in the industrial ecology system, which in turn is a means of describing the science of ecology and economy, which offers guidance in managing the global system. Understanding these relationships is the key rationale for the hierarchy.

The resulting "strategic sustainable development" decision-making model [1] is a planning approach that

Table 1
Strategic sustainability decision-making approach [1]

	Focal scale	Questions answered	Definition and examples[a]
Level 1	Defining the system	• How is the system itself constituted? • What are the relevant principles for the constitution of the system, including both ecological and social principles?	Understanding function of the ecosphere[b] and "constitutional principles of the functioning of this system (e.g., thermodynamics, biogeochemical cycles, ecological interdependencies of species, societal exchange with, and dependency on the ecosphere)" [1: p. 198]
Level 2	Identifying outcomes and success	• How can sustainability be defined? • What are the basic mechanisms by which humanity can destroy the system? • What are the principles for sustainability (i.e., a successful outcome)?	Specifying the Brundtland Commission definition[c] through the Natural Step's System Conditions[d]
Level 3	Articulating strategies for forward movement	• What are the basic strategic principles and guidelines for sustainable development by which specific actions can be fostered in a strategic way to move purposefully towards success?	• *Principles for strategic investments in society at large as well as in individual organizations* (utilize "backcasting;" seek "flexible platforms"; ensure good return on investment; follow the precautionary principle) • *Principles for socially aware/responsive investments* (ensure dialogue and transparency) • *Political means for forwarding issues* (seek sustainability-focused the "differential taxes; Address subsidies (for non-sustainable actions); remove "traditional privileges", address current norms and standards, consider international agreements, etc.)
Level 4	Determining actions	• What concrete actions should be undertaken in order to reach success?	"Turning to renewable energy, recycling, and more resource-efficient engines," insofar as they comply with all system conditions [1: p. 204]
Level 5	Listing available assessment tools	What tools would help us to: • manage and monitor our actions so that they comply with our plan; • build our capacity to carry out effective actions in support of the strategy; and • measure directly whether progress had the intended effect in the system?	*For example:*Life Cycle Assessments (LCA), Ecological Rucksack (or Material Input per Service Unit (MIPS)), Total Material Flow (TMF), Ecological Management Systems (EMS)

Source: Adapted from [1].

[a] For specific information, please see, pre-dialogue paper appendices at http://www.naturalstep.org/learn/docs/working_papers/altmats_preeventappendice.pdf.

[b] The ecosphere occupies the full space above the lithosphere—the earth's crust—to the outer limits of the atmosphere.

[c] The Brundtland Commission (1987) defines sustainability as "to meet the needs of the present without compromising the ability of future generations to meet their own needs."

[d] The Natural Step's System Conditions for *ecological* sustainability are derived from the three basic mechanisms by which natural life sustaining systems can be destroyed, followed by inserting a 'not' to create the converse of these mechanisms. The system condition for social sustainability is simply stated as the requirement to meet human needs (within the frame set by the three System Conditions for ecological sustainability) which leads to: In a sustainable society, nature is not subject to systematically increasing… (1) concentrations of substances extracted from the earth's crust, (2) concentrations of substances produced by society, (3) degradation by physical means, (4) and in that society human needs are met worldwide [3].

relies on continual consideration of the broader system in which specific actions are embedded. The authors assert that there are essential elements for ensuring that specific actions (e.g., transitioning from one chemical to another following a LCA) are not simply exchanging one set of non-sustainable actions for another set[2] (e.g., CFCs for HCFCs). The first needed component is a clear articulation of successful outcomes for a sustainable system—defined by principles, such as The Natural Step's system conditions [3]. The second essential element is a method for moving toward the desired outcome, from where you are today, through a structured process that uses the basic principles for sustainability [4]. The core argument is that without a sustainability vision of the future—based on principles to achieve success—it is possible to invest in measures that provide short-term benefits without addressing the long-term sustainability of systems. The overall approach urges decision-makers to consider granular findings in terms of broader system

[2] For example, "…since recycling of cadmium in batteries (as an alternative to phasing it out) may lead to increased concentrations of this metal in ecosystems…, and since more efficient car engines may lead to increased use of fossil fuels…, it is important that activities are chosen and examined from a complete sustainability perspective. Compliance with all system conditions is the strategic starting point for planning" [1].

dynamics. The net effect is a process that ensures that specific decisions and actions are consonant with moving toward sustainability within a full systems perspective.[3]

This framework was developed to clarify how many of the existing principles, strategies, and tools offer complementary and integrated methods for guiding strategic planning for sustainability. The results are intended to enable business decision-makers to understand the sustainability assessment field as a complementary and textured arena with a range of ways to move toward more ecologically restorative and socially just production and product selection. The "strategic sustainable development" approach was developed to be adaptive and expanded upon, through additional tools, and analytical support systems.

This article offers refinements on the "strategic sustainable development" decision-making approach by suggesting additional analytical support systems. It emerged from the dialogue that was convened among key (predominantly US-based) players across areas of specialty related to sustainability, materials, and products. The goal was to take a step back to consider this field of work as a whole.[4] This article follows from the dialogue and suggests three specific areas for additional analytical support systems within the "strategic sustainable development" model. First, a set of "Sustainability Factors in Product Criteria and Characteristics" is proposed to serve as a "bridge" between actions (level 4) and tools (level 5). It is essential to note that this recommendation is *not* intended to generate a long list of key product characteristics, but rather to help decision-makers identify pathways toward sustainability within the larger strategic approach. Second, more explicit and expanded consideration of social aspects of sustainability are recommended. Third, landscape-level factors, ecosystem impacts, and cumulative effects are highlighted as key issues to begin to integrate into sustainability-oriented decision-making.[5] The rationale for, and details about, each of these proposed analytical support systems to the framework are described below.

3. Criteria for assessing products in terms of sustainability factors: synthesis and expansion of existing work

A set of sustainability-related criteria and characteristics would identify indicators that can be used to track (and bridge) between actions and tools. Such criteria and characteristics would offer additional analytical approaches that can be used within the process of integrating sustainability into business decisions, including ones occurring within a multistakeholder context.

These proposed criteria are distinct from the other levels of the "strategic sustainable development" framework [1] in that they translate the set of actions into a set of clear indicators. Thus, these criteria enable assessment of how an activity is operationalized. This addition provides elements needed for guiding oversight of products (and producers' actions) following specific tool-based assessment results. Overall, the reasons for these new criteria, include:

- offering the basis from which to develop a clear "screen" for business managers to consider specific actions following assessment of products;
- aggregating a long list of actions to provide a few-core areas of consideration relevant to tracking a shift toward sustainability on a product scale; and
- highlighting key factors in system dynamics and analyses as they relate to sustainability and product considerations.

