

## ***A Flexible Framework for Integrating Sustainable Design***

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## **Abstract**

Over the last decade, we have witnessed increasing recognition of the importance of products and product systems as a target for both corporate environmental strategy and government environmental policy. This has led to the development of a number of concepts and tools that enable organizations to evaluate and improve the environmental performance of product systems. Concepts and tools that explicitly focus on products include: design for environment, life cycle assessment, sustainable design, green procurement, and life cycle engineering

The purpose of this paper is to explore the challenges of implementing one of the leading conceptual approaches for evaluating and improving product systems, namely sustainable design. A complex, and often confusing set of factors influence the evolution and integration of sustainable design and design for environment (DfE) in organizations. Responding to these factors requires an understanding and sensitivity to the organization's internal culture, existing systems, initiatives, its market and stakeholders (to name a few). Unfortunately there are few guidelines or frameworks for understanding these factors and designing/implementing successful sustainable design and DfE programs. The goal of this paper is to discuss several different approaches that have been used by organizations to develop and implement these programs.

The paper will elaborate upon how and why sustainable design and DfE have evolved within these companies. The experiences of two private companies and one public sector organization will be captured through a combination of primary and secondary research methods using published materials. The findings indicate that there are several common challenges faced by companies integrating sustainable design or design for environment (DfE) into their activities. A key challenge faced by each of these organizations is managing the internal complexities (change management, motivating staff, planning etc.) associated with implementing such initiatives. In addition, the findings suggest these challenges can be better understood and overcome by using a framework that can be adopted and customized to the organization. The paper will propose a framework and discuss it in the context of the case examples. Its utilization within a private or public sector organization will also be explored.

## Introduction

Over the last decade, we have recognized the importance of products and product systems as a target for both corporate environmental strategy and government environmental policy. This has led to the development of a number of concepts and tools that enable organizations to evaluate and improve the environmental performance of product systems. Concepts and tools that explicitly focus on products include: sustainable design, design for environment, life cycle assessment, green procurement and life cycle engineering.

It has been recognized that the integration of environmental considerations into a company's core activities, such as design and development, is an evolutionary process (Fava, et al, 2001). A complex, and often confusing set of factors influence the evolution and integration of sustainable design in organizations. Responding to these factors requires an understanding and sensitivity to the organization's internal culture, existing systems, initiatives, its market and stakeholders (to name a few). The goal of this paper is to discuss several different approaches that have been used by organizations to develop and implement these programs. The findings indicate that there are some common challenges faced by companies integrating sustainable design into their activities. In addition, the paper will propose a framework that can be adopted and customized to the organization and discuss it in the context of the case examples.

For the purposes of this paper the term sustainable design addresses the environmental as well as the social and economic components of sustainability within the design and development process of products, product systems and services. However, it is important to note that the organizations discussed here are primarily trying to improve the environmental performance of their products/product systems (i.e. an integral part of sustainable design). It is believed that the findings and framework discussed are applicable to addressing the social and economic components of sustainability. Therefore, the term sustainable design will be used throughout this paper, except in the case examples (where the terminology used is that of the organization).

## Several Different Approaches

Over the last several years, three organizations, Teknion, Black & Decker and New York City Transit have taken a journey to implement sustainable design or design for environment programs within their core activities. Responding to distinctively different business drivers, each organization has taken an approach specific to its internal culture and external business climate. The brief case studies below will highlight the main process or steps of implementing sustainable design or design for environment programs while identifying similarities and common challenges.

