SMART DESIGN = SUSTAINABLE DESIGN
Connecting lifecycle insights with design decision making

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THE STATE OF SUSTAINABLE DESIGN

The product development process is poised to take a quantum leap forward when designers and lifecycle scientists can work together in creative partnerships to make products that meet environmental sustainability goals. Until this happens, it is unlikely that product systems will effectively address relevant sustainability criteria and meet environmental performance standards.

To accomplish this, design practice must be adapted and expand beyond what is already a broad skill set: designers are skilled systems thinkers, capable of investigating, understanding, synthesizing and proposing useful and appealing responses to the system of human needs and wants. However, 'useful and appealing' is not enough–what has been [and is being] produced has depleted resources, fostered unhealthful working conditions, littered the oceans and generally toxified the earth. Lifecycle-to-Design can advance an aesthetic in which potential adverse environmental impacts are considered and managed, and positive impacts optimized. Integrating product lifecycle information into design and product development teams can promote strategic and smart design decision-making leading to desirable, low-impact, and innovative products and services.

A WORD ABOUT LIFECYCLE ASSESSMENT

Lifecycle Assessment [LCA] is a useful and critical tool used to assess the environmental impacts of production, use and disposal of a given product system. But if these assessments are so useful, why aren't all designers trained in LCA? Why aren't design students taught how to work with LCAs and lifecycle scientists to use that information in their creative process? Why isn't LCA in the design brief? Designers began exploring the relationship between lifecycle science and design only recently, and realized that both are fundamental to environmental sustainability. Moreover, designers are not scientists and scientists are not designers: they don't speak the same language and operate by different rules.

Yet designers, and the project teams they are guiding and providing creativity for, clearly need information contained in lifecycle studies to achieve solutions that are environmentally responsible, in addition to being functional and appealing. Without scientific, lifecycle data, designers will continue to tweak, making slightly 'greener' products, without achieving any recognizable, calculable, and significant reduction in adverse environmental impacts. Alternatively, if designers are 'smart' about product lifecycles and material and energy flows, they can apply that knowledge to transform entire product systems.

ART CENTER + NESTLÉ RESEARCH PROJECT

Art Center College of Design faculty and student researchers teamed with Nestlé lifecycle assessment experts, product developers and designers to investigate how lifecycle information could effectively be incorporated into the design process and guide environmentally sustainable outcomes. The challenge was not convincing anyone of the importance of sustainable product development, but rather of translating lifecycle information and integrating it into the workflow and decision-making process of new product development or renovation. Where, when and how should lifecycle information be introduced to inform the design team and influence the design? Consequently, can the strategic and timely introduction of lifecycle information provide challenging constraints and a new and rich source of inspiration for the designers, and set the stage for innovative outcomes?

Our research activity revealed that designers (and the R&D project teams they are supporting) were motivated to address sustainability and eager to expand their skill-set but found the structure and language of scientific inquiry, the basis of lifecycle assessment, complicated and not actionable. In addition, the designers were challenged by a lack of tools to formulate sustainability-based responses.

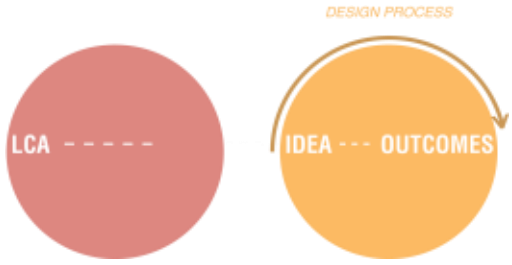
LIFECYCLE-TO-DESIGN [L2D] METHODOLOGY

In response, we introduced the Lifecycle-to-Design (L2D) method, which was first developed in the classroom with Art Center design students. L2D is a method to convert lifecycle results into actionable design goals. Incorporating research insight, the project team expanded the L2D method and developed an 'L2D Methodology' to make the designer, and the design, smarter about lifecycle. The methodology combines lifecycle-based goals and strategy development for sustainable design outcomes with custom communication and design tools.