[3] For example, Robert et al. [1] assert: "…[S]ince renewable energy, for example, may lead to destruction of forests through overharvesting (thereby violating system condition 3), since recycling of cadmium as an alternative to phasing it out (e.g., large flows of cadmium in batteries between industry and households) may lead to *increased* concentrations of this metal in ecosystems (thereby violating system condition 1), and since more efficient car engines may lead to increased use of fossil fuel through rebound effects, rather than to saving which—within the same or even reduced global use of fossil fuels—would allow a more equitable distribution to the developing world (thereby violating system conditions 1 and 4), it is important that activities are chosen and examined from a complete sustainability perspective".

[4] The specific objectives of the dialogue were to begin the process of:

- Developing a system-based overview of the challenges to integrating environmental and social issues into material, product, and supply chain decision-making processes.
- Creating a shared analytical map of how current tools and approaches inter-relate.
- Identifying gaps in the existing set of tools and approaches, from a systems perspective.
- Exploring the possibility, and utility, of developing a common meta-level approach to assessing the sustainability of materials and products.
- Developing an action plan and identifying next steps.

The event was structured as a small, focused workshop to allow for in-depth discussions. Presentations were made on the existing knowledge and work on integrating sustainability into forestry and wood products, chemical management, product design, architecture and building, energy, and other areas of work. (For more information, see: http://www.naturalstep.org/learn/docs/events/sus_prod_mat/index.php.)

[5] For example, impacts of harvesting or producing various materials may not be the same across desert and rainforest ecosystems. These differences are essential to consider particularly given the great variability across the world's distinct ecosystems where materials are extracted, manufactured, produced, transported, used and disposed of.

These decision-making criteria can inform actions by focusing attention on trends and directionality of change across a number of areas of work.

Ideally, forward progress on all of the proposed criteria could be realized equally and concurrently. However, there may be a need for weighting, trade-off, and prioritizing tools in certain contexts in order to ensure forward movement toward more sustainable products and companies.

The selection of these criteria and characteristics can be based on both a synthesis and aggregation of existing analytical work, including consideration of the broader system dynamics (e.g., sustaining ecological, social and economic systems, as highlighted by The Natural Step System Conditions) and environmental and socially screened characteristics (e.g., Universal Declaration of Human Rights, Green Seal). Drawing on bodies of pre-existing work in these related sustainability sub-fields,[6] a set of criteria in terms of physical practices could include:

- decreased (systematically) flows and volumes of materials and products in relation to key sustainability factors (e.g., human exposures, resource availability for specific communities, waste assimilation, etc.);
- used materials and inputs that are:
  (a) non-toxic, non-persistent, non-bioaccumulative, non-fossil fuel-based, non-endocrine disrupters, non-ozone depleting, and
  (b) harvested and/or produced by using more sustainable practices (as defined within specific sub-fields, e.g., Forest Stewardship Council);
- relied on efficient, renewable and sustainable sources of energy.

These criteria, however, still have key gaps, particularly related to social aspects of sustainability and landscape-level issues.

4. Social aspects of sustainability

Social aspects of sustainability span from labor conditions and wages through access to natural resource-based needs (e.g., food, water, etc.), as well as access to socio-economic resources (e.g., health, informational/educational, financial, etc.). Therefore, questions about social aspects of sustainability relate not only to what employees are paid, but also to how the product, and production process, affects the parameters of people's lives (e.g., access to the full range of resources—natural, informational/educational, health, financial, etc.). In addition, these considerations extend to not only immediate employees, but also to the broader communities exposed to the full life cycle impacts of the product (e.g., the people who live near production, transportation, and disposal facilities, as well as displacements of people that may occur in these processes). Thus, the full range of social issues includes questions that go far beyond the more traditional, and essential, wage and workers' rights issues, to include:

- Is the room or factory poorly ventilated (for workers)?
- What is the impact of a large production company on traditional cultures?
- What are a company's contributions to internal population shifts, from rural to urban areas?
- What is the impact on access to land and natural resources? To health care? To information and education?
- When these products are disposed of—possibly in communities far from where they were made—do they breakdown and emit further chemicals that are affecting human health?

Given this span of social impacts and issues, the challenges for considering the issues systematically, without being overwhelmed, appear immense. However, there is a substantial literature on, and guidelines about, social aspects of sustainability, including, human rights, labor/worker's rights, access issues, social capital development, and other aspects of socio-economic elements of sustainability.[7] The most widely recognized approaches begin with the international human rights standards, presented in the United Nations Universal Declaration of Human Rights (UDHR).[8] Additional international documents address social aspects of sustainability. For example, there are also "Voluntary Principles on Security and Human Rights" as well as a set of "Norms on the Responsibilities of Transnational Corporations and Other Business Enterprises with Regard to Human Rights" [5]. More specifically, the International Labor Organization (ILO) conventions

[6] Sources include: [12,15–29].

[7] For introductory lists of existing principles and guidelines see: http://www.business-humanrights.org/Principles.htm, as well as Appendix A.

[8] One example of the rights presented in the Universal Declaration on Human Rights (UDHR) is in Article 23(2) of the UDHR, which states: "Everyone, without any discrimination, has the right to equal pay for equal work." In regards to the most basic human needs, the Declaration unequivocally states:

> Article 25: "(1) Everyone has the right to a standard of living adequate for the health and well-being of himself [and herself] and of his [and her] family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control" (http://www.un.org/Overview/rights.html).

focus on labor issues, including, child labor, freedom of association, working hours, and health and safety.

In addition, an increasing number of non-governmental organizations have begun to develop guidelines for business operations. Amnesty International has established a set of principles concerning the link between business and human rights.[9] Social accountability 8000 has also addressed social and human issues as applied to the workplace.[10] The Fair Labor Association has a workplace code of conduct.[11] The Ethical Trade Initiative has a "base code" for labor issues.[12] The Clean Clothes Campaign has a "model code."[13] A sustainability management toolkit from the United Kingom SIGMA project provides additional information.[14] A sub-committee of the Global Reporting Initiative (GRI)—which has created as an international standard for corporate social responsibility and sustainability reporting[15]—highlights the importance of considering workplace and human rights, as well as broader community, society, and socio-economic development issues.[16]

Throughout all of these approaches, there is concern not only for a particular company's practices, but also those of their supply chain partners throughout product life cycles. In practical terms, this approach means that consideration spans from extraction through production, manufacturing, transportation, re-use/re-cycling and/or disposal.

Considering this range of existing work on social aspects of sustainability in terms of refining the Robèrt et al. "strategic sustainable development" decision-making approach [1], additions emerge for level 3 (strategic principles and strategies), level 4A (actions), and level 4B (criteria and characteristics), including:

- *Level 3: Strategies*
  Adhering to human rights principles.
  Ensuring transparency in decision-making processes.
  Reinvesting in "social capital" [6] and resilient social systems.
- *Level 4A: Actions*
  Operationalize human rights principles.
  Establish mechanisms for transparency in decision-making processes (e.g., engage with stakeholders; highlight how input changes/influences decision; provide broad-based access to information, etc.).
  Shift away from non-transparent political means for influencing decisions.
  Assess and address community impacts as well as role within broader social dynamics.
  Protect and support long-term socio-economic options and livelihoods of local communities (in geographic areas throughout the lifecycle of a material or product (e.g., from extraction through manufacturing, use, and disposal/re-use)).
- *Level 4B: Criteria and Characteristics*
  Enforced human rights policies (for both company and suppliers), linked to UDHR and ILO principles, such as:
    Safe and healthy working conditions.
    Freedom of association.
    Non-discrimination in personnel practices.
    Prohibition of forced or child labor.
  Established programs to:
    dialogue with stakeholders;
    integrate stakeholder input into decision-making processes;
    enable broad-based access to, and use of, a range of benefits (health, financial) and resources (natural, financial, educational, information, etc.);
    support realization of rights to basic health, education, and housing;
    Created functioning mechanisms for (re)invest ment in social, natural, and infrastructral capital of localities affected by operations.

