# Herman Miller's Design for Environment Program

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Herman Miller launched its Design for Environment (DfE) program in the 1990s. At the core of the Herman Miller DfE program is the McDonough Braungart Design Chemistry (MBDC) Cradle to Cradle Design Protocol, which evaluates new product designs in three key areas:

- **Material Chemistry** -- What chemicals are in the materials we specify, and are they the safest available?
- **Disassembly** -- Can we take products apart at the end of their useful life to recycle their materials?
- **Recyclability** -- Do the materials contain recycled content, and more importantly, can the materials be recycled at the end of the product's useful life?

Herman Miller's commitment to DfE includes requiring all new products be evaluated within the MBDC Protocol.

## Material Chemistry Assessment

When Herman Miller launched its DfE program, the challenges for the DfE team were substantial: Learn how to use and integrate the MBDC protocol into the launch of new products, modify MBDC's protocol to meet the needs and unique circumstances of Herman Miller, gather the data necessary to meet material evaluation criteria as required by MBDC's material health protocol, gain acceptance from product development teams for design process changes, and complete all this work on a schedule that would not delay the launch of products.

A core component of the MBDC cradle-to-cradle method is its materials assessment protocol, which evaluates the hazards posed by the chemical constituents of materials. All chemical constituents of a material, down to 100 parts per million, are included in the assessment. The goal is to select materials that are based upon non-hazardous chemical inputs.

The difficulty of collecting chemical constituent data varies across materials. Ascertaining the chemical constituents of steel and aluminum is relatively easy because constituents are specified by industry standards. For example, to identify the chemical constituents of a 1010 steel shaft consult the A.I.S.I.--S.A.E. Steel Specifications.

Identifying the chemical constituents of materials such as plastics, colorants or coating finishes is far more difficult. Constituents and formulations vary across the petrochemical supply chain. In addition, there are no industry standards as with metals, and the manufacturers consider their formulations proprietary.

To collect data the Design for the Environment team scheduled face-to-face meetings with over 200 members of its supply chain. Suppliers within the supply chain initially were reluctant to reveal their chemical constituents. After the face-to-face meetings where

[1] This is an abbreviated version of a longer case study by the same authors. Affiliations of authors: Mark Rossi, Clean Production Action; Scott Charon and Gabe Wing, Herman Miller Inc.; and James Ewell, McDonough Braungart Design Chemistry.

Herman Miller explained the purpose of the data collection, how the data would be used, and that future business was contingent upon providing the data, nearly all the suppliers furnished data on chemical constituents after non-disclosure agreements were signed. To alleviate supplier concerns with confidential business information (CBI), Herman Miller assigned a chemical engineer to be the sole proprietor of CBI data.

Herman Miller's preference is to work within its established supply chain and has spent a lot of time educating its suppliers about the goals and requirements of the DfE program. Supplier support of these goals is crucial. The usual interaction between the DfE team and a supplier is: 1) introduction to DfE program and metrics; 2) explain purpose of material assessment process; 3) guide supplier through the material inventory process; 4) provide feedback about assessed material; 5) work with supplier to find substitute inputs or, if necessary, a new material; and 6) if supplier refuses to provide data or is unable to make needed formulation changes, seek an alternative supplier. In the course of designing the Mirra chair, a supplier did refuse to disclose the additives used to manufacture its polypropylene plastic. Herman Miller dropped the uncooperative supplier after it found an alternative supplier willing to provide the data.

Upon receiving the chemical constituent data, the DfE team engineer incorporates it into Herman Miller's database and sends the formulation to MBDC -- excluding supplier and product trade name -- for assessment. The Mirra's components involved 40 different materials constituted from 200 different chemicals. In the MBDC protocol, each material is classified into one of four categories based upon a hazard assessment of the chemical constituents used to manufacture the material: green (little to no hazard), yellow (low to moderate hazard), orange (incomplete data), and red (high hazard).[2] Table 1 lists the human and ecological health criteria MBDC uses to evaluate the hazards posed by the constituents of a material.