Since we found design teams needed lifecycle information to be accessible and visually differentiated to be useful, we proposed an interactive LCA platform to facilitate data access. We also proposed an icon system to better visualize and communicate essential LCA results. With a more accessible LCA, we further proposed to integrate lifecycle information into the design process. We adapted our L2D method, and created a complementary strategy tool to inspire design ideation and solutions.

Lifecycle-to-Design (L2D)

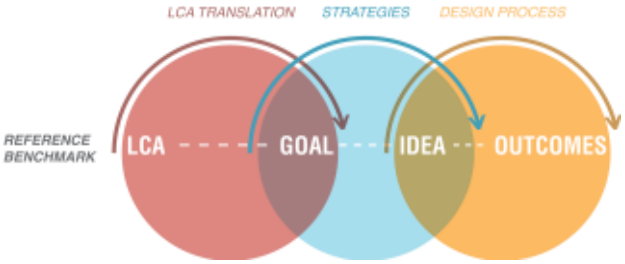
Lifecycle assessment [LCA] and design process exist as separate activities, conducted by specialists, resulting in what are in effect, exclusive and proprietary results. This insight, which the research supported, led to further development of a method to connect the two activities to achieve what would be lifecycle design decision-making.



The 'L2D' method is a simple and effective framework for connecting lifecycle assessment information with design development. It considers LCA impact data and conclusions, and restates them as design goals. These LCA-derived environmental sustainability goals become a part of the team's Design Brief, and guide the selection of strategies to drive product concepts. This approach prioritizes environmental

sustainability, embeds critical lifecycle information into the design process, and provides a design rigor around sustainable product system development.

The method is linear and proceeds through five steps. First, the designer reviews the LCA's environmental impact data and conclusions. Based on this review, the designer develops and articulates environmental goals for the design. During the design process, the designer considers multiple strategies and creates product concepts that address the environmental goals.



Step 1 / **Begin with a representative LCA and understand it.**
The L2D process begins with a reference lifecycle assessment. The designer uses the LCA to more fully understand the product system and the product's potential environmental impacts. Understanding the LCA's data and format is often difficult for non-scientists. We created a strong lifecycle iconography and optimized an LCA platform to make lifecycle assessment data and conclusions more accessible and useful to the designer and other non-scientists.

Step 2 / Translate the lifecycle impact insights into design goals.
The LCA's impacts and conclusions are stated as design goals, which aim to reduce or eliminate negative impacts and increase positive impacts. In this way, designers derive design goals using lifecycle and environmental impact information relevant to the product system rather than create generic or narrowly focused environmental goals.

Step 3 / Select and propose strategies that address the stated design goals.
Using the design goals derived from the lifecycle assessment, a variety of design strategies are considered. We proposed a design strategy tool to suggest specific environmental goals as well as environmental impacts and sustainability in general. Strategies can target the stated goals, but may also be broad and unexpected so that concept development is rich and imaginative. The use of strategies, and the strategy tool in particular, is meant to provide not only 'best practice' concepts, but also to provoke 'leading' sustainable design outcomes. The tool should be seen as a design instigator for sustainability, with new strategies periodically added by designers thus forming a living, collective knowledge base.

Step 4 / Create design concepts using strategies based on the lifecycle goals.
Use the strategies to aid in creating design concepts that directly address lifecycle impacts and improve lifecycle performance. The purpose is also to inspire different and potentially innovative design concepts.

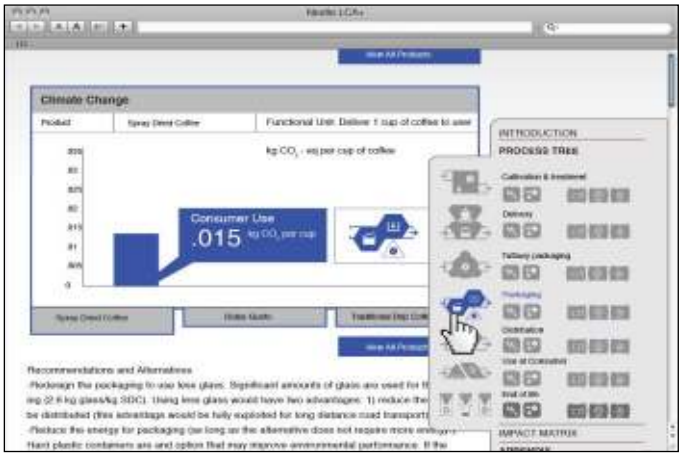
Step 5 / Iteratively test and improve the concepts.
The design solution may be tested using lifecycle assessment process. Impacts are compared and the achievement of lifecycle goals evaluated. Importantly, the design and system is evaluated in terms of form, function and sustainability.