Since many tools currently exist, at this time there is more of a need to highlight complementarities in

[9] http://www.amnestyusa.org/business/checklist.html.
[10] http://www.cepaa.org/Standard%20English.doc.
[11] http://www.fairlabor.org/html/amendctr.html.
[12] http://www.kavlaoved.org.il/word/ethical_trading_initiative_base_code_28may2003.pdf.
[13] http://www.cleanclothes.org/codes.htm.
[14] http://www.projectsigma.com/.
[15] The specific social indicators are based on the International Labor Organization's Tripartite Declaration, the OECD Guidelines for Multinational Enterprises (which provide international standards for business in terms of social issues), and the Universal Declaration of Human Rights.
[16] Global Reporting Initiative (GRI) Measurement Working Group's Social Performance Indicators included:

1. *Labor:* (a) employment and decent work (conditions of work) (e.g., indicators that "seek to capture the reporter's performance in terms of quality of jobs created and efforts to maintain positive workforce relations" (p. 16), drawing on the ILO's "Decent Work."); (b) industrial relations; (c) health and safety; (d) training and education, and (e) diversity and opportunity;
2. *Human Rights:* (a) strategy and management; (b) non-discrimination; (c) freedom of association and right to collective bargaining; (d) child labor; (e) forced and compulsory labor; (f) disciplinary practices; (g) security practices, and (h) indigenous rights.
3. *Community/Society/Development:* (a) customer and health safety; (b) product declaration; (c) advertising; (d) respect for privacy; (e) customer satisfaction; (f) bribery and corruption; (g) political contributions; (h) public policy; (i) competition and pricing.

(Global Reporting Initiative/Final Report of the Measurement Working Group (January 2002) (http://www.globalreporting.org/WorkingGroups/Measurement/MWGFinal25-01-02.pdf).

Although the GRI states that a company has a decreasing level of responsibility between the first (labor) and the third item (community/society/development), all three are proposed for assessment of a firm.

the field rather than generate new tools. (See Appendix A for list of a selection of existing guidelines and tools.)

However, in terms of the outcome/success level, it is useful to suggest a clear pathway in which to assess the social aspects of sustainability. One such approach could be to focus on core dynamics and current ways in which socio-economic aspects of sustainability are either being ruptured or undermined. This point of departure enables a focus on the overarching social dynamics, relations, and social systems that support—or fail to support—people's ability to meet their human needs. As in ecological systems, these social dynamics occur within a series of nested spaces and places, each of which have ripple effects. Privileged access and use can positively influence accrual of benefits and enable a buffer from impacts.

For example, poverty has been shown to track with the existence, and reinforcement, of access problems in several ways. A concrete, simple illustration is that within low income communities funds are often unavailable to influence policy or invoke legal rights in a court of law. De facto rules, in the form of physical force or simply cultural norms, can more strongly shape relations than codified laws. Within these contexts, social networks can become very important to access resources of all kinds. For example, if people cannot get a bank loan, they borrow from a lender who knows them (though she/he may charge extremely high interest rates). Access to resources thus becomes a set of replicating dynamics that are embedded within, and shaped by, a complex set of factors.

Applying this approach, and reviewing academic research on critical dynamics related to people, regions, and countries meeting human needs, a few key issues areas can be distilled, including: (1) access[17] to resources;[18] (2) use of resources;[19] (3) flow of benefits; [20] and (4) accrual of impacts.[21] Consideration of these dynamics can be built into the model at the outcome/success level focused on avoiding: consolidation of access to resources (e.g., natural, financial, human, information); consolidation of resource use institutions; concentration of benefit flows, and concentration of impacts. Fig. 1 illustrates these issues.

All of these social aspects of sustainability begin to get at the fundamental differences and complexities within and between communities, regions, nations, and continents.

5. Landscape-level issues, cumulative effects, and eco-regional specificity

Landscape-level factors and impacts are another area in need of a supporting set of analytical approaches and tools for use within the current "strategic sustainable development" model [1]. Such an analytical support system would begin to bridge the gap between principles of sustainability on a global scale and ecological dynamics on local or regional scales. Several dimensions of sustainability and landscape-level issues are important to consider.

First, there are spatial aspects to ecological structure, function, and diversity—such as connectivity between specific habitats—that can be altered by extraction of raw materials, construction of buildings, development of other infrastructure, and other aspects of business operations. These issues are essential to address when considering sustainability, as research in the field of landscape ecology demonstrates [7–10]. Research in this field has shown that landscape connectivity is a critical determinant of species survival, which in turn relates to

[17] All of these terms should be interpreted in the broadest sense, that is, in terms of defining each element:

- *Resources* include all the natural/ecological, sustenance and health-supporting, educational/informational, and financial elements available to various people(s) in their lives.
- *Access* occurs through cultural norms and practices, identity/social groups, social networks, community-based bodies/authorities, informal and formal agreements (non-codified, de facto, and legally recognized), laws (de jure), policies, economic transactions, etc.
- *Use* is similarly mediated through a complex set of social and institutional dynamics, including, individuals, small and medium business, large and multinational business, governments (state, regional, national, international), quasi-autonomous non-governmental organizations, bilateral and multilateral institutions, etc.
- *Benefits* are many ranging from wages/financial returns, education/training, information, quality of community services (schools, transportation, hospitals, etc.), and other factors.
- *Impacts* similarly cover the gamut from exposure to substances that jeopardize human health (e.g., toxic, persistent, bio-accumulative substances), inadequate access to food, water, health care, and sanitation; discrimination, violence, child labor, forced labor, etc.

[18] There has been considerable work on access to resources, particularly focused on natural resources. For example, see: [30–40].

[19] A wide range of social scientific studies exist on how and why natural resources are used in particular ways, with many different analytical and theoretical bases. Most notably, research has occurred within areas of:

1. collective action, rational choice, and institutional rational choice (for example, see, [41–45]);
2. a merging of political economy analyses with human and cultural ecology approaches into political ecology analytical approaches (for example, see, [46–51]); and
3. work informed by cultural studies, Foucauldian approaches to understanding the diffuseness of power, and post-structuralist analytical approaches (for example, see, [52–54]).

