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Integrating Sustainability into New Product Development

Available tools and frameworks can help companies ensure that sustainability is embedded as a fundamental building block of new product development.

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Integrating Sustainability into New Product Development

Available tools and frameworks can help companies ensure that sustainability is embedded as a fundamental building block of new product development.

Debbie Kalish, Susan Burek, Amy Costello, Lawrence Schwartz, and John Taylor

OVERVIEW: Increasingly, organizations are embedding sustainability into business functions—including new product development—to increase business value. As more companies come to see sustainability as an opportunity rather than a cost, processes and tools are needed to facilitate the embedding of environmental sustainability into new product development. Several practical tools are available, both to advance the sustainability mindset in the organization and to ensure that sustainability is included as a fundamental building block of new product development. This article describes several of them and reports on their adoption.

KEYWORDS: New product development, Environmental sustainability, IRI Research

Sustainability is becoming a key element in new product development processes; academic research and business reports show that both the revenue from and the market demand for sustainable products is increasing. Indeed, sustainability is becoming key to performance: a 2014 study of 180 companies found that "high sustainability" companies "significantly outperform their counterparts over the long term, both in terms of stock market and accounting performance" (Eccles, Ioannis, and Serafeim 2014).

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Copyright © 2018, Innovation Research Interchange. Published by Taylor & Francis. All rights reserved. As companies increasingly come to see sustainability as an opportunity rather than a cost, they are seeking processes and tools to facilitate the embedding of environmental sustainability into new product development (NPD) processes. However, although many authors and researchers have written about the importance of sustainability (see, for instance, Elkington 1997; Hart 1995), few have focused on the role of sustainability in new product development or on the tools available to support that role.

In fact, several practical tools are available, both to advance the sustainability mindset in the organization and to integrate sustainability as a fundamental building block of product development. Today, sustainability is being built into new product development more regularly than it was even five years ago, in companies of varying sizes and industries. These companies are commonly engaging with a number of different tools and frameworks.

Background

Early efforts to incorporate sustainability into NPD processes primarily addressed environmental issues. Although this study takes a more holistic approach, addressing the three pillars of what has become known as the triple bottom line (Elkington 1997)—environmental sustainability, social sustainability, and economic sustainability—it focuses primarily on environmental sustainability because industry's attention is focused primarily on this pillar.

Early research on the integration of environmental concerns into the design of products and services dates back more than 20 years. Although much work (including, for instance, Brezet and Hemel 1997; Charter and

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IRI Research Profile

Implementing Sustainability into the New Product Development Process

Exploring the rationale for and tools to support incorporating environmental sustainability into the new product development process.

Goal: To develop a framework and explore tools to help companies overcome the gap between a high-level view of the importance of sustainability and the processes needed to actually incorporate sustainability into design and innovation processes.

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Tischner 2001; Graedel and Allenby 1995; Park 2015) describes how firms can develop new green products, most do not describe how to link green new product development with traditional new product development processes.

Indeed, some researchers have suggested that traditional and sustainability-focused product development are at odds. For instance, Berchicci and Bodewes (2005) argue that introducing environmental considerations into new product development requires a trade-off between environmental concerns and traditional product evaluation attributes; introducing a technology that may reduce a product's embodied energy, for example, may delay the product's launch. This thinking is reflected in a pervasive separation of sustainability considerations from new product development processes in practice; many companies continue to see sustainability as an add-on, to be considered only after the product concept is stabilized. In a study of 10 innovative companies, Kerga and colleagues (2011) found that sustainability issues were not considered at all at the concept phase and only entered into the process during design (60 percent) or prototyping (30 percent). Similarly, Park (2015) found that sustainable design is rarely considered at the front end of product development.

The omission of sustainability considerations from product design is a missed opportunity to engage in true sustainable design. Research shows that separating sustainability from product development removes the logical opportunity to integrate sustainability into the product design, making sustainability part of the product's functional DNA rather than an afterthought (Deutz, McGuire, and Neighbour 2013). Critical decisions regarding product performance, materials, energy usage, and other factors are made in the early stages of product development. Further, if sustainability is not included early in product design and conceptualization, it becomes difficult to implement at later stages—and thus, unlikely to be accomplished (Goffin and Micheli 2015).