The L2D method can be used to target specific environmental impact categories. It is also flexible and can be used to inspire innovative design concepts. Essentially, the method enables the designer to clearly link design attributes back to specific lifecycle-based goals.

Optimized Lifecycle Assessment Format / LCA+

The structure and data display of an LCA follows the format of scientific reports, and consequently is unfamiliar to and not easily understood by the non-scientist. An optimized format, a system of lifecycle icons, and a concept for an interactive platform was created to improve the accessibility of lifecycle information. This proposal for a useful and functional LCA is a key step in the overall research objective of integrating lifecycle information into design process.

However, the research showed there exists a substantial communication gap between LCA information and the user. The research team considered a modified LCA structure as well as an interactive platform. An example is shown here.



The interface would be web-based and allow users to quickly access relevant product LCA data to guide their design process. LCA+ offers a number of new features, in particular the 'pull-out process tree,' to access a diagram of lifecycle process steps on demand. The process tree tab also serves as a navigation tool for additional information. Website analytics would track usage patterns informing Nestlé scientists of LCA usage trends, for the purpose of updating and adding to active areas. Currently, LCA+ content is guided by ISO 14000 series standards. Finally, LCA+ was developed using data from three Nestlé LCAs supplied to the research project [Humbert, et al., Rossi et al., and Quantis].

Lifecycle Information Graphics / LCI+

The research demonstrated that users would respond to the information if it were presented using a graphic, visual form of communication. Using graphic language to make LCA data more understandable became an opportunity to link LCA with design. In particular, designers found the Process Tree, which represents the processes, and material and energy flows through the product system, to be a useful diagram for understanding the lifecycle. This suggested that an expanded, graphic representation of the Process Tree would be a valuable outcome of the research. Therefore, a visual shorthand, representing the lifecycle and the process tree, became an important objective of the research.

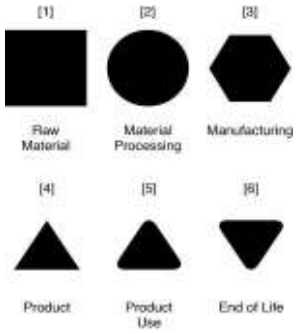
An icon-based lifecycle graphics system was created to enhance the optimized LCA+. The system was designed with the following parameters, with a view to expand and create a comprehensive set of icons:

- Represent the process steps in the lifecycle, and the material and energy flows.
- Clear and comprehensive set of icons to work in combination with the system.

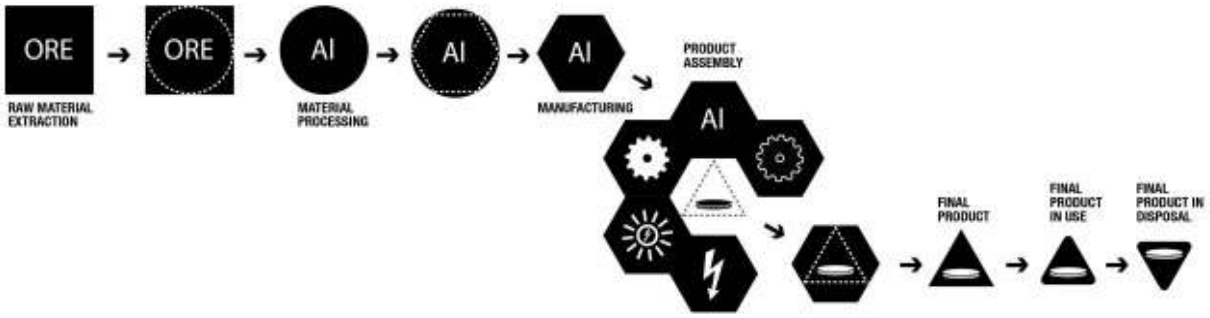
- Ability to diagram simplified lifecycles, as well as complex lifecycle systems.
- Legible at different scales, and functional in color, black and white, and greyscale.