[20] The flow of benefits has been examined in much of the literature noted above, as a component of understanding the dynamics, and rationales underpinning, current resource use regimes. Also of relevance are historical analyses of the conditions under which resource access and use patterns are transformed (for example, see, [35,50,55–57]).

[21] A growing body of literature has examined who bears what costs of particular political, social, cultural, and ideological systems and dynamics. This work spans many fields, including political science, economics, anthropology and the other social sciences. Perhaps most starkly laying out some of these issues is work on environmental justice (for example, see, [58]).

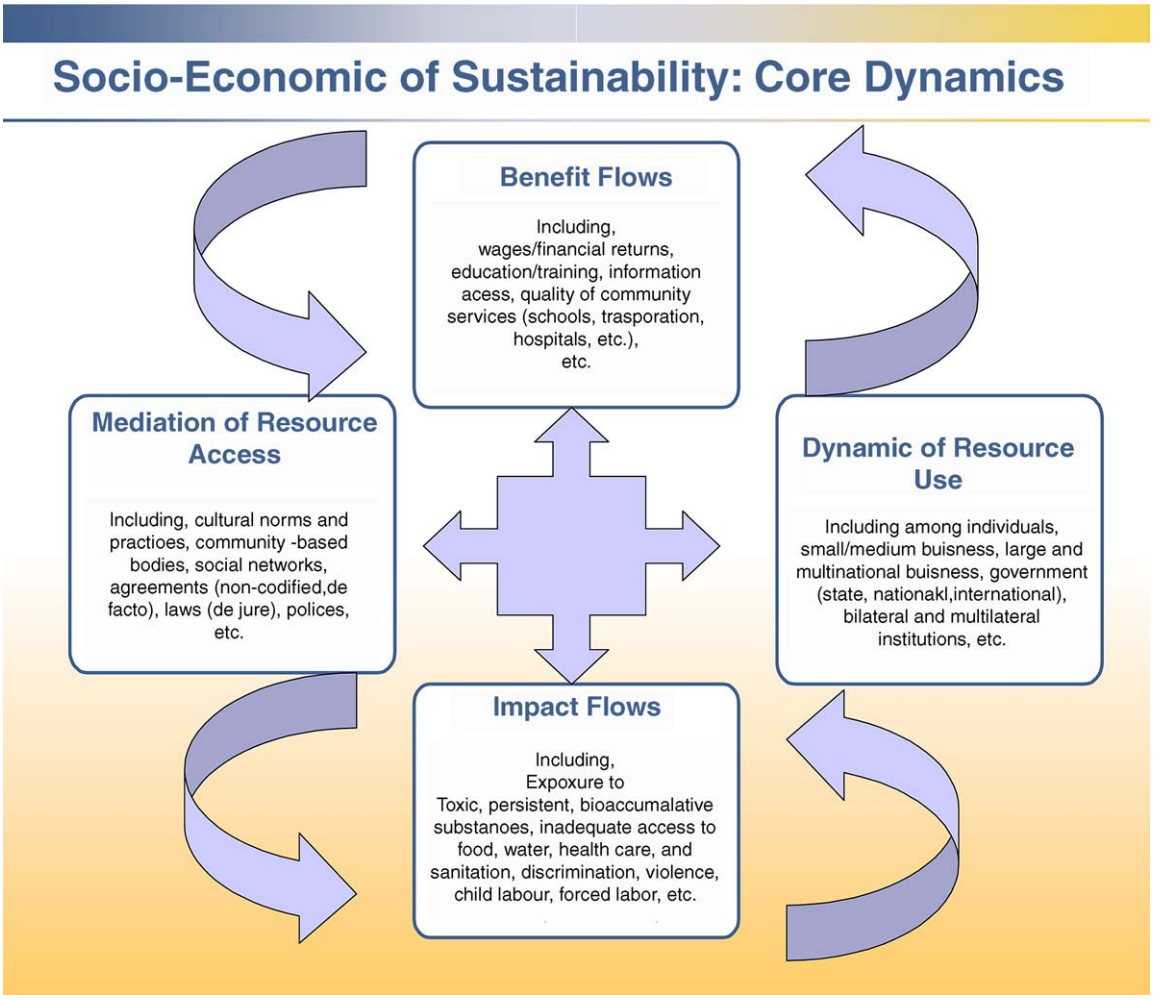

Fig. 1. Socio-economic aspects of sustainability: core dynamics.

overall ecosystem diversity and resilience.[22] Connectivity depends in complex, non-linear ways on the spatial distribution of various habitat types. In addition, ecological resilience is often a function of (diverse) spatial distribution of ecosystems across the landscape [11]. The net effect is that biodiversity and biological productivity can display extreme spatial and temporal variation. Therefore, relatively minor changes in management regime may cause significant changes in ecosystem response, depending on where shifts are occurring. For instance, the timing of fish harvests, rules on age or size classes, allowable by-catch, and fleet location may have large effects over many years.

Second, there are landscape-level, spatial factors that are relevant to understanding, and assessing, cumulative effects.[23] For businesses, the question is not merely related to the impacts of one computer or one

[22] In terms of spatial dimensions of ecosystem structure, function, and diversity, several brief examples can illustrate the issues. Consider a population of mountain lions, or elephants, that becomes fragmented into several sub-populations as fences and buildings are constructed, due to development of a human community or factory. Each of the sub-populations may face food shortages, due to decreasing habitat size, as well as have the potential for genetic inbreeding.

Another example stems from considering a one cubic foot gravel mine pit versus a ten mile-long stretch of gravel mines situated beside a river and the associated potential effects of each—on water flow, quality, turbidity, oxygenation and other factors relevant to aquatic and terrestrial species alike—reverberating throughout a watershed. Alternatively, imagine the effects on habitat connectivity, erosion, and other ecological factors of a one-acre clear-cut surrounded by thousands of acres of single-tree selection harvesting of secondary growth versus the ecological dynamics of two thousand contiguous acres of clear cuts. All of these examples begin to show how spatial distribution of actions on a landscape can matter.

[23] For more information on the significant literature on cumulative effects, please see the "Cumulative Environmental Effects Cross-Referenced Annotated Bibliography" on the website of the Canadian Environmental Assessment Agency (http://www.ceaa.gc.ca/0012/0005/0001/2_e.htm).

palm pilot, but of millions of these products and the impacts at the locations where they are made, used, and disposed of. Will a number of companies' palm pilots be combined with computer screens, and other electronic items in one area, leading to adverse cumulative effects from multiple products? Considering products in terms of sustainability is not just a matter of assessing one item, but the cumulative effects of the total volume that will be produced within specific geographic areas, and ecosystems, where there may be impacts (e.g., from extraction of inputs through manufacturing and disposal or re-use). The end result is that what may be sustainable at one local site, or even when considered from a global perspective, may be unsustainable in another local site.

Third, there are fundamental distinctions to consider between regional ecosystems that shape the relative sustainability of various material, product, or other decisions in specific contexts. For example, the use of wood has one set of sustainability-related implications in the moist temperate rainforest of the North American Pacific Northwest and quite another in the North African Sahara. Absent robust methods for integrating ecological differences in various regions, sustainability aspects of products will not be fully, and rigorously, assessed. Overall, specific ecosystem functions matter and must be factored into understanding of sustainability impacts of decisions related to products and corporate actions.