Thus, research supports the value of integrating sustainability at the front end; the gap is in the understanding in industry how to do that. Developing products that succeed both environmentally and against traditional metrics requires a deep understanding of both the development process and environmental concerns. What is required is "an integrative framework" that "confirms that green NPD is not fundamentally different from traditional NPD but that also highlights unique aspects of green NPD, such as green company policy" (Driessen et al. 2013, p. 15). Driessen and colleagues supply such a framework, one that integrates research on strategic orientations and green concerns in new product development. Similarly, Carlson and Refinejad (2008) offer a predictive model that considers the impact of new product development decisions on future resources and environmental conditions. The model attempts to link financial performance to design and process characteristics that may affect future resources and the environment.

While these models do merge sustainability and new product development, they do so on a theoretic plane; they do not offer advice for how to accomplish such an integration. A number of researchers suggest practical tools or approaches for addressing sustainability in product development. Sutcliffe and colleagues (2009) assert that four kinds of assessments are needed to measure the success of new product development with regard to sustainabilitystrategic environmental assessment, environmental impact assessment, social impact assessment, and life cycle assessment. Fish (2015) articulates several attributes that should be considered best practices for sustainable product development, including sustainable supply chain management, product life cycle management, adherence to general environmental management standards (for instance, ISO 14001), and life cycle assessment. He also proposes sustainability metrics to track progress, allow benchmarking against other companies, and enable reporting of progress to the outside world. While none of these authors offer specific advice for the integration of sustainability into new product development, the attributes they describe do capture the sustainability focus for product development.

A few companies have figured out how to integrate sustainability into product development. For example, Esty and Winston (2009) describe the process Swiss company Rohner Textile used to meet its goals after it decided, almost 20 years ago, to make itself an industry leader in sustainability. To begin its long-term work to incorporate sustainability considerations into product development, the company engaged in a rigorous process to identify materials and dyes that met challenging environmental criteria. A survey of all of the company's suppliers found that only one could provide the requested information: Ciba-Geigy. Ciba-Geigy found that 1 percent of its products met Rohner's new environmental criteria. The 16 chemicals that make up the approved 1 percent are now the only chemicals Rohner uses. Rohner went on to meet evolving market sustainability requirements through a redesign of fabrics that incorporate supplier scoring and material screening tools. Rohner's journey illustrates how a company can begin to address sustainability issues by looking at its supply chain. "Once a company has a feel for where environmental issues arise in the value chain, it can redesign to avoid these problems" (Esty and Winston 2009, p. 198). Once the company decided to be a sustainability leader, it implemented supplier assessment and sustainability design tools that allowed it to source dyes and other elements that both meet specific environmental criteria and allow the company to meet market needs.

We sought to understand how companies like Rohner succeed at embedding sustainability into new product development and to identify potential best practices, by surveying companies about their sustainability approaches and interviewing a sampling of companies across multiple industries and geographic locations that are at various points in developing new product development processes that integrate sustainability. Our aim was to identify the frameworks, practices, and business decisions that are needed to create a product development process that incorporates both sustainability and economic viability.

The Study

The study was executed in two phases. First, surveys were administered to assess the sustainability landscape in companies and gauge their interest in incorporating sustainability into new product development. In the second part of the study, team members conducted in-depth interviews with select companies to uncover tools and processes companies interested in improving their level of maturity in sustainability were using. The goal was to develop a model, including both frameworks and tools, to help companies overcome the gap between high-level acknowledgment of the importance of sustainability and practical implementation.

The Survey

The survey was designed to explore how extensively sustainability is being embedded in the product development toolbox, what tools are being used, and what metrics are being applied to measure success. The survey consisted of 26 questions—12 Yes/No, 8 multiple-choice, and 5 openended items; one of the multiple-choice items allowed for additional feedback. The items asked about the company's purpose in incorporating sustainability into new product development, sustainability requirements that must be met to pass product development gates, specific sustainability tools used, hurdles encountered when embedding sustainability in product development processes. Some questions were intended to identify common cultural elements and tools. The survey also asked for information