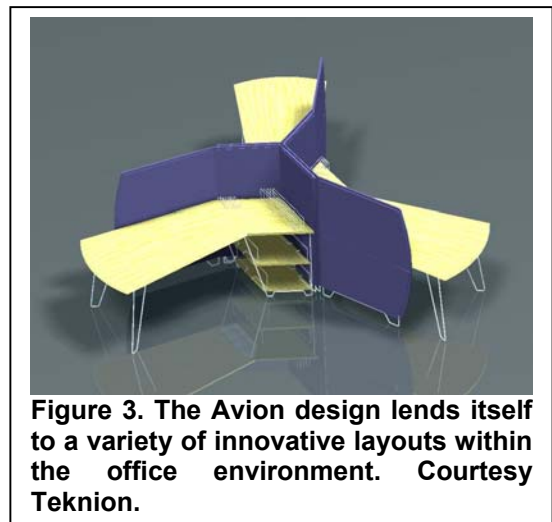
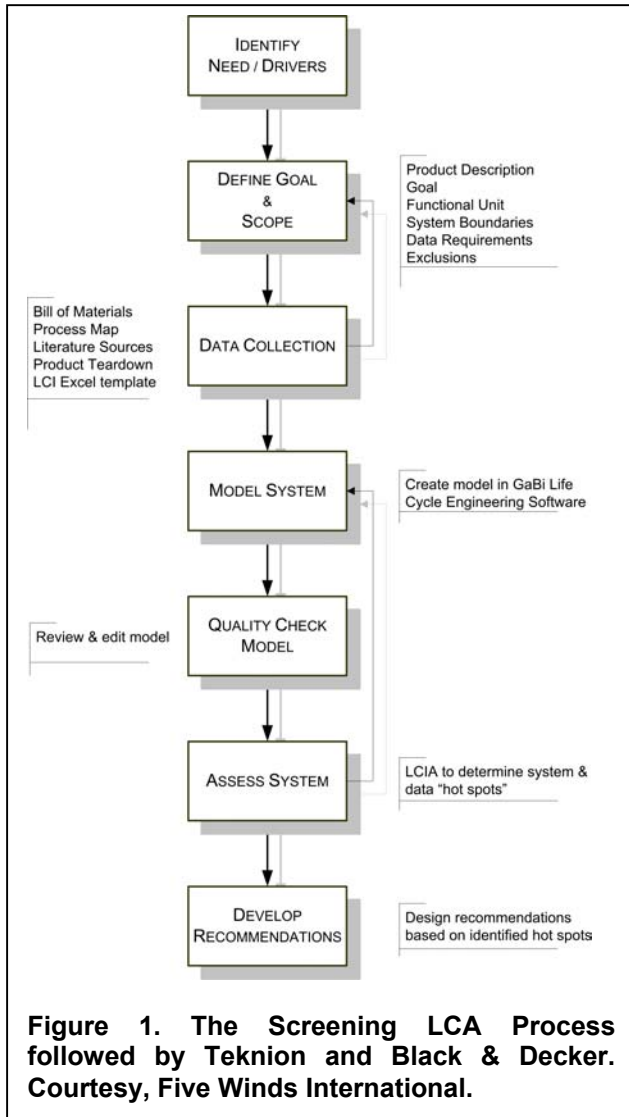
### ***Teknion Furniture Systems***

Teknion is an international designer and manufacturer of office systems and related furniture. The company is based in Toronto, Canada. Having won over 50 major design awards since 1997, Teknion is seen as an innovator within the contract furniture market in North America and parts of Europe. Teknion employs over 3,600 people and operates in more than 50 countries through a worldwide network of offices and facilities in Canada, the United States, the United Kingdom, Western Europe and the Pacific Rim. The company's products are geared towards a mid- to high-end marketplace, particularly through interior designers, architects and other corporate or institutional purchasers. Over several years, this market has seen a growing level of purchasing requirements from public and private institutions that relate to sustainability and the environmental performance of products. For example, the United States Environmental Protection Agency's (EPA) Environmentally Preferable Purchasing Program along with the US Comprehensive Procurement Guidelines Program and Canada's Environmental Choice eco-logo standard for Office Furniture and Panel Systems (EP-66) are among many "eco-procurement" initiatives influencing North American markets. These requirements are fuelled by an increased awareness of interior designers, architects and institutions about the benefits of high performance buildings, resource conservation, indoor environmental quality and sustainable design (IIDA, 2000).

Teknion noticed these changes in the market and responded by working to understand and improve the environmental performance of their products and facilities. The company began to implement an environmental management system (ISO 14001) in 1999 and to explore the concept of sustainability within the Department of Design, Development and Innovation in 2000. In 2001 the Advanced Concepts group within the Department investigated “sustainability” as a theme within their annual work plan. The Advanced Concepts Program was established in 1998 to explore trends in all aspects of life – work, demographics, technology, fashion, architecture and pop culture – and translate them into new ideas for office furniture systems and working environments. The Program has explored themes such as “Generation X” and “Call Centers” and has earned Teknion several awards including a Gold award in the concept category for its *Rug* in the 2000 Industrial Design Excellence Awards (IDEA).