Together, these three dimensions present another critical set of issues in considering the sustainability of materials and products (and ultimately businesses). The implications of integrating these elements into the "strategic sustainable development" decision-making model [1] are several, including:

- *Level 3: Strategies*
  Integrating spatial, geographic and landscape-scale principles, approaches, and/or tools into all aspects of product design and decision-making.
  Creating tools for considering cumulative effects in materials and product decision-making processes.
  Developing (and/or linking current) tools for factoring ecosystem and regional differences in sourcing materials and considering full life cycle impacts.
- *Level 4A: Actions*
  Partner with landscape ecologists in assessing material selection and sourcing options (particularly vis-a-vis landscape-level effects and ecosystem and/or eco-region-specific issues).
  Collaborate with experts in cumulative effects when considering product materials and disposal or re-use options.
- *Level 4B: Criteria and Characteristics*
  Maintained the resilience, the structure, and function of landscape-level ecological processes.
- *Level 5: Tool Box*
  Create spatially sensitive overlays to existing LCAs and assessment tools.
  Develop cumulative effects-focused tools to interface with existing assessment tools.

Unfortunately, there are considerable implementation challenges to each of these issue areas. First, relatively few tools and approaches exist for considering landscape-level effects of products—and the spatial and temporal complexity of landscapes—particularly in terms of volumes produced.[24] Second, consideration of these landscape-level sustainability attributes are not as clear on an individual product level (e.g., one 2×4 piece of lumber, one Rolex watch with inset diamonds), but rather serve as a bridge between assessments of individual products and total volumes/amounts of these products (e.g., total board feet of timber sold through one retail chain, total number of watches with inset diamonds made by one jewellery retailer). Therefore, with the exception of reporting use of materials, water, and energy, companies are perhaps more likely to address cumulative effects through collaborative efforts

[24] That is, while material flows can be aggregated in straightforward ways and compared with baseline flows, there is a need for tools that can enable consideration of landscape impacts using a sophisticated—and non-aggregated—spatial lens.

A harbinger of analytical work to come includes efforts within specific certification systems for forestry (e.g., Forestry Stewardship Council) and fisheries (e.g., Marine Stewardship Council) that factor in some of these landscape-level concerns. In addition, the Center for Maximum Building Potential has worked with several other organizations to integrate these issues by linking tools including: baseline input–output/LCA, process LCA, and land use/life cycle balancing and embodied life cycle balancing. The goal of linking together these tools is to enable the "balancing" of human impacts within a given ecological system and also eliminate "unbalancable" flows. These tools would require a complete GIS inventory, including human and natural features and processes. A range of data sets would be embedded within this GIS format, including input/output data (e.g., on materials, monetary, and energy flow), so that quantitative relationships could be developed. Due to the fact that the US EPA impact date (on GHG, criteria air pollutants, and TRI) is now correlated with monetary flow in a specific position on the land, it becomes possible to relate aggregate businesses to environmental conditions such as non-attainment of condition and land, air, water metrics. The largest offenders per pixel area could be easily identified and the entire life cycle ladder of supplier compared to their own conditions wherever they exist in the continental US. (For more information, contact the Center for Maximum Potential Building Systems.)

It is important to note that these sustainability issues relating to landscape-level complexity, as well as ecosystem structures and function, may ultimately need to be assessed at a continental scale (and even a global scale, e.g., fisheries, plants, birds, etc.) to ensure that a sufficiently representative and connected system of ecosystems that enables ecological viability and resilience.

at the scale where the effects occur.[25] Third, cost will be an issue. Few businesses have the resources to evaluate supply chain impacts down to the one-acre level. The difficulties range from tracking the origin of globally traded commodities to the suppliers' asserting confidentiality on site-specific impacts. This issue highlights the need for both government and non-governmental organizations to play roles in the development of methods for applying landscape-level assessment approaches.

Given these challenges, there is significant work (and resources needed) prior to systematic implementation. Addressing these issues and obstacles will require collaboration between researchers, businesses, and land-use planners within local, state, and national governments. Although much of this work lies in the future, these approaches will be essential for moving toward sustainability and considering products fully within a systems perspective.

Nonetheless, until these challenges are addressed, small steps can be taken in product design and business decision-making processes. At the most basic level, business decision-makers can become accustomed to asking questions about specific spatially related/geographically based impacts of product decisions throughout the lifecycle. For example, having a map present at product design or decision-making session can enable the asking of simple questions about the locations of extraction, production, transportation, manufacturing, sales, and disposal of products. Questions could include:

- Are any, or all, of these activities concentrated in particular areas? If so, what are the potential sustainability implications?
- What are the possible spatially related sustainability implications of sourcing all of the needed metals from one mega-mine versus many smaller mines, relative to eliminating use of that input?
- What are the sustainability implications of disposing of a company's products in many county landfills around a nation (or world, depending on market reach) versus in one concentrated area?

Fundamental questions about spatial aspects of ecosystems, cumulative effects, and distinctions between ecosystems are important to begin considering—even at the highest level—in terms of sustainability impacts of products and businesses.[26]

6. Fitting together the building blocks

All of these elements are combined within an adapted version of the "strategic sustainable development" decision-making model [1] (Table 2). The flow—from outcomes/success principles, to strategy, actions, criteria, and tools—shows the nested decision-making approach suggested as a pathway forward for business decision-makers seeking to integrate sustainability factors.

Further, Table 3 offers sustainability-oriented product criteria linked to illustrative characteristics that could enable designers, as well as business decision-makers, to begin asking questions about products and companies as a whole.

Together these two tables begin to provide clarity on a process-oriented pathway forward in assessing and acting on a directive to integrate sustainability concepts into decision-making of a retail business with many products. The tables show the adapted "strategic sustainable development" [1] process of considering the overarching system (ecological and social) in which businesses are embedded and then focusing on:

- outcomes/principles of success;
- strategies;
- actions;
- criteria;
- tools.

Decision-makers will move "up" and "down" this process—determining strategies, selecting actions, conducting assessments (according to criteria and with specific tools) and then perhaps re-visiting actions. The process is dynamic yet clear in which "bases" are needed to cover the issues systematically. This approach enables business decision-makers, such as retail managers, to see where to start applying sustainability concepts to the current context and what process to follow. By providing overarching principles and guidance on attributes

[25] For example, principles and goals in dealing with cumulative effects may be adopted at the watershed level. A pollutant load limit may be set and/or reduction goal on releases and/or quality goal in the water agreed, for example. (California has many good examples of such approaches (for example, see, http://www.cleanestuary.com). Or a region may develop environmental indicators. A large firm may participate in these processes. Similarly, in deciding how to approach water use issues, a firm or business group may participate in a strategic impact assessment. The same is true for considering cumulative impacts of materials. Firms could form consortia, often in response to policy initiatives, to research effects and college data by material (e.g., lead) or sector (e.g., electronics, mining).