TABLE 1. Survey sample characteristics

	Ν	%
Industry		
Chemicals/Materials	16	23
Manufacturing	14	20
Services	6	9
Consumer Goods	6	9
Construction	4	6
Industrial Equipment	3	4
Energy	2	3
Transportation/Aerospace	2	3
Other	16	23
Sales Revenues		
< \$1 million	5	7
\$1 million–\$100 million	13	19
\$100 million–\$500 million	7	10
\$500 million–\$1 billion	5	7
\$1 billion–\$25 billion	29	42
\$26 billion–\$50 billion	4	6
> \$50 billion	3	4
Unspecified	3	4

about industry focus and annual revenue for respondent companies. The survey allowed respondents to remain anonymous but asked them to identify themselves if they were interested in being interviewed or wished to know more about the study.

Invitations distributed at the 2016 IRI Annual Meeting and via LinkedIn generated responses from approximately 350 individuals; these produced 69 complete responses. Respondents were from a variety of companies, in terms of industry type and size (Table 1). Nearly all respondents reported being based in North America (90 percent), with the remaining equally split between Europe and Asia (5 percent each).

The Interviews

Survey respondents who indicated that they were willing to discuss details of their company's sustainability practices and tools were contacted for interviews. Additional interviews were solicited with companies identified by research group members as including sustainability in their product development processes. In this group, companies known to be successful in integrating sustainability in design or new product development were targeted. Every company indicating a willingness to be interviewed was interviewed. In total, interviews were conducted with 22 individuals at 22 companies; the sample included organizations at every stage of maturity in integrating sustainability into product development, as defined by the IRI Sustainability Maturity Model (Hynds et al. 2014).

Interviews were conducted using a questionnaire developed by the team; the 26 questions explored a number of topics related to the implementation of sustainability in new product development. Seven questions were focused

TABLE 2. Interview sample characteristics

	N	%
Industry		
Chemicals/Materials	2	9
Manufacturing	3	13
Services	1	5
Consumer Goods	2	9
Construction	3	13
Industrial Equipment	4	18
Energy	1	5
Transportation/Aerospace	6	28
Sales Revenues		
< \$1 million	0	0
\$1 million–\$100 million	2	9
\$100 million–\$500 million	2	9
\$500 million–\$1 billion	1	5
\$1 billion–\$25 billion	10	44
\$26 billion–\$50 billion	3	14
> \$50 billion	3	14
Unspecified	1	5

on identifying companies' use of sustainability in new product development, including the processes and tools used to embed sustainability in product development.

Two interviews were conducted in person at an opportune conference. The other interviews were conducted by phone by a single research team member. For all interviews, the questionnaire was completed by the interviewer, either by hand or electronically. Most of the interview questions were qualitative, requiring descriptive answers. Non-qualitative questions asked for yes or no responses. Once interviews were completed, the questionnaires were aggregated and the data were analyzed to identify common themes and trends.

As with the survey, the pool of participants spanned a variety of business types (Table 2). Compared to survey respondents, the interview pool included a higher proportion of companies from the transportation, industrial equipment, and construction industries; manufacturing, chemicals/ materials, and services are much less represented in the interviews than in the survey data. Interviewed companies were primarily based in North America (68 percent); Europe (18 percent) and Asia (14 percent) accounted for the remainder.

Results

Overall, the survey results show that companies are addressing

environmental sustainability in product design and looking for ways to embed sustainability in the full product development process; 90 percent of survey respondents said they were working to include sustainability in their product development processes. In the 90 percent of companies that include environmental sustainability requirements in their product development process, 32 percent impose those requirements in all projects; the remaining companies have incorporated sustainability into product development less consistently. The most common reasons for engaging with sustainability in product development, survey respondents said, were to improve a product or service (37 percent) or to increase differentiation and competitive advantage (47 percent); only a small number (13 percent) reported doing so solely for compliance purposes (Figure 1).

A common practice among companies that consistently integrate sustainability into product development was the required use of sustainability assessment tools to pass process stage gates. Companies used a wide variety of tools and practices, both proprietary tools created to meet specific needs and commercially available tools. The tools and practices most commonly reported by survey respondents as being integrated into the product development process included early integration of environmental aspects into product conceptualization, life cycle assessments, integration of supply chain considerations into product design, chemical and materials screening tools, EcoDesign tools (Vallet et al. 2012), and scorecards or checklists. Life cycle assessment processes were found to be the most common tool used in product development (77 percent). Supply chain considerations were also prevalent, with 54 percent using a tool that considers supply chain sustainability indicators as part of new product development. More than half (59 percent) of respondents reported that their company also uses sustainability tools and practices outside of new product development.

