Green Chemistry Education Webinar

Introduction to Life Cycle & Alternatives Assessment

June 18th, 2015
What is the GC3?

- Cross-sectoral, B2B network of over 70 companies and other organizations
- Formed in 2005
- Collaboratively advances green chemistry across sectors and supply chains
Today’s Speakers

Ann Blake
Principal & Founder, Environmental & Public Health Consulting

Thaddeus Owen
Chief Engineer, Sustainability, Herman Miller

Tom Etheridge
Program Manager, LCA and CF, Hewlett-Packard
Ground Rules

• Due to the number of participants in the webinar, all lines will be muted

• If you have a question or comment, please type in the Q&A box located in the drop-down control panel at the top of the screen

• Questions will be answered at the end of the presentation
Introduction to Alternatives Assessment Practice

Green Chemistry & Commerce Council Webinar
June 18, 2015
Introduction to Alternatives Assessment Practice

- What is it?
  - Definition of alternatives assessment/analysis
  - Why alternatives assessment?
- How do we do it?
  - Frameworks for AA and practical applications
  - Overview of available tools & approaches
- Current practice: evolution & continuing challenges
  - Exposure considerations
  - Decision-making
  - Data gaps
What’s Our Goal?

- Safer chemicals, materials, processes, products
  - Increased supply chain transparency & communication
  - Fill data gaps for robust assessment
  - Improvement in human health and environment as well as the economy
- Triple Bottom Line: people, planet, prosperity
What is Alternatives Assessment?

- A process for identifying and comparing potential chemical and non-chemical alternatives that can be used as substitutes to replace chemicals or technologies of high concern
- Includes assessment and evaluation
LCA, Risk Assessment, AA: Answering Different Questions

- LCA helps to answer, “What are the environmental impacts of a product throughout its life cycle?”

- Risk assessment considers hazard, dose-response, and exposure and helps to answer, “Is it safe enough?”

- Comparative chemical hazard assessment helps to answer, “Which alternative is safer?”

- Alternatives assessment:
  - chemical hazard assessment, exposure assessment, other assessment approaches in a decision framework
A Framework to Guide Selection of CHEMICAL ALTERNATIVES

NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES
Trade offs and Regrettable Substitutions: A Rogues’ Gallery

- From one environmental medium to another
  - MTBE as a fuel additive in place of lead
    - Goal: reduce air pollution by enhancing combustion
    - Contaminated surface water
- From one health impact to another:
  - Methylene chloride to nMP in paint strippers
- From the environment to workers
  - n-hexane replacing CFCs in aerosol brake cleaners
- From human health to the ecosystem
  - Copper in brake pads
  - Pyrethroids; improvement for human health; persistent in aquatic sediment
  - Neonicotinoids: better than OP’s for humans, deadly for bees via plants; ng/l toxicity
    - Inappropriate ecotoxicity tests; water-soluble!
What Decision Do you Need to Make?

- Raw material/ component supplier
  - Provide information to downstream user, customer
- Manufacturer/Assembler/ OEM:
  - Choose safer alternative materials/ components for your product
- Retailer
  - Screen products for potentially hazardous chemicals
- Regulator
  - Regulatory framework to drive demand for safer alternatives
  - Find solutions to specific hazards (e.g. Maine deca-BDE AA)
Types of Available Tools

- Green Screen: benchmarking chemical hazards
- Emerging Hazard/ Alternatives Tools
  - ChemHAT
    - hazard and alternatives information for workers
- Sector tools:
  - CleanGredients, MIQ, Pharos
  - Retailer tools (see GC3 references)
  - Outdoor Industry Association’s EcolIndex/ Higg Index
- GoodGuide
  - Safer product choices for consumers
  - Retailer buyer tool
- Company Ranking Tools
  - (GoodGuide)
  - B Corporation’s Impact Assessment
- Regulatory Framework for Assessing Safer Alternatives
  - Maine, Washington, California, EU REACH
  - IC2 (Interstate Chemicals Clearinghouse) modular AA guidelines
Challenges: Exposure Assessment

- The NAS report: Comparative Exposure Assessment
  - Consider the potential for reduced exposure due to inherent properties of the alternative chemicals;
  - Ensure that any substantive changes to the routes and any substantive increases to the levels of exposure are identified; and
  - Allow for consideration of the routes (dermal, oral, inhalation, etc.), patterns (acute, chronic) and levels of exposure (irrespective of any exposure controls)
  - When integrating the evidence related to human and ecological toxicity among alternatives
Decision-Making: You’ve got the Data, Now What?