[26] In all of these cases, landscape ecologists, conservation biologists, and GIS specialists are invaluable resources to seek out from within academic institutions, think-tanks, and regional watershed or ecosystem groups. Maps are increasingly available on the world wide web, many of which can be found with details about specific vegetation cover, water availability, and other key ecological attributes (albeit with a range of error margins, depending on how the data were gathered and whether or not it was ground-truthed). The process will also include continuing to ask the questions and considering the whole system and broader principles of sustainability to ensure that a decision is not just optimizing one aspect of sustainability but actually undercutting broader systems as a whole.

Table 2
Overview of core outcome/success principles, strategic actions, and criteria

Areas of work	Outcomes/success principles[a] and strategies	Actions[b]	Criteria[c]
Physical practices	Outcomes/success principles *In a sustainable society, nature is not subject to systematically increasing:* 1. concentrations of substances extracted from the earth's crust; 2. concentrations of substances produced by society; 3. degradation by physical means... *Therefore, the principle-based objectives include:* eliminate contribution to systematic increases in (1) concentrations of substances extracted from the Earth's crust; (2) concentrations of substances produced by society; (3) physical degradation of nature through over-harvesting and other forms of modification... Strategies • Adopt the precautionary principle • Integrate spatial, geographic and landscape-scale principles, approaches and/or analyses • Create tools for considering cumulative effects in material and product decision-making processes • Develop (and/or linking current) tools for factoring ecosystem and regional differences into sourcing materials and considering full life cycle impacts	• Dematerialize and increase resource productivity (e.g., reduce material use and mass; as well as net volumes/flows) *[Goal: Zero waste and zero emissions]* • Establish—and minimize adverse sustainability impacts of—take-back, up-grade, re-use, and recycling programs for materials and products (particularly of metals) *[Goal: Sustainability-characterized closed loop industrial material use]* • Substitute—and ultimately eliminate—use of toxic, persistent, and bioaccumulative inputs and materials (e.g., mutagens, teratogens, carcinogens, endorphins, and endocrine disruptors) *[Goal: Zero toxic, persistent, and bioaccumulative inputs]* • Minimize embodied energy (material+process) • Convert to renewable and sustainable energy and material sources *[Goal: 100% renewable and sustainable energy]* • Optimize LCA criteria base (including potential of: global warming, acidification, ozone depletion, eutrophication, photochemical oxidant, aquatic eco-toxicity, human toxicity, terrestric eco-toxicity, and resource index) *[Goal: Zero on all fronts]* • (Re) design products and processes to: 1. reflect biomimcry approaches, 2. use sustainably-generated inputs within sustainable processes and transport systems, 3. pivot on a service business model, 4. replenish natural and social systems. *[Goal: 100% for all measures]* • Partner with landscape ecologists in assessing material selection and sourcing options (particularly vis-a-vis landscape-level effects and ecosystem and eco-region-specific issues) • Collaborate with experts in cumulative (chemical) effects when considering product materials and disposal or re-use options	*Product processes (from extraction through manufacturing and transportation) that show trends toward:* • decreased (systematically) flows and volumes of materials and products, • used materials and inputs that are: (a) non-toxic, non-persistent, non-bioaccumulative, non-fossil fuel-based, non-endocrine disrupters, non-ozone depleting (b) harvested and/or produced by using sustainable practices (as defined within specific sub-fields, e.g., Forest Stewardship Council) • relied on efficient, renewable and sustainable sources of energy and transport, • improved—and avoided cascading effects that alter—the structure and function of landscape level ecological processes.

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Table 2 (*continued*)

Areas of work	Outcomes/success principles[a] and strategies	Actions[b]	Criteria[c]
Social practices	Outcomes/success principles *and, in a sustainable society…* 1. human needs are met worldwide *Therefore, the principle-based objectives include:* increase contributions to the meeting of human needs in our society and worldwide Strategies • Adhere to human rights principles • Ensure transparency in decision-making processes • Shift away from non-transparent political means for influencing decisions • Reinvest in social capital and social systems	• Operationalize human and labor rights principles • Assess and address community impacts and role within broader social dynamics • Engage with stakeholders • Ensure transparency in decision-making processes and in access to information • Shift away from non-transparent political means for influencing decisions • Re-invest in, and protect long-term economic options and livelihood of, local communities in geographic areas throughout the lifecycle of a material or product (e.g., from extraction through manufacturing, use, and disposal or re-use)	• Enforced human rights policies (for both company and suppliers), linked to UDHR and ILO principles, such as: –safe and healthy working conditions –freedom of association –non-discrimination in personnel practices prohibition of forced or child labor • Established programs to: –dialogue with stakeholders, –integrate stakeholder input into decision-making processes, –enable broad-based access to, and use of, a range of benefits (health, financial) and resources (natural, financial, educational, information, etc.), –support realization of rights to basic health, education, and housing • Functioning mechanisms for (re)investment in natural and infrastructral capital of localities affected by operations
Business strategic practices	Outcomes/success principles • Remain in business Strategies • "Backcast" from principles • Create flexible platforms for forward movement • Consider return on investment	• Redefine and (re)envision company strategy and policies to fully integrate sustainability • Set targets for progress and indicators • Monitor, evaluate, and report on progress • Adopt international guidelines and standards[d] • Work with suppliers to improve sustainability performance • Exercise precaution	• Articulated sustainability vision for company • Established process for assessing, and gathering data on, progress toward broader goals, throughout supply chain

[a] Sources include: [59].
[b] Sources include [12,15–29].
[c] Sources include [12,15–29].
[d] http://www.unepie.org/pc/cp/declaration/implment.htm.

Table 3
Sustainability-related criteria and illustrative characteristics

Outcomes/success principles	Criteria	Illustrative characteristics: potential indicators and examples (Source: Green Seal 2002)[a]
In a sustainable society, nature is not subject to systematically increasing: 1. concentrations of substances extracted from the earth's crust; 2. concentrations of substances produced by society; 3. degradation by physical means...	Physical practices *Product processes (from extraction through manufacturing and transportation) that:*	
	• decreased (systematically) flows and volumes of materials and products,	*Product durability, repairability, and reusability* • designed to be: -repairable in case of routine malfunctions -modularly working with other components -upgraded easily -disassembled and reassembled easily • warranted for a lifetime *Product materials* • uses least material needed for function and amount trend is decreasing over time • uses reusable, recycled, or recyclable materials wherever possible and when it is more sustainable (based on backcasting from principles) • recyclable materials are clearly marked and not contaminated with any material that impedes recycling *Machine through-put* • uses least amount of materials allowable in process (e.g., double-sided copying) in default mode • uses reusable, recycled, or recyclable materials in process (e.g., re-refined engine oil; recycled paper) • emits lowest levels of pollutants in its class *Packaging* • uses least material for packaging and amount trend is decreasing over time • uses reusable, recycled, or recyclable primary packaging