Interview data both support and amplify survey findings. Nearly two-thirds (64 percent) of the companies in the



FIGURE 1. Why companies include sustainability in new product development

interview pool told us they had incorporated sustainability into their product development processes, a smaller proportion than in the survey sample, likely reflecting a greater degree of comfort in sharing details among companies with more maturity in this area. More than 40 percent of the companies represented in the interview pool were rated as Succeeding or Leading on the IRI Sustainability Maturity Model (Hynds et al. 2014; see "The IRI Sustainability Maturity Model," below). Among companies rated as Beginning or Improving, many reported that they were either already using some sustainability tools in product development or planning to do so. Most participating companies, regardless of their place on the maturity continuum, reported seeing revenue or profit gains from sustainability.

The reasons interviewee companies gave for pursuing sustainability in new product development were slightly different than those given by survey respondents; interviewees mentioned differentiation and competitive advantage, but they also identified as motivators the strategic opportunities presented by a focus on environmental sustainability; the role of sustainability as an innovation Companies differed in how they integrated sustainability into product development, depending on strategic goals, customer requirements, and internal imperatives.

driver; and the need to meet customer needs, maintain credibility, and protect their access to the market. In other words, including sustainability in product development aligned with corporate strategy. Only one interviewee noted risk avoidance as a driver for incorporating sustainability into product development.

Companies differed in how they integrated sustainability into product development; the particular implementation depended on the company's strategic goals, customer

Stage 4: Leading

Company publishes an

.

The IRI Sustainability Maturity Model

Most frameworks for maturity models include four or five levels of maturity, with each level representing a greater degree of competency in the capability than the previous one. The IRI Sustainability Maturity Model, developed by the IRI Sustainability Maturity Model ROR group, has four levels—Beginning, Improving, Succeeding, and Leading (Hynds et al. 2014). Like the present research, the maturity model focuses primarily on environmental sustainability; it allows a company to benchmark its progress in developing and growing a sustainability focus in new product development. The model was validated using data from 20 companies and by comparing this model with other sustainability ranking systems. The maturity model can be used to assess and guide R&D organizations in creating innovative sustainable products and services that drive growth. At each level, the model describes a set of behaviors, processes, tools, and outcomes that a company at that level of competency should demonstrate.

		Stage 3: Succeeding		annual sustainability report that discusses all aspects of the triple bottom line.
 Stage 1: Beginning Corporate policies do not recognize the triple bottom line (economic, social, and environmental). Overall strategy for sustainability is focused on compliance with the minimum legal requirements. Limited sustainability awareness in setting new product goals and specifications. Supplier policies do not incorporate sustainability. Limited sharing and 	 Stage 2: Improving Centralized sustainability reporting function is in place. Environmental, health, and safety policy publicly states metrics and goals. Carbon, energy, and water footprints are established and measured at the plant level. Regulatory and policy issues are actively communicated throughout the organization. Business and product strategy anticipates future customer behavior based on sustainability trends. Supplier assessment includes a review of suppliers' sustainability policies. Checklists and other tools are used to compare sustainability of new 	 Best practices for improving the triple bottom line are consistently leveraged across the entire enterprise. Sustainability metrics are established at the enterprise level and linked to the business success of the company. Product development processes consider and encourage sustainability throughout the phase gate process. Company focus is shifted from meeting regulations to exceeding requirements (benign by design). Supply chain impacts to sustainability goals are well understood and improvement activities are implemented. Supplier assessment is based on suppliers' environmental and 	· · ·	Corporate sustainability policy is fully integrated into other company policies and viewed as an important lever to drive growth and profitability. Sustainable ideas and IP are leveraged for broader use by way of the supply chain, licensing, sale of IP, joint ventures, etc., with the specific intent of having broader impact. Organization emphasizes R&D to develop new technologies and design methods that will reduce the overall environmental footprint of new products. Majority of company's products are certified according to industry standards and 3rd-party assessments. Product sustainability metrics are shared broadly
development of sustainability metrics.	development process.	sustainability policies and efforts.		and seen as providing a competitive edge.

requirements, and internal imperatives, such as corporate social responsibility initiatives (see "Implementing Sustainability," below). Another factor was the nature

Implementing Sustainability

The companies we interviewed integrated sustainability into their development processes in many different ways, depending on their culture, maturity level, and business and customer needs. To some extent, the implementation also depended on the company's maturity in integrating sustainability in new product development.