Icons for Lifecycle Stages

The basis for the system is a set of shapes that relate to different process steps in the lifecycle. The shapes are illustrated at right and begin with 'Raw Material' and progress through 'Disposal.' The shape changes to suggest the activities taking place in the lifecycle, from the unprocessed [1] Raw Material square, to the rounded [2] Material Processing circle, to further processing in [3] Manufacturing, represented by a hexagon. The [4] Product is represent by a triangle, which becomes rounded when it is [5] in Use, and inverts for [6] Disposal/End of Life.



The following simplified diagram shows how the system of shapes, transformations, text and icons may be used to describe the lifecycle of a product. Using the aluminum lid of a baby food jar as an example, a complete lifecycle, from raw material to disposal, is visualized and communicated.

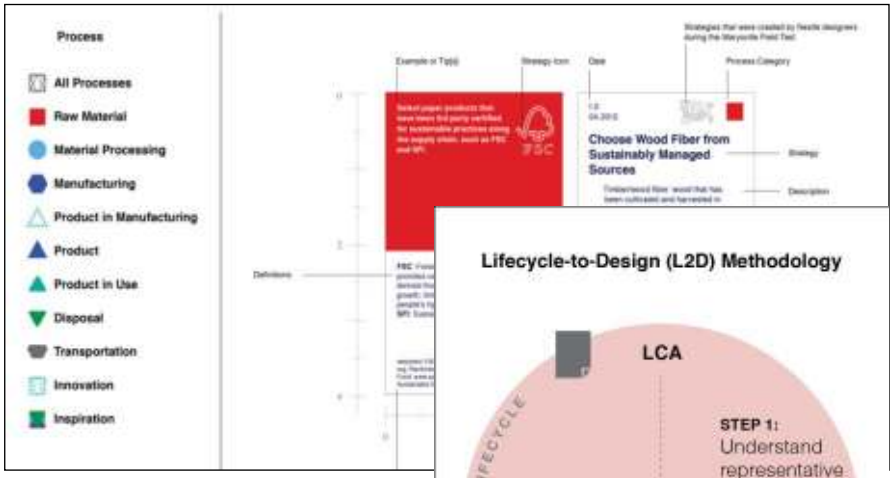


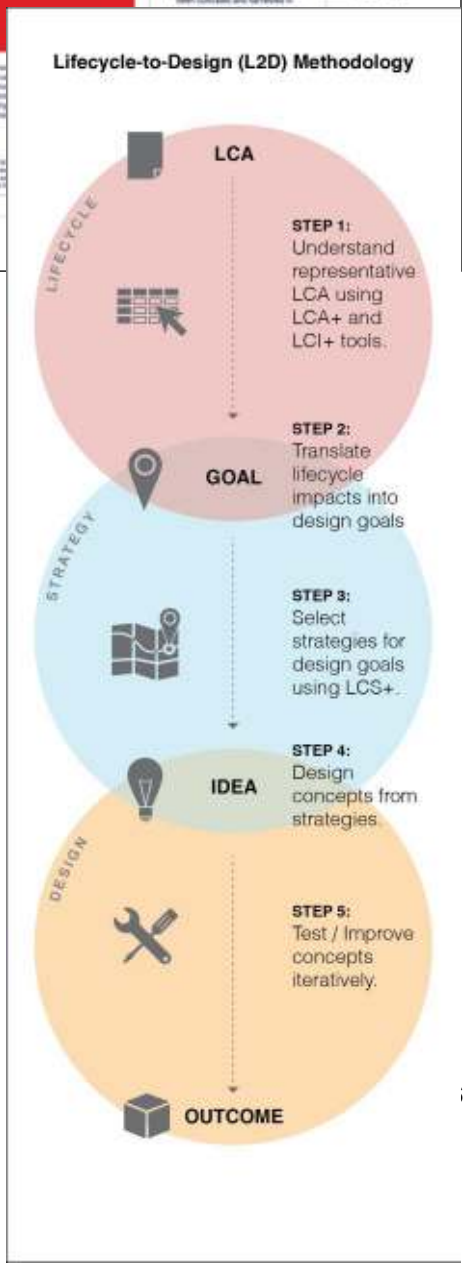
Lifecycle Strategy Tool: LCS+

Minimizing the environmental impacts of products and product systems is a priority of sustainability in design. Although product development teams may consider a variety of potential strategies for sustainable product development, many are new, unknown and untested. Consequently, product designers routinely use the same strategies, slowing progress towards more sustainable outcomes. Encouraging creative professionals to consider alternative and/or innovative strategies and ideas could speed the adoption of products with reduced environmental impact. In response, the research team created a set of cards as a strategy development tool to guide, influence and inspire product concepts and outcomes that specifically address lifecycle and environmental concerns.

Used with the L2D method, the Strategy tool facilitates the translation of lifecycle-based goals into possible strategies for concept development and design creation. The tool was tested and refined throughout the project. The present tool contains general strategies, new and open-ended strategies, and strategies specific to Nestlé. It is expected that the tool can support product development and design activities, for teams as well as for individual use. We propose it as an interactive, web-based program, which allows for an expandable and updatable strategy set, as well as a printed deck. The list of possible strategies is almost infinite, because sustainable consumption requires the broadest possible view of product systems. The tool is intended to be in continued revision to remain useful and representative of 'best practices' and 'leading indicators'.

While the purpose of LCS+ was very specific, in that it was developed to assist designers, it is expected that its usefulness will be much greater, extending to the entire product development team. Strategists and developers, packaging technicians, technical teams and marketing & communication groups may find the LCS+ tool helpful to facilitate the advancement of sustainability within the company and throughout product lines.