**Table 1. Human and Ecological Health Criteria included in MBDC's Materials Assessment Protocol[3]**

| Human Health Criteria | Ecological Health Criteria |
|---|---|
| Carcinogenicity | Algae toxicity |
| Teratogenicity | Bioaccumulation |
| Reproductive toxicity | Climatic relevance |
| Mutagenicity | Content of halogenated organic compounds |
| Endocrine disruption | Daphnia toxicity |
| Acute toxicity | Fish toxicity |
| Chronic toxicity | Heavy metal content |
| Irritation of skin/mucous membranes | Persistence/biodegradation |
| Sensitization | Other (water danger list, toxicity to soil organisms, etc.) |
| Other relevant data (e.g., skin penetration potential, flammability, etc.) | |

[2] William McDonough, Michael Braungart, Paul T. Anastas, and Julie B. Zimmerman, 2003, "Applying the Principles of Green Engineering to Cradle-to-Cradle Design," *Environmental Science and Technology*, December 1:434A-441A.
[3] Source: McDonough, et al., 2003, "Applying the Principles of Green Engineering to Cradle-to-Cradle Design," *Environmental Science and Technology*.

Herman Miller's goal for the Mirra chair and all new product launches is to use materials that rank yellow or better -- i.e., no red or orange. The target "red" materials and chemicals include brominated flame retardants (BFRs), hexavalent chrome plating, and polyvinyl chloride (PVC) plastic. All of these materials are manufactured with or contain chemicals that are persistent, bioaccumulative, and/or chronic toxicants.

Polyurethane foam containing BFRs were eliminated when the design team decided not to use traditional foam materials for seat and back support (see photo insert for absence of the cushions). Interestingly, environmental concerns were not the motivating force behind eliminating the foam cushions. Rather the motivation was improving chair performance: increase breathability and comfort -- keep the body cool -- by creating open spine and seating. The elimination of foam cushions exemplifies how product and environmental performance can be simultaneously enhanced through design choices.

In 2001, Herman Miller made an organizational commitment to phase out the use of PVC plastic in new product launches. According to MBDC's material protocol, PVC is considered to be an ecologically inappropriate material partially because of its organochlorine content, and to a lesser degree due to the use and generation of chronic toxicants in manufacturing, including the known carcinogens vinyl chloride monomer and dioxins. Other factors motivating the decision include: customer demand for PVC-free products and shareholder opposition to PVC use.

Herman Miller calculates a single material chemistry score for all of its products by:

- Identifying the weight of each component.
- Multiplying the component's weight by its material chemistry assessment color code, which is translated into a percent -- Green = 100%, Yellow = 50%, Orange = 25%, and Red = 0%.
- Adding up the material chemistry weight of each product and dividing by the total weight of the product to calculate a final material chemistry score for the entire product.

Over the course of its development the Mirra's final material chemistry score increased from 47% to 69% in the final chair. A key change improving the material chemistry was eliminating the PVC products. The color code breakdown of materials by weight in the Mirra is: Yellow = 52%; Red = 1%; Orange = 4%; and Green = 43%. The remaining "red" materials for the base chair model are a steel shaft that contains lead and a very small, high performance Teflon™ (a perfluorinated organic compound) impregnated bushing.

## Disassembly

Herman Miller evaluates the ease of disassembling products based upon four questions:

1. Can the component be separated as a homogeneous material, with no other materials attached? Mixed materials have little to no value in recycling programs. The goal is for disassembly to create individual components that may have value when recycled.
2. Can the component be disassembled using common tools -- screwdriver, hammer, and a pair of pliers? The goal is for the chairs to be easily disassembled anywhere in the world.

3. Does it take less than 30 seconds for one person to disassemble the component? The product development team disassembled many products and concluded that any component that takes greater than 30 seconds to remove is too long.
4. Is the material identifiable and marked? If parts are not marked, then disassemblers will not know which recycling bin to place them in.