- Maturity Level Beginning: A mid-sized Chinese company that supplies high-voltage electronic components worldwide does not have a formal product development process. Rather, its executive team meets regularly to discuss progress on new products in development. Sustainability requirements are solely dictated by compliance requirements or customer product specifications (generally Restriction of Hazardous Substances [RoHS] regulations). There are no internally driven environment, health, and safety or sustainability requirements, other than a nonsmoking environment.
- Maturity Level Improving: A tier one automotive parts supplier in Mexico uses a company-developed product development process that focuses on internal environment, health, and safety concerns as well as energy efficiency, recyclability, and greenhouse gas generation. Its customers also require products that consume less energy in installation and meet the requirements of RoHS regulations, so these are also key components of the company's product development process.
- Maturity Level Succeeding: Customers of a large US-based maker of diverse consumer goods have different sustainability needs and wants, depending on the product or business. All new products follow a standard development process that has sustainability considerations embedded, with slight differences to accommodate the varied product portfolio. The company uses a decision tool to determine whether a life cycle assessment is needed for a particular product. Additional tools used in the process include internal sustainability checklists, frameworks for including life cycle material considerations, and a sustainability design workbook.
- Maturity Level Leading: Sustainability is one of the value propositions that a mid-sized European chemical company offers its customers. The company strongly believes that sustainability is an important business and innovation driver that will lead to more future-proof business as well as competitive differentiation. The company uses sustainability workshops at the inception of a new product's development, prior to the beginning of its formal product development process, to embed sustainability in the product design. Life cycle assessments consider both environmental and social impacts, and the results are a factor in decisions about whether to continue projects or terminate them.

of the existing product development process. Most interviewees (66 percent) told us their companies have a single standardized process; for example, the interviewee from DSM, a chemical company based in the Netherlands, told us, "We have an NPD process which is anchored in our innovation requirements for all business units. Every phase gate has specific deliverables with respect to sustainability. We strongly believe that sustainability is a very important business and innovation driver and will lead to more future-proof business as well as differentiation with respect to competitive positioning."

Other companies have multiple processes used in different areas of the company. Multiple processes typically occurred when new acquisitions were not yet following the company's standard process and in companies with highly disparate product offerings with widely differing requirements. For example, an international energy company that participated in interviews has totally different product development processes for its fossil fuel and renewable energy businesses. The conventional business's processes focus on compliance, while the renewable business's process includes rigorous cradle-to-cradle assessments. One or two participating organizations reported not having a standardized process.

Interviewee companies that reported integrating sustainability into product development measured success in a variety of ways. The most common metrics related to both the company and the products. Company metrics included reporting on progress toward defined sustainability goals, such as energy or waste reduction targets, and participation in voluntary external sustainability standards, such as the Carbon Disclosure Project (CDP), the Global Reporting Initiative (GRI), and the Sustainability Accounting Standards Board (SASB). These metrics may include factors related to product design-for example, capturing information about product-related considerations such as energy or water use in manufacturing—but they are not directly related to product development. Some companies also set product-related goals, such as requiring all new products to achieve a sustainability-related certification or to avoid materials identified as not environmentally friendly. These metrics, whether company or product focused, can identify the value created by sustainability-related design features (for instance, in saved costs due to reduced materials use), enable product differentiation, and enhance brand value.

Our data suggest that companies are using a variety of approaches and tools to integrate sustainability into their product development processes and using metrics to measure success in the effort.

Implementing Sustainability into the Product Development Process

Our research suggests a way forward for companies seeking to implement sustainability in product development, or to integrate it more effectively. That way forward includes considerations of both larger issues, such as strategy and culture, and of the specific tools, frameworks, and approaches to be implemented.