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Table 3 (*continued*)

Outcomes/success principles	Criteria	Illustrative characteristics: potential indicators and examples (Source: Green Seal 2002)[a]
	• used materials and inputs that are: (a) non-toxic, non-persistent, non-bioaccumulative, non-fossil fuel-based, non-endocrine disrupters, non-ozone depleting…	*Materials and product toxicity and persistence (e.g., chemicals)* • product and its inputs are *not*: –required to be labelled as toxic by Consumer Products Safety Commission –formulated with heavy metals, ozone-depleting substances, carcinogens or human reproductive toxins –processed and/or manufactured with (i) known carcinogens as intermediaries, (ii) agents (e.g., chlorine) that produce carcinogenic and other toxic by-products (e.g., dioxins) –treated, or applied with heavy metals, carcinogens, reproductive toxins, or ozone-depleting substances (e.g., chlorine bleaching for paper, chromated copper arsenate preservatives for wood, and ozone-depleting agents for foam) –determined to be toxic to aquatic life • product as used contains no more than 0.5% by weight of total phosphorus[b] • each organic ingredient exhibits ready biodegradability • volatile organic content and emissions shall be in lowest products in class and on trend to zero (0) *Product manufacture (e.g., machines)* • does *not* use: –hazardous ingredients at more than 1% concentration or carcinogenic[c] or reproductively toxic ingredients at more than 0.1% concentration of respective materials (goal for both: 0%) –class I ozone-depleting substances • waste produced shall be recycled in a closed-loop process (or moving in that direction) *Product disposal, reuse, or recycling* • provides clear actions and instructions for reuse and recycling
	• used materials and inputs that are: (a) s*ee above*… (b) harvested and/or produced by using sustainable practices (as defined within specific sub-fields, e.g., Forest Stewardship Council)	*Source of the materials:* • uses: –renewable, sustainably harvested raw materials where possible (rather than non-renewable, petrochemicals) –wood from sustainable sources (e.g., FSC-certified) (if not available, uses domestic woods in good supply and not tropical hardwoods or endangered wood species) –non-renewable inputs are preferably from reused, recycled (post-consumer), or waste materials • avoids use of virgin plastics unless recycled plastics or biodegradable plastic substitutes are not available or cost-effective

Outcomes/success principles	Criteria	Illustrative characteristics: potential indicators and examples (Source: Green Seal 2002)[a]
	• relied on efficient, renewable and sustainable sources of energy and transport	• Source and processing should be: –as close to user as possible, and –logistics management made efficient, and –vehicles non-GHG emitting • Total fossil fuel energy used in production, including for process, transportation, and material feedstock, shall be in lowest 25% of products manufactured and declining (goal 0%) • Qualification for existing seals, such as: –Energy efficiency rating/seal –Fuel efficiency rating/seal –Water efficicency rating/seal
	• improved—and avoided cascading effects that alter—the structure and function of landscape-level ecological processes	• cultivated in manner that protects natural ecosystems (e.g., shade-grown coffee, free-range, sediment control) • does not use GMOs or artificial growth hormones
and, in a sustainable society... 1. human needs are met worldwide	Social practices *Product processes (from extraction through manufacturing and transportation) that:*	
	• Enforced human rights policies (for both company and suppliers), linked to UDHR and ILO principles, such as: –safe and healthy working conditions –freedom of association –non-discrimination in personnel practices prohibition of forced or child labor	*Illustrative characteristics:* • Production and manufacturing sites certified by a third-party human rights monitoring organization.
	• Established programs to: –dialogue with stakeholders, –integrate stakeholder input into decision-making processes, –enable broad-based access to, and use of, a range of benefits (health, financial) and resources (natural, financial, educational, information, etc.), –support realization of rights to basic health, education, and housing	*Illustrative characteristics:* • Production and manufacturing sites certified by a third-party human rights monitoring organization
	• Functioning mechanisms for (re)investment in natural and infrastructral capital of localities affected by operations	*Illustrative characteristics:* • Certified by a third-party human rights monitoring organization

[a] [68].
[b] *Source*: Green Seal Environmental Standard for General-Purpose, Bathroom, and Glass Cleaners Used for Industrial and Institutional Purposes, GS-37, section 4.9.
[c] Carcinogens are defined as known, probable, or possible human carcinogens by IARC, the International Agency for Research on Cancer. Reproductive toxins are those listed by the State of California under the Safe Drinking Water and Toxic Enforcement Act.

of a successful outcome, as well as strategies, actions, criteria, and tools, the decision-maker is offered a high-level process that can be adapted in a way that is appropriate for that particular company context.

7. Future areas of work

The process of applying the approach outlined in this article—and integrating sustainability into product decisions—will cut to the core of the business, raising questions such as, what product to make, how to design it, how and where to manufacture and market it for what uses, and how to recycle/re-use/dispose of it. Questions will also emerge about who needs to be involved in these decisions, both within and outside the company. Overall, this sustainability-oriented decision-making approach will require changes in the product development process, from the business strategy, and product lines, through operations practices. An illustration of these shifts is offered in Fig. 2.

There remain, however, an overarching set of issues to adequately implement such an approach. First, data for many of these assessment areas are either unavailable (e.g., proprietary, or not yet gathered), costly, or unverified. For example, even with well-understood toxics, it is difficult to get the information on impacts so that a company may choose materials based on environmental and social impacts. Most companies are only beginning to develop a process to consider these issues. With a few exceptions, governments seldom provide information that would help a company think through the impact of its products. Although, researchers are beginning to develop needed analytical tools and approaches [12], ongoing efforts are needed. Addressing this issue could be filled by a government agency, such as the US Environmental Protection Agency, through the creation of public databases with "building block" LCA information as well as the maintenance of these databases over time. All of this information must be transparent and "open-source" and remains to be developed.

A second area of future work is on sustainability criteria and characteristics of products. Such criteria will have to be agreed upon through some process that has yet to be determined, such as through combined stakeholder negotiation and academic review. This