## Recyclability + Recycled / Renewable Content

Ideally at the end of their useful life in the chair the components of the Mirra can either be recycled over and over again into the same component or composted into healthy, non-hazardous biological nutrients for soil. Herman Miller evaluates the recyclability/compostability of a component based upon three criteria:

1. Material is a technical or biological nutrient and can be recycled (or composted) within an existing commercial collection and recycling infrastructure? If yes, the component receives a score of 100%.
2. Can the component be down-recycled (recycled but into a lesser value product) and does a commercial recycling infrastructure exist to collect and recycle it? If yes, the component receives a score of 50%.
3. Is there no recycling potential or infrastructure for the product? If yes, the component receives a score of 0%.

The recyclability score for each component is calculated by multiplying the recyclability percentage by the weight of the component. The final recyclability score is the ratio of the total recyclability weight to the total weight of the chair. Herman Miller's goal for all products is to attain a recyclability ranking of 75%.

Appendix 1 describes how Herman Miller calculates a single DfE score for each product.

## Lessons Learned and Next Steps

Critical lessons learned in implementing the cradle-to-cradle framework at Herman Miller were the need to:

- Go outside of the organization to MBDC for a different perspective of "sustainable" design.
- Hire dedicated full-time staff that could eventually become a valuable resource to all product development teams.
- Establish a comprehensive database to manage data and to transmit complex information in a simplified presentation to design teams. This is an essential tool for learning organizations who wish to leverage valuable information across many product platforms versus a single project. DfE team members also found that it was necessary to hold training sessions with development teams to clarify and reinforce the DfE process.
- Develop partnerships with suppliers. Herman Miller and suppliers have found material transparency to be mutually beneficial. Larger suppliers may also have toxicity data that is absent from publicly available sources. Partnerships also foster trust which is essential when asking suppliers to share proprietary formulation information or to make formulation changes to meet new requirements.

## Corporate Commitments

President and CEO Brian Walker, has established a 2010 DfE goal that 50% of all sales from products must meet the DfE protocol. The strategies that will help meet this goal include:

- Develop a "YELLOW" or better palette for major commodities.
- Eliminate "RED" materials.
- Design for disassembly.
- Maximize recycled content and recyclability.
- Incorporate energy concerns into material selection.
- Eliminate PVC for a product set.

These strategies are part of Herman Miller's "Perfect Vision" initiative. Brian Walker, CEO, explains: "we have designated the year 2020 as our deadline to achieve a range of sustainability targets, including zero landfill and zero hazardous waste generation. This initiative, which we have named 'Perfect Vision,' charts a challenging course. With continuing improvements in technology and a strong commitment among Herman Miller employees, we fully intend to reach these goals."

## Barriers & Opportunities to Implementing Green Chemistry & Sustainable Materials Selection

### Barriers

- **Staffing.**
  - Implementing DfE requires staff that focuses on environmental issues yet are integrated into the design team.
- **Collecting chemical constituent data for plastics, colorants and coating finishes.**
  - Constituents and formulations vary across the petrochemical supply chain. Industry standards are absent for these products, unlike metals, and the manufacturers consider their formulations proprietary.
  - Collecting chemical constituent data from manufacturers of these products required signing confidentiality agreements with vendors.
  - Herman Miller had to be clear and firm with suppliers that providing the data was a requirement to being a supplier of the firm.
- **Evaluating the hazards of a chemical.**
  - Gathering more comprehensive data on a chemical required, in some cases, going back to the supplier and requesting additional data and tests.
  - Performing a comprehensive assessment of the hazards associated with chemicals required turning to outside expertise at MBDC.
- **Eliminating materials that lack an easily identifiable and cost competitive alternative.**
  - The elimination of PVC in the Mirra chair challenged the design team both in terms of performance and cost. Investing the time to finding suitable alternatives required senior management support.
- **Integrating significant design changes into existing products.**
  - The DfE team knew that changing the design of Mirra chair after product launch would be difficult: resources for testing alternatives would be scarce, the product development team would be disbanded, and gaining attention for the need to change an existing component would be difficult.

Note that a common barrier to DfE implementation, executive management level support, is absent at Herman Miller where senior managers support the integration of DfE into all product development.