Strategy and Culture

The frameworks, tools, and metrics described by our interviewees and survey respondents must be matched by an organizational focus on and support for sustainability. Park (2015) notes a number of factors that must be present if sustainability is to be embedded in the product development process; these match the elements required of nearly any change program-senior management support, a vision for sustainability, internal communication, crossfunctional teams, a supportive company culture, and supportive attitudes among individual managers and staff. Of course, the sustainability strategy must align with the overall company strategy, and both strategies must be clearly communicated and understood at all levels. The employees implementing sustainability in the product development process must have a clear understanding of the company's sustainability strategy, understand the company's sustainability goals, and, finally, have the knowledge and influence to implement sustainability effectively.

Most importantly, sustainability must be built into the company's culture-there must be what Genc (2013) calls a "sustainability culture," defined as a company's recognition of the impact of its activities on society and communities and of the need to minimize negative impacts. The culture of a company represents the collective beliefs of the whole; if sustainability is part of the culture or values, then the company as a whole will support that value-in this case, sustainability. Unsurprisingly, then, companies that excel in sustainability tend to have values and philosophies that embed it into everyday decisions and practices (Pagell and Wu 2009). In other words, "Cultures that are sustainability-oriented provide an atmosphere where everyday conversations have a sustainability angle and decisions made in the organization take a triple bottom line rather than just an economic view" (Marshall et al. 2015, p. 7). Thus, the first step in developing a culture of sustainability is embedding sustainability in organizational policies.

Another key to success in sustainability-focused innovation is the recognition of the necessity of a holistic approach. Sometimes, the more sustainable choice is not the one that's most obviously "sustainable." For instance, an industrial paint manufacturer that participated in interviews found through its life cycle assessment process that a better-performing but less environmentally friendly product actually provided stronger overall environmental performance (reduced potential impact over the product's lifetime) in one customer's application—the right environmental choice in this case was not the obvious "green" choice. These kinds of trade-offs must be fully understood and aligned with corporate culture and customer needs.

Process and Tools

Once a company has made sustainability part of its strategy and culture, formal processes and tools must be utilized consistently in the product development process. Like the Once a company has made sustainability part of its strategy and culture, formal processes and tools must be utilized consistently.

approach itself, these tools and processes must match the company's culture and strategy, as well as market needs. Every tool, process, or metric should be matched to a clearly defined rationale (Panko et al. 2017). For example, if a company wants to assess all of a product's impacts across its lifetime, a life cycle assessment study could be chosen as the standard tool. Using specific tools and processes in conjunction with the strategy and culture allows for the sustainability attributes desired by the company to be included from the beginning of development.

The survey and interview data identified a number of specific tools that are commonly used to embed sustainability into new product development. The tools most commonly mentioned, by survey respondents and interviewees, include

- new product sustainability checklists,
- life cycle assessment tools,
- materials screening tools,
- the EcoDesign Strategy Wheel, and
- supplier scorecards

Some of these tools can be (and often are) customized by the company; others require support from outside sources to implement and maintain.

New product sustainability checklists. Sustainability checklists are among the most commonly used tools. These lists enumerate considerations (often in the form of questions) a project team must address in various stages of product development. Often sustainability checklists start with regulatory requirements and are then expanded to address strategic sustainability issues, as companies extend their sustainability efforts beyond compliance to reducing business risk or achieving competitive differentiation. The checklists prompt teams to assess sustainability opportunities, risks, and actions, and track sustainabilityrelated decisions throughout the development process; they usually align with the company's product development process. Most checklists used by participants in this study are customized to meet specific business needs. Because these checklists often include proprietary considerations, few are publicly available. As an example, and a starting point for companies considering such a checklist, the research team developed a generic checklist, based on tools reviewed as part of the research process, which can be accessed online (for specific information, see "Additional Resources," p. 43).

Additional Resources

There are a number of publicly available tools and resources that are useful for organizations seeking to enhance their understanding of environmental sustainability and embed sustainability into their new product development processes. We list here a few that our team has found particularly useful, as well as resources developed by the research team in the course of the project.

Checklists and Scorecards

The research team has developed two tools, generic versions of checklists and scorecards that companies typically customize to their needs and context. These tools provide templates and guidance for organizations seeking to incorporate sustainability into their product development processes. Both of these are available at http://www. iriweb.org/articles/integrating_sustainability_into_NPD.