RESEARCH INSIGHTS

Research is always challenging, and in the case of the Art Center-Nestlé research, it was provocative and optimistic as well. The results suggest that our hypothesis was correct: Designers who are informed and intelligent, in a word 'smart,' about product lifecycles, would be able to make appropriate design decisions and create products that minimize negative environmental impacts. We also found that by introducing lifecycle information into the designer's data set, we were adding a level of rigor to the design process that could lead to new and innovative outcomes.

The research taken on by Art Center College of Design and Nestlé presented a unique opportunity for inquiry by those engaged in product design and lifecycle assessment. By making product lifecycle information available, can we make products

and services that are designed to have less environmental impact? Can we integrate 'environmental sustainability' into product functionality?

While classroom and studio instruction in Design for Sustainability at Art Center suggested a possible method for doing this, it was not until faculty and student researchers conducted this case study research with Nestlé designers and scientists that it could be more fully developed. This methodology, named Lifecycle-to-Design [L2D], is a framework for integrating lifecycle information and insights into concept development, and includes tools that support the methodology. The research was sponsored and nurtured by Nestlé scientists and Design leads in the spirit of contributing to general knowledge and transparency on best practices around sustainability within the design community.

The key instrument of product environmental information is lifecycle assessment [LCA], an analysis of material and energy flows throughout a product's life. Early in the research we learned that designers are challenged by the scientific nature of the LCA format, text and data, and were less able to make use of the information. Since lifecycle data is key to making design environmentally smarter, we turned to design to solve this and created new tools and a visual vocabulary to facilitate understanding and navigation of this complex analysis. Within the framework of L2D, we created a more easily accessed LCA [LCA+], an icon-based system to communicate and visualize LCA information [LCI+], and a living deck of sustainability strategies to inspire and guide environmentally improved product concepts [LCS+].

The overarching insight of the research is that design represents one of the most immediate and effective ways to make product systems that are based on environmentally responsible material and energy choices. By integrating smart lifecycle information into the design process, the products of design reduce adverse impacts to the environment. There is an opportunity for designers, lifecycle smart designers, to make this possible.

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