During the early stages of approaching the new theme, the Advanced Concepts group (who normally investigate external trends) found themselves looking internally, at their products and processes. Together with Teknion’s environmental management system (EMS), purchasing, production and sales staff, the Advanced Concepts team engaged in the following approach:

- To gain a better understanding of their supply chain and the impacts of resources and materials purchased by Teknion, the company collected and analyzed qualitative and quantitative life cycle information regarding materials and processes from suppliers and raw material producers. Emerging customer requirements such as the criteria in LEED™ drove this research. LEED™ (Leadership in Energy and Environmental Design) is an environmental performance rating system developed by the United States Green Building Council for various building types. Some criteria in the system influence components that will be used to furnish new or existing buildings.
- To better understand the end-of-life and secondary use scenarios of their products, Teknion participated in research into where and how office furniture systems are handled once they reach the end of their initial use with the customer. Teknion found that refurbishing is a common practice in the industry and usually requires stripping, re-upholstery and repainting. Refurbishers in the industry try to ensure that the functionality of the systems (furniture) is maintained and pay less attention to scratches or other blemishes; customers of refurbished furniture do not expect new finishes (Williams et al, 2001).
- To complement the knowledge gained about the supply chain and end-of-life scenarios, Teknion conducted a screening level life cycle assessment (LCA) of one of Teknion’s biggest selling workstations. This provided Teknion with a greater understanding of the environmental performance of their products, processes and the materials used in their production. The 6' x 8' workstation’s impact was assessed against seven commonly used indicators including energy use, climate change, smog, toxicity, acidification, eutrophication, and ozone depletion. The process used follows that illustrated in Figure 1.
- Teknion, along with external consultants, developed several designs that conceptually explored the sustainability theme. Teknion’s own internal team developed the Avion concept with strategic guidance from Five Winds International (Figures 2 & 3). The features of the workstation include:
  - Only four materials are used; stainless steel, PET (polyester fiber from pop bottles), bio-composite with wood veneer;
  - All components are flat when dismantled and packaged to maximize shipping volume; and,
  - The overall form and planning layouts encourage social interaction within the workplace.



- To engage existing and potential customers in an open dialogue around environmental issues, related to office furniture and systems, Advanced Concepts produced and delivered a Sustainable Design Primer presentation and report. To engage the local community and raise awareness internally, the company sponsored a lecture series with various speakers whose work involved environmental issues or aspects.

## Conclusions

Prior to the Advanced Concepts work on sustainability, Teknion's interpretation and response to sustainability pressures was facilities-oriented; it had implemented a system for environmental management that included energy, water and other plant-specific programs. The company now recognizes new face of sustainability, one oriented towards their products. Teknion believes that this increase in scope is primarily due to four factors:

- Commitment from the Board of Directors to develop and pursue an EMS and ISO 14001 certification;
- Increased awareness and demands in the marketplace for environmentally preferable products and services;
- Ability to understand what the main environmental "hotspots" of the product are, and their associated aspects through life cycle assessment and other techniques; and,

- Increased internal dialogue between business functions over environmental issues and performance.

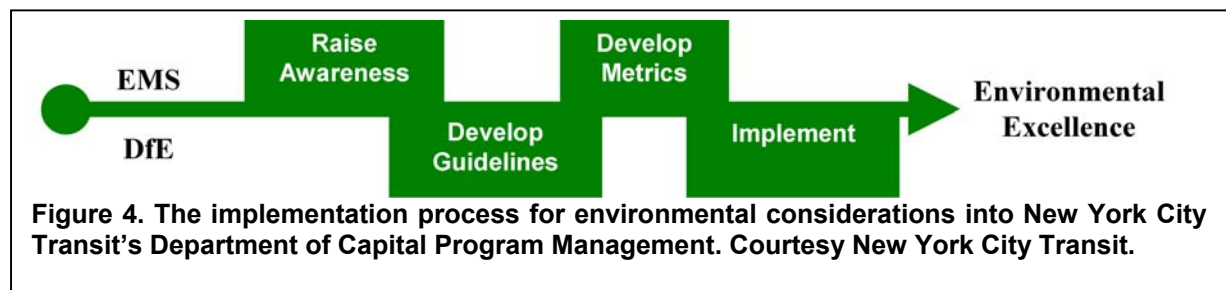
Although the integration of sustainable design is evolving, the work by the Advanced Concepts team and the EMS staff has enabled Teknion to expand their facilities-oriented approach to understand and identify their product's significant environmental aspects. This understanding of the life cycle impacts of the products provided a catalyst and motivated designers within the Department of Design, Development and Innovation to research and integrate environmental considerations within their existing activities. The EMS Manager and the Department are now active in providing the sales department with product oriented environmental information. In short, the work has laid a foundation for integrating environmental considerations into not only the design and development process, but also the sales, procurement and production activities.