- The New Product Sustainability Checklist
- The Supplier Decision Matrix Tool

Life Cycle Assessments

Life cycle assessments are the most commonly used tools to assess the environmental impact of products. Life cycle assessments require access to third-party global databases. A number of resources discussed how, why, and when to use both full and streamlined life cycle assessments; this research especially relied on two:

- Joel Ann Todd and Mary Ann Curran, eds. 1999. Streamlined Life-Cycle Assessment: A Final Report from the SETAC North America Streamlined LCA Workgroup, July. http://ertc.deqp.go.th/ertc/images/stories/user/ct/ct1/cp/ design_for_environment/Streamlined%20LCA.pdf
- Viachaslau Filimonau. 2015. The Life Cycle Thinking Approach and the Method of Life Cycle Assessment. In Life Cycle Assessment and Life Cycle Analysis in Tourism, pp. 9–42. Springer International Publishing.

Materials Assessment Tools

As organizations seek to assess the materials (most notably chemicals) used in their products, some available resources are available to assess impacts, compare different materials, and provide understanding of the possible impacts, including:

• Mario Chen. 2010. Chemical Screening Visualization Tool: Resource for Rapid Chemical Assessment. Dupont,

Life cycle assessment tools. Life cycle assessment studies assess the environmental impacts associated with a product throughout its life, beginning with raw material extraction and proceeding through materials processing, manufacturing, distribution, use, repair and maintenance, and disposal or recycling. The studies are governed by two standards, ISO 14040 and 14044, and are broadly recognized as a means to improve the environmental performance of products and services and reveal opportunities to prevent or mitigate negative environmental effects (Ortiz, Castells, and Sonnemann 2009). If a full life cycle assessment is not feasible or not needed, companies may October 27. https://www.epa.gov/sites/production/files/ 2014-08/documents/communities_of_practice_mario_ chen_dupont.pdf

Jessica Lyons Hardcastle. 2016. Do Chemical Assessment Tools Work? Environmental Leader, May 6. https://www.environmentalleader.com/2016/05/do-chemical-assessment-tools-work/

Standards and Checklists

Several well-respected advocacy organizations have developed lists, tools, and financial accounting standards related to environmental sustainability:

- Living Future's Red List names worst-in-class materials prevalent in the building industry. The commonly used chemicals on the Red List "are polluting the environment, bio-accumulating up the food chain until they reach toxic concentrations, and harming construction and factory workers," according to the organization. https://living-future.org/declare/declareabout/red-list/
- The Carbon Disclosure Project (CDP) runs a global disclosure system that enables companies, cities, states, and regions to measure and manage their environmental impacts; the organization now possesses the most comprehensive collection of self-reported environmental data anywhere, which investors, purchasers, and policy makers can use to make better-informed decisions. https://www.cdp.net/en/info/about-us
- The Global Reporting Initiative (GRI) has developed a set of standards for reporting on sustainability designed to "help businesses and governments worldwide understand and communicate their impact on critical sustainability issues...The GRI Sustainability Reporting Standards are developed with true multi-stakeholder contributions and rooted in the public interest." https://www.globalreporting.org/
- The Sustainability Accounting Standards Board (SASB) "develops and maintains sustainability accounting standards—for 79 industries in 11 sectors—that help public corporations disclose financially material information to investors in a cost-effective and decision-useful format." https://www.sasb.org/

screening life cycle assessments (Hochschorner and Finnveden 1999). A streamlined assessment is often effective for product development, as it uses readily available data and standard assumptions to fill in data that may be missing (such as manufacturing data that may not yet exist for a product still in development). The simplified study does not provide a complete assessment with accurate impacts for all aspects, but it does offer the capability to envision potential impacts and, in some tools, the ability to compare designs. The impact modeling at the heart of life cycle assessments requires access to a third-party global database and support from internal or external subject matter experts. There are a number of sources for software and databases, as well as subject matter experts, include PRé, Thinkstep, and (in the EU) EPLCA.