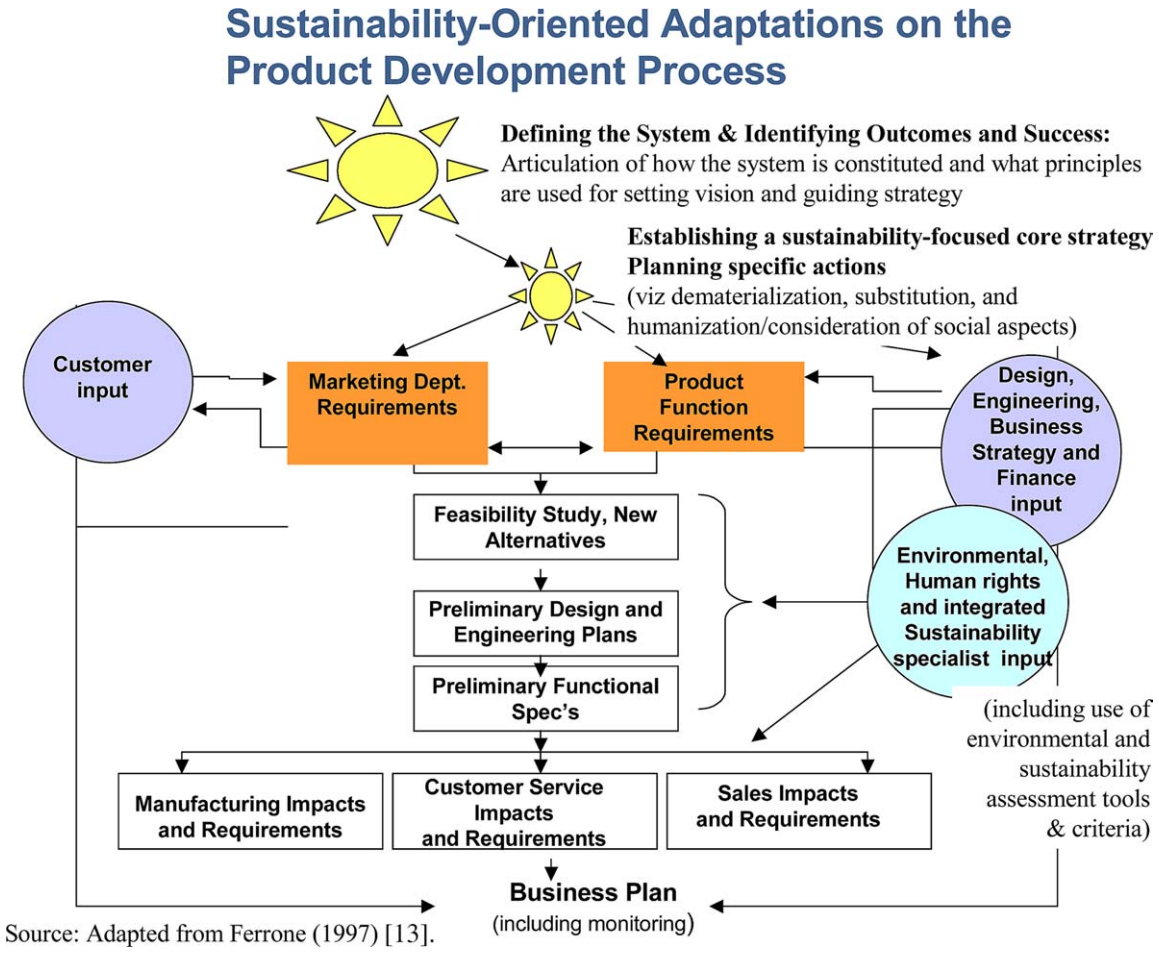

Fig. 2. Sustainability-oriented adaptations on the product development process.

article merely begins the process by suggesting a few. The discussion, and ultimate agreement on criteria and characteristics of products that are more sustainable, will be essential to the establishment of common reporting mechanism(s) by which companies can measure their progress (such as, a GRI-type effort focused on products). This step will require significant work and discussion.

Third, and related to development of these criteria and characteristics, is the issue that impacts accumulate. A single product may only be an incremental problem from most materials and energy use standpoints. Many units of the same product, however, may be the cause sustainability-related issues. Considering and addressing impacts that accumulate across time and space is key a role of governmental policy. Businesses, however, can also play a role by integrating sustainability issues into decision-making processes.

Despite these challenges, companies can begin to adopt sustainability-oriented criteria decision-making processes such as the approaches highlighted in this article. Although the analytical support systems are still being developed, immense opportunities—in terms of risk reduction and brand enhancement [14]—lay ahead for the leaders in this new and emerging field of sustainability, materials, and products.

Appendix A. List of select existing social sustainability-related principles and guidelines

Certification programs, guidelines, strategies, and principles of social aspects of sustainability

Guideline name	Organization	Focus	Notes	Relevant websites
AA 1000	International Council of the Institute of Social and Ethical AccountAbility	Applied to organizations and/or companies	Social and ethical accounting, auditing, and reporting	http://www.accountability.org.uk/aa1000/default.asp
Business Principles for operating in China	Amnesty International (USA)	Companies	A set of human rights principles specifically adapted for companies working in China	http://www.amnestyusa.org/business/chinaprinciples.html
Company specific codes of conduct or ethics	Individual companies and associations	Individual companies and associations	Varies company-by-company. Some companies create their own social performance polices, guidelines and/or monitoring programs	http://www.ethics.ubc.ca/resources/business/codes.html
Fair Trade	International Federation of Alterative Trade (and member organizations)	Consumers, Companies, Governments	Creating trading partnerships that also have the goal of sustainable development. Carried out by member organizations in many countries	http://www.ifat.org/dwr/index.html
Global Compact	United Nations	Companies	Operating principles for corporate labor, human rights and environmental behavior	http://www.unglobalcompact.org
Global Reporting Initiative	Overseen by large steering committee (including UNEP, CEP, CERES, and others)	Applied to organizations and/or companies	Are "developing globally applicable guidelines for reporting on the economic, environmental, and social performance"—a framework for disclosure and public reporting	http://www.globalreporting.org/
Global Sullivan Principles	Initiative of South African Reverend Sullivan (1922–2001)	Companies	Eight principles for ethical business operations	http://www.globalsullivanprinciples.org
Human Rights Principles for Business	Amnesty International (USA)	Companies	An introductory checklist for companies on human rights principles	http://www.amnestyusa.org/business/checklist.html -or- http://www.web.amnesty.org/ai.nsf/index/ACT700011998
OECD Guidelines for Multinationals	Organization for Economic Cooperation and Development (OECD)	Companies and governments	Labor, environmental, and fair business operating principles	http://www.oecd.org/daf
Principles for Business	Caux Round Table	Companies	A set of principles that would like to be a "world standard against which business behavior can be measured". Includes stakeholder principles	http://www.cauxroundtable.org/ENGLISH.HTM

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Appendix (*continued*).

Certification programs, guidelines, strategies, and principles of social aspects of sustainability				
Guideline name	Organization	Focus	Notes	Relevant websites
Social Accountability (SA) 8000	Social Accountability International	Factories	SA8000 is a standard and verification system for companies covering: • Child labor • Forced labor • Health and Safety • Freedom of association and the right to collective bargaining • Discrimination • Disciplinary practices • Working hours • Compensation In addition, the SA 8000 requires a "Social Management System" be put in place prior to certification	http://www.sa-intl.org/introduction.htm
The Minnesota Principles	Center for Ethical Business Cultures (Formerly the Minnesota Center for Corporate Responsibility)	Companies	A set of principles, developed by business leaders, "to foster the fairness and integrity of business relationships in the emerging global marketplace." The principles include specifics in the area of suppliers, employers, communities and competitors	http://www.cebcglobal.org/ and http://www.cebcglobal.org/Publications/Principles/MN_PRIN.htm
Universal Declaration of Human Rights	United Nations	Humans	Set of human rights principles for all people, created in 1948	http://www.un.org/Overview/rights.html

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