### **New York City Transit's Capital Program Management**

New York City began operating its first official subway in 1904. Fifty years later, the State Legislature created what is now the Metropolitan Transit Authority, of which New York City Transit (NYCT) is a part. Today, NYCT operates the largest bus fleet in North America with 5,086 buses, making 45,550 trips per day totaling 107 million miles, or 171 million kilometers, per year. The subway system is no less impressive with an annual power consumption of 1.8 billion kilowatt hours. The whole system moves 7.2 million people every single workday or about 2 billion New Yorkers per year.

The Department of Capital Program Management (CPM) within New York City Transit (NYCT) has responsibility for the design, construction and rehabilitation of infrastructure associated with running bus and subway systems. CPM's 1,600 engineers, architects, planners and designers currently manage a total budget of 10.4 billion USD (2000-2004). This infrastructure includes: stations, maintenance shops, elevated lines and subway track, communication, power and signaling systems.

In an overall effort to improve performance, public image and reduce long term operating costs, CPM began implementing a strategic plan in 1999 to move towards environmental excellence as the "Sixth Pillar for Performance," alongside customer satisfaction, quality, budget, safety, & schedule as part of their Project Delivery Process. As the first step in their journey, CPM achieved ISO 14001 certification in 1999. These efforts led to the establishment of a Design for Environment Initiative that saw CPM begin implementing programs to integrate environmental considerations into their engineering, design, contracting and specification procedures. Figure 4 illustrates the overall approach taken by the multi-stakeholder Initiative Team. The Team was comprised of representatives from Capital Program Management, the New York Power Authority, New York State Energy Research and Development Agency, the Natural Resources Defense Council, Fox & Fowle Architects and Five Winds International. Although internally NYCT uses the term design for environment it is important to note that much of their building and infrastructure work addresses social and community aspects as well (i.e. sustainable design).



The overall approach involved:

- Launching the overall initiative by reaching out to NYCT stakeholders through a *Design for Environment Seminar* in February 2001. The Seminar introduced the Initiative to CPM and NYCT staff, suppliers and the architecture and engineering community of New York City. The Seminar, chaired by the head of CPM, Senior VP and Chief Engineer, Mysore Nagaraja,

allowed CPM to raise awareness and buy-in for their design for environment and eco-purchasing efforts.

- Providing an on-going series of awareness raising training sessions to CPM engineering and design staff on design for environment, DOE-2 building energy analysis, and eco-procurement.
- In order to guide both CPM staff and contracted architecture and engineering firms, CPM developed environmental performance guidelines for buildings, stations, depots and maintenance shop design and other construction projects. The guidelines are based on the significant aspects identified through CPM's ISO 14001 management system and touch upon the following principles: Energy Efficiency, Enhanced Indoor Environment Quality (IEQ), Conserving Materials and Resources, Operations & Maintenance, Water Conservation and Site Management, Construction Waste Management & Recycling. CPM environmental staff work with project managers to select and suggest specific guidelines that can be applied to the specific project and included in scopes of work, RFPs and specifications. While the long term vision is to have all project managers and design staff apply the appropriate guidelines, CPM recognizes that specific "subject experts" (e.g. electronics and signals) are necessary to build capacity and act as liaisons to Departments outside CPM.
- To track and measure performance for key projects, CPM developed a set of design for environment performance measures. These measures stemmed from the following needs:
  - Ensure that guidelines are adhered to throughout the design and construction phase of the project (some of which can take upwards of 10 years and involve multiple contractors and consultants); and,
  - Ensure that the final design performs as intended.