**Opportunities**

- **Investing in high quality design pays off in the long run.**
  - In terms of aesthetics: a well-designed product retains its aesthetic value and therefore economic value over time. Reflecting Herman Miller's investment in design, the Mirra chair's awards included: a Gold Award in the Best of NeoCon 2003, a Silver Award from 2004 Industrial Design Excellence Awards (IDEA), GOOD DESIGN™ Award for 2003 from the Chicago Athenaeum Museum of Architecture and Design, and a "Top 10 Green Building Product" for 2003 from *BuildingGreen*.
  - In terms of production:
    -- The long-term, repetitive manufacture of the same product is efficient and reduces cost.
    -- In the case of the Mirra chair, the elimination of foam cushioning exemplified how product and environmental performance can be simultaneously enhanced through design choices.
- **Customer demand.**
  - In building interiors and finishes there is growing environmental awareness and demand for environmentally preferable products.
- **Shareholder concerns.**
  - Socially responsible investors are taking notice of the chemicals and materials used by manufacturers and demanding that firms evaluate and select for less hazardous, more environmentally preferred chemicals and materials.

## Appendix 1. Herman Miller's DfE Product Assessment Tool - Calculating a Product's DfE Score

The DfE Product Assessment Tool calculates a single DfE score for each product. To derive this score Herman Miller:

- Calculates a final DfE score for each part in the product. The DfE score for each part is determined by the scores received in each of the three assessment categories: material chemistry, disassembly, and recyclability-recycled/renewable content. These scores are summed and divided by the total potential DfE weight of the part to create a final DfE score for each product:

$$\frac{\text{⅓ Material Chemistry Score (g)} + \text{⅓ Disassembly Score (g)} + \text{⅓ Recyclability-Recycled/ Renewable Content Score (g)}}{\text{Total Potential Weight (g)}} = \text{Final DfE Score for each part}$$

  Thus the highest potential score of 100% requires a part receiving its full weight for each of the three assessment categories.
- Weights each of the three assessment categories equally: material chemistry, disassembly, and recyclability-recycled/renewable content are of equal importance. Within the last category, recyclability of materials carries a higher weight than recycled/renewable content.
- Adds the DfE weights for all the parts divided by the "total potential DfE weight" of the parts to calculate the final DfE score for the product, e.g., the Mirra chair.

Table 1 below details the calculation process for Fictional Product X. Included in Table 1 are the data points collected by the DfE team for each part, including: part description, material content, supplier, and weight. The final DfE score for Fictional Product X is 62.6% of a possible score of 100%. For the Mirra chair, its final DfE score was 70.6%, which represented a 43% increase in environmental design improvements from the initial design.

### Table 1. Calculating the Final DfE Score for Fictional Product X

| CHA-1234 | ECO Chair | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bill of Material | | | | | | DfE Score | | |
| Part # | Qty | Description | Material | Supplier | Wt (g) | DfE Weight: Mat. Chem. + Dis-assembly + Recyclability (g) | Potential DfE Wt | Final Score |
| 123456-BK | 1 | FRAME, SEAT | 16 Ga. 1008-1010 Steel | Frame Inc. | 2,500 | 1933.3 | 2500 | 77.3% |
| 123457 | 1 | PAN - SEAT | 20% GF Polypropylene | Molders Plus | 600 | 175.0 | 600 | 29.2% |
| 123458 | 4 | FASTENER - PU | Sintered Metal | Fastener Land | 42 | 39.2 | 42 | 93.3% |
| 123459 | 4 | FASTENER - ST | Spring Steel | Fastener Land | 1 | 0.8 | 1 | 76.7% |
| 123460 | 4 | BUMPER | Super Rubber | Importers R'Us | 26 | 10.8 | 26 | 41.7% |
| 123461 | 4 | CONNECTOR CLIP | Nylon 6/6 | Molders Plus | 26 | 10.8 | 26 | 41.7% |
| 123464 | 2 | ARM ASSY, RH & LH | 380 Aluminum | Importers R'Us | 404 | 84.2 | 404 | 20.8% |
| 123468 | 2 | O-RING | Silicone Rubber Fill | Importers R'Us | 1 | 0.0 | 1 | 0.0% |
| | | | | | **3,599** | **2,253.4** | **3,599** | **62.6%** |