Materials screening tools. Product development teams often need to assess the environmental profile of a material to be used in a proposed product. A number of third-party screening tools provide information on particular materials to help teams identify areas of concern (Table 3). For instance, the Pharos Chemical and Material Library provides chemical hazard information for more than 20,000 Chemical Abstracts Service Registry Number (CASRN)-identified substances. Users can look up chemicals or materials by CASRN or name to find out about specific human and environmental health hazards. The Pharos tool was developed by the Healthy Building Network (HBN) as part of a suite of tools to evaluate the health and environmental impact of building materials. Because the Library includes global lists such as the European Union's Substances of Very High Concern and the International Agency of Research of Cancer (IARC) list, it can also help global teams quickly identify concerns based on regional geography. Another screening tool used primarily by North American manufacturers in the building products sector is the International Living Futures Institute's Red List, which identifies worst-in-class materials prevalent in the building industry. Other screening tools identified by survey respondents and interviewees include Walmart's (2017) Implementation Guide for Policy on Sustainable Chemistry in Consumables, which provides Safer Chemical Databases that are made publicly available. Similarly, the Sustainability Apparel Coalition (SAC) has developed a suite of self-assessment tools to help the apparel industry understand the sustainability performance of a product. The Higg Materials Sustainability Index (Sustainable Apparel Coalition 2016) empowers brands, retailers, and facilities of all sizes to measure their environmental, social, and labor impacts and identify areas for improvement.

EcoDesign Strategy Wheel. The Okala EcoDesign Strategy Wheel can be used as a brainstorming tool to guide

Tool	Catalogue	Framework	Expert Analysis
CleanGredients	Х		
GreenScreen			Х
GreenWERCS	Х		
Pharos Chemicals and Material Library	Х		
SciVera Lens			Х
US EPA Safer Choice Chemicals List	Х		
Higg Index		Х	
USEPA Design for Environment		Х	
Living Building Challenge Red List	Х		
Walmart Sustainable Chemistry Implementation		Х	

the development of product design strategies with regard to sustainability considerations (White, St. Pierre, and Belletire 2012). The Strategy Wheel is based on a manual (Brezet and Hemel 1997) that addresses the issue of sustainable product development and offers a method for designing environmentally sustainable products. The Strategy Wheel clusters sustainable design strategies according to the stages of the product's life cycle. Designers can use many of the strategies together or focus on a few. The wheel divides design strategies into categories based on the phases of a product's life, from manufacturing to end of life. The tool also includes examples of specific strategies.

Supplier scorecards. Among our participants, scorecards or screening tools were already commonly used to measure supplier performance; as companies begin to move sustainability-focused product development, toward environmental sustainability criteria are often added to these existing tools. In some companies with diverse product portfolios, like Walmart, product category-specific scorecards have been implemented (Walmart 2017). Scorecards usually score suppliers on multiple environmental factors, including greenhouse gas emissions, energy efficiency, waste, and other criteria. Category-specific score cards would also include questions specific to the product category; for example, a scorecard for a supplier of computer batteries might include information about efficiency and recycling, while a bread supplier's scorecard would address issues specific to food processing and food waste. Companies typically design scorecards to encourage partnering with suppliers that support their sustainability values. For example, if greenhouse gas emissions are important to a company, suppliers will be asked about greenhouse gas commitments, goals, and initiatives. These scorecards are generally created by companies and customized to their needs and concerns. As with new product checklists, these scorecards often incorporate proprietary concerns and thus are not generally made publicly available. Here, again, the research team created an example scorecard, available online, to serve as a starting point for companies embarking on a sustainability effort (see "Additional Resources" for specific information).

Conclusion

All companies, regardless of size, can incorporate sustainability into their product development processes, as long as a concern for sustainability is embedded in the company culture and employees understand how the company defines "sustainability." Embedding sustainability in the product development process is itself a process, one that few companies have fully navigated, but is important to incorporate early in the NPD stage gate process. Most companies have introduced sustainability practices to address compliance; fewer have both realized that integrating sustainability beyond compliance offers greater business value and managed to act on that knowledge.

While more companies are realizing the competitive advantage sustainability can provide, many have had

difficulty determining how to embed a sustainability focus into their standard product development methodologies. This study provides some insight into how companies are moving forward, suggesting practices, tools, and processes that can facilitate the inclusion of sustainability in product development.

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