These measures are now being implemented on several of NYCT's large capital projects, including an eight-mile subway line extension with sixteen stations, along 2<sup>nd</sup> Avenue in Manhattan.

- To increase awareness and improve the effectiveness of the initiative, various support programs have been or are in the process of being implemented in the areas of "greening the supply chain," waste minimization, end-of-life management and communications & marketing. Furthermore, guidelines are currently being developed for power, communication and signal systems.

## Conclusions

During the course of this implementing the Initiative, CPM has recognized that a number of key factors were crucial to the initiatives' success:

- An upfront understanding of key challenges facing the Initiative Team, stakeholders and CPM staff is important in gaining commitment and changing design processes and procedures. Table 1 illustrates these challenges (e.g. understanding staff and management motivations) and the success factors (e.g. simplifying existing decision-making processes, providing tools) involved;
- The development of guidelines that can be applied at early stages in the conceptual design stage of capital projects is desirable. If included at this stage in a capital project, design features become a requirement for the subsequent stages of the project (i.e. Preliminary Design, Detailed Design and Construction); and,
- Measuring and tracking performance of long-term capital projects that involve multiple contractors, departments and elements (e.g. buildings, systems, track, tunnels etc.) is vital to ensuring that design concepts are ultimately realized.

Although the integration of sustainable design (under the title of design for environment) at NYCT is evolving, the work by CPM has enabled numerous key projects (including subway and bus maintenance shops, subway and inter-modal stations, painting systems etc.) to incorporate design features that will not only reduce their environmental impacts, but also reduce long term operating costs, improve staff productivity and reduce risks.

Addressing Challenges	Success Factors
Change: <ul style="list-style-type: none"> <li>• Change management within public sector</li> <li>• Understanding motivations</li> </ul> Management Commitment: <ul style="list-style-type: none"> <li>• Bringing champions on board level by level</li> <li>• Meeting their needs</li> </ul> Business Case: <ul style="list-style-type: none"> <li>• Learning from other organizations</li> <li>• Communicating benefits (cost &amp; risk management)</li> </ul> People: <ul style="list-style-type: none"> <li>• Getting the right people on board</li> <li>• Decision makers</li> <li>• Drivers</li> <li>• Listeners</li> <li>• Compromisers – sensitive to politics and management’s needs</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Having a clear strategy;</i></li> <li>• <i>Gaining management commitment;</i></li> <li>• <i>Simplifying existing procedures, decision making processes and providing tools;</i></li> <li>• <i>Developing cost-effective capital projects over the total cost of ownership;</i></li> <li>• <i>Empowering employees at all levels of organization; Establishing accountabilities, tracking procedures and responsibility centers;</i></li> <li>• <i>Setting realistic targets and implementing incentives;</i></li> <li>• <i>Gaining understanding and acceptance from contractors, consultants etc.</i></li> </ul>

**Table 1. Key challenges and success factors for New York City Transit's implementation of design for environment initiative (Singh et al, 2001).**

### **Black & Decker**

Black & Decker (B&D) is a global manufacturer and marketer of power tools and accessories, hardware and home improvement products, and technology-based fastening systems. B&D's products and services are marketed in more than 100 countries and the company has manufacturing operations in ten countries.

To support its corporate commitment to providing “Products and packaging designed in consideration of the environment in terms of raw material usage, manufacturing techniques, energy requirements, customer usage of the product, and end-of-service aspects” (B&D, 2002) the corporation's Power Tool and Accessories division began a project to improve the integration of environmental aspects into its product development process. The division produces corded and cordless electric power tools, lawn and garden tools, home products, accessories and attachments for power tools along with providing product service, repair and reconditioning. While other environmental management efforts have focused on waste minimization, product stewardship and health and safety, the main focus of this effort involved developing practical checklists and guidelines that designers can use to help them to consider environmental issues over a product's life cycle.

Unlike the previous case examples, the following discussion provides an in-depth look at B&D's DfE guideline development and implementation process. The example highlights the depth and detail necessary to systematically implement activities that support sustainable design within an organization. It is important to note that Black & Decker focuses on improving environmental performance and uses the term design for environment.

### **Process**

Rather than develop numerous checklists simultaneously for each type of power tool, a single checklist was used as a starting point. More specific checklists could be developed later on. B&D wanted to ensure that guidelines developed were relevant to the particular product types while also addressing current drivers facing the company (e.g. standards on energy efficiency and toxic materials, customer requests for information on the environmental features of products, etc.). The process B&D is using to develop the DfE checklist and guidelines is as follows:

- **Selection of a “generic product”:** Because B&D manufactures numerous categories of power tools that share common families of parts and platforms (e.g. motor armatures, gears, gear cases and switches), the company tried to identify a product that shares many common design features/parts in order to encompass a range of environmental issues. A matrix of

B&D components vs. products was used to select a cordless power tool to create the initial checklist.

- **Screening LCA:** Once the product was selected, a screening LCA of the product was conducted with Five Winds, based on the requirements of ISO 14041 (see also Figure 1). The goal of the study was to identify and understand the environmental issues of the product and thus the product category. This step involved collecting primary and secondary data from B&D and building a life cycle model using GaBi 3 life cycle engineering software. The model allowed the team to interpret the results of the life cycle inventory and gain a clear and quantifiable picture of life cycle issues for the cordless power tool.
- **Driver Identification:** Market, customer, regulatory, and internal drivers for DfE were identified for both the organization in general and specifically for cordless power tools.
- **Identification of environmental aspects:** Utilizing a proprietary method for screening the LCA results for significance, an initial list of environmental aspects was developed and combined with the drivers identified to create a master list of environmental aspects for the cordless power tool category.

			Is Action Required? Why?							
Product Component	Aspect	Root Cause	Environmental Impact	Regulatory Issue	Financial Liability/Opportunity	Stakeholder Interest	Level of Control/Influence	Objective	Potential Guideline	Assignment/Responsibility

**Table 2. Excerpt of master table headings for significant aspect identification. Courtesy, Black & Decker.**

- **Prioritizing Environmental Aspects and Developing DfE Guidelines:** The results of previous steps were then used to determine a prioritized list of significant environmental aspects. To aid in this, B&D considered the level of control it has over each aspect. A master table (Table 2) was created to summarize the list of aspects that were identified based on: environmental impact (determined as a result of the screening LCA), regulatory issues, market issues and customer issues. This allowed B&D to determine an initial set of objectives to help guide the overall DfE program including: reduce environmental impact of processes, use environmentally preferable materials, increase recyclability of products and reduce use phase energy consumption of products. Design guidelines were then developed which target the reduction of a specific aspect and also help to achieve an objective. This was done using the master table to clearly demonstrate the link between the aspects identified and the proposed guidelines.
- **Guideline review:** The master table was then circulated to a key group of designers affected by the guidelines within the cordless tool category. Interviews were conducted with key members of a product development team to further understand and validate the results of the aspect identification process, gain understanding of design decision-making, and identify opportunities for application of a DfE Checklist in the design process. The findings from the interview effort identified the following:
  - The model and results from the life cycle study were accurate with only minor modifications needed;
  - The designers would have a greater likelihood of addressing environmental considerations if they were mandated to do so through the existing procedures, reporting, communications and sign-offs within the design process (particularly in the earliest stages of the product development process); and,

- The designers articulated a need to have specific guidance for their product category and components that addressed environmental aspects. Several expressed interest in having engineering standards and other resources, information and data to aid in decision-making.
- **Guideline Refinement & Checklist Design:** Based on the feedback from the designers, B&D refined the results of the aspect identification process and began to refine and transfer guidelines from the master table into a format useful for designers. A tool was developed—the *DfE Checklist for Cordless Products*—that contains the objectives and guidelines (from the master table), examples of how these are to be met and an allocation of responsibility for each guideline (i.e. in some cases, purchasing, process engineering or R&D would be responsible for implementing specific guidelines). Table 3 below is an excerpt from the final draft checklist produced as a result of the project. The resulting checklist identifies priority guidelines that are directly related to a significant aspect, thereby focussing the designers' efforts on those guidelines that have the greatest potential to improve the environmental profile of the product. The overall DfE objectives may also be used to help determine key metrics to track the continuous improvement of B&D's products.

Objective	P/R	Guideline	Activity	Action Taken	Comments	Fulfilled	
						Resp	Date
<i>Increase recyclability of products</i>	R	Design components / product for disassembly & serviceability	<ul style="list-style-type: none"> <li>• Design using a hierarchical and modular design structure</li> <li>• Keep sub-assemblies simple (i.e. wiring, brushes, etc.)</li> <li>• Easily separable connections, use detachable joints such as snap, screw or bayonet joints instead of welded, glued or soldered connections</li> <li>• Minimize type and number of fasteners</li> <li>• Easy to reach screw heads</li> </ul>				

**Table 3. Excerpt from draft B&D DfE Guidelines & Checklist. (P=preferred, R=required, Resp.= responsible individual/unit). Courtesy, Black & Decker.**

## Conclusions

As a result of this process, B&D is now integrating the use of the DfE Guidelines, objectives and targets into the product development process of the division. It recognizes that the integration of DfE into the design process is an ongoing process. A number of factors are important to note:

- The process is incremental, but is based on a comprehensive understanding of the pressures the company faces, combined with actual data and information about products over their life cycle;
- The development of tools, techniques and methods that include more than life cycle assessment (other business drivers) during the aspect identification process focuses the company's efforts on product components where the most improvements can be made;
- B&D sees the input from designers at the company as a crucial factor to creating tools and procedures that will be effective and readily adopted; and,

- B&D also noted that the use of ISO 14001 language (e.g. aspects, objectives, etc.) and framework is familiar to the company and thus more easily understood by those involved in both environmental management and design.

The process and the resulting tools developed within B&D illustrate the importance of implementing design for environment in an incremental, systematic fashion that gains employee buy-in and works within the organization's existing business climate and corporate culture.

## A Flexible Framework

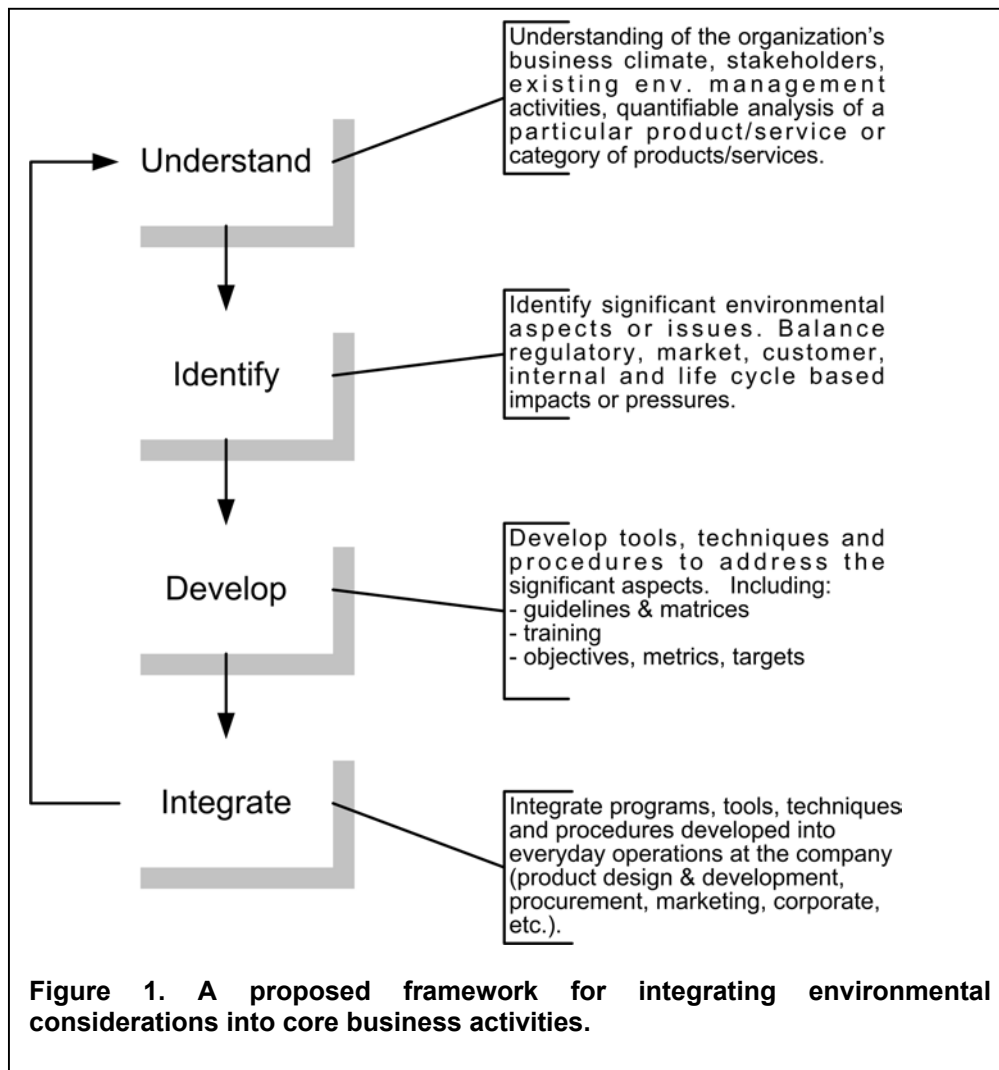
Each case example illustrates a different journey to implement sustainable design within the organization's core activities. Although facing distinctively different business drivers, the conclusions from each case study emphasizes a number of common challenges:

- **Gaining understanding:** Each organization identified that understanding the organization's internal and external context was a key factor in starting and implementing their efforts. This includes understanding organizational culture, customer and market pressures, stakeholder needs and regulatory issues. It was also noted that the potential internal challenges (NYCT) faced during the implementation process are important to recognize (e.g. management commitment, employee buy-in).
- **Identifying significant aspects:** Both Teknion and B&D engaged in work to identify the significant environmental aspects of the product or system. This guided their efforts to improve their environmental performance and also served to raise awareness with staff (Teknion). Furthermore, B&D balanced these aspects with their regulatory, market, customer and internal pressures.
- **Developing tools, techniques and procedures:** The organizations identified that developing guidelines, decision-making tools and procedures was an important aspect of their efforts to implement sustainable design. It was also noted that effective tools, techniques and guidelines require input from design, engineering and other staff.
- **Integrating tools, techniques and procedures:** The examples illustrate that integrating sustainable design is an incremental process that can enhance or involve a number of different business functions. The need to work with other business functions underlies the importance of using language and approaches familiar to the organization (B&D, NYCT). Both B&D and NYCT also noted that measuring and tracking performance of their products/systems was a key point of implementation.

These case examples indicate that to implement sustainable design, companies must not only be aware of the challenges, but also have ways to address each in an effective manner. A potential framework that addresses these challenges is: (1) **Understanding** the situation a company is in, (2) **Identifying** what environmental issues are most important, (3) **Developing** means to address these environmental issues, and (4) **Integrating** these means into everyday operations. When carried out in sequence, this framework (Figure 5) can help to provide a pathway for companies to follow when implementing sustainable design at the organizational level. It should be recognized that the four main stages could be applied to a range of organizations, private or public. However, what occurs within each stage may differ, depending on the organization, its drivers, products, product systems and services. For example, at B&D and Teknion, LCA's were conducted in what would be the first stage, in order to obtain a more rigorous quantitative understanding of environmental issues because LCA is suitable tool for product assessment. For NYCT, however, an LCA was not conducted at this stage; rather they utilized the results of their ISO 14001 aspect identification to help understand specific environmental issues.

As proposed, the framework is a series of four key, sequential stages. Within each stage, the organization undertakes activities based on their unique situation and product/project development processes. It can also be noted that the stages can be seen as a cyclical pattern that always returns to (or begins with) gaining understanding. For example, without a true understanding of the pressures and demands on the organization (e.g. stakeholder, customers etc.) – whether products such as B&D and Teknion, or services such as NYCT – the efforts can become misguided. With true understanding of the situation, the organization's efforts can focus on the most significant issues, which may differ from those that are perceived to be significant. This indicates that business functions whose role it is

to understand the organization's business context (e.g. marketing, management, etc.) have an important role to play in integrating sustainable design.



## Conclusions

The case examples discussed in here provide insights into how three organizations have integrated sustainable design into their core business functions such as design and development. Several key factors and challenges were identified, indicating this is an evolutionary process and a continual effort. Based on the findings of the case examples, a framework was proposed:

- Understanding
- Identifying
- Developing
- Integrating

This framework can provide similar organizations with an understanding of the main stages of implementing sustainable design activities into their organization.

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