- **Decision-Support Tools:**
  - Green Screen for Safer Chemicals

- **Decision-Making Frameworks:**
  - Multi-Criteria Decision Analysis
    - As modeled for the California Safer Consumer Product Regulations
  - Biz-NGO Working Group Alternatives Assessment Protocol
    - Incorporates Green Screen, LCA, risk assessment
  - IC2 Framework: allows for different decision processes
Green Screen Benchmarks

**GreenScreen for Safer Chemicals v 1.2**
**GreenScreen Benchmarks**

**Abbreviations**
P = Persistence
B = Bioaccumulation
T = Human Toxicity and Ecotoxicity

**GS Benchmark 3**
a. Moderate P or Moderate B
b. Moderate Ecotoxicity
c. Moderate T (Group II or II* Human)
d. Moderate Flammability or Moderate Reactivity

Use but Still Opportunity for Improvement

**GS Benchmark 2**
a. Moderate P + Moderate B + Moderate T (Ecotoxicity or Group I, II, or II* Human)
b. High P + High B
c. High P + Moderate T (Ecotoxicity or Group I, II, or II* Human)
d. High B + Moderate T (Ecotoxicity or Group I, II, or II* Human)
e. Moderate T (Group II Human)
f. Very High T (Ecotoxicity or Group II Human) or High T (Group I* Human)
g. High Flammability or High Reactivity

Use but Search for Safer Substitutes

**GS Benchmark 1**
a. PBp = High P + High B + [very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
b. vPvB = very High P + very High B
c. vPvT = very High P + [very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
d. vBpT = very High B + [very High T (Ecotoxicity or Group II Human) or High T (Group I or II* Human)]
e. High T (Group II Human)

Avoid — Chemical of High Concern

**GS Benchmark 0**
Unspecified Due to Insufficient Data

See Guidance (GreenScreen for Safer Chemicals Hazard Assessment Procedures) at www.greenscreenforchemicals.org for instructions.

**Group I Human** includes Carcinogenicity, Mutagenicity, Genotoxicity, Reproductive Toxicity, Developmental Toxicity (incl. Developmental Neurotoxicity), and Ecotoxicity. **Group II Human** includes Acute/Mammalian Toxicity, Systemic Toxicity/Organ Effects—Single Exposure, Neurotoxicity—Single Exposure, Eye Irritation and Skin Irritation. **Group II* Human** includes Systemic Toxicity/Organ Effects—Repeated Exposure, Neurotoxicity—Repeated Exposure, Respiratory Sensitization, and Skin Sensitization. Inverse Systemic Effects are included in Systemic Toxicity/Organ Effects. **Ecotoxicity** includes Acute Aquatic Toxicity and Chronic Aquatic Toxicity.

* For inorganic chemicals persistence alone will not be deemed problematic. See Guidance.
Alternative Assessment

Physical Chemical Hazards

Human Health Hazards
- Toxicity
- Exposure

Ecological Hazards
- Toxicity
- Exposure

Environmental Impacts
- Adverse Air Quality Impacts
- Adverse Water Quality Impacts
- Adverse Soil Quality Impacts

Product Function and Performance Analysis

Economic Impact Analysis

Alternatives:
1
2
N

...
What’s Driving the Decision?

![Score Chart]

- Economic Feasibility
- Technical Feasibility
- Environmental Impacts
- Ecological Hazards
- Human Health Impact
- Physical Chemical Hazards

<table>
<thead>
<tr>
<th>Score</th>
<th>PERC</th>
<th>DF-2000</th>
<th>Green Earth</th>
<th>Rynex</th>
<th>nPB</th>
<th>CO2</th>
<th>Wet Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.14</td>
<td>0.11</td>
<td>0.06</td>
<td>0.12</td>
<td>0.14</td>
<td>0.10</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>0.08</td>
<td>0.10</td>
<td>0.16</td>
<td>0.09</td>
<td>0.11</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>0.14</td>
<td>0.11</td>
<td>0.07</td>
<td>0.10</td>
<td>0.07</td>
<td>0.07</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>0.13</td>
<td>0.07</td>
<td>0.06</td>
<td>0.10</td>
<td>0.13</td>
<td>0.12</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>0.13</td>
<td>0.07</td>
<td>0.06</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>0.12</td>
<td>0.07</td>
</tr>
<tr>
<td>0.13</td>
<td>0.07</td>
<td>0.06</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>0.12</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Materials Assessment And Alternatives Screening

Herman Miller’s Story

Thaddeus Owen  Thaddeus_owen@hermanmiller.com
Formaldehyde

BPA

Phthalates

PVC
Brominated Flame Retardants
Red Lists

& More beyond!

Courtesy of Healthy Building Network

Herman Miller
Eco-inspired Design Goals

Every product is sustainable

100% Safe Chemistry 100% Recycled/Bio-based Materials 100% Closed-Loop Systems

100% Life Cycle Assessment

10 YEAR GOALS

100% DfE Approved Products
100% Level 3 Certified Products
Takeback 125,000 tons of product
Eco-Inspired Design

Chemistry  Disassembly  Recyclability

Chemical of Concern List  Life Cycle Assessment
Start with the Product
Generate a Bill of Material (BOM)

### Bill of Materials

<table>
<thead>
<tr>
<th>BOM Level</th>
<th>Product Part Number</th>
<th>Rev</th>
<th>QTY</th>
<th>Material Description</th>
<th>Material - Print</th>
<th>Material ID#</th>
<th>Material - Finish</th>
<th>Tier 1 Supplier</th>
<th>Wt (g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1F000</td>
<td>1.00</td>
<td></td>
<td>XXX Table Veneer Top</td>
<td></td>
<td></td>
<td></td>
<td>Supplier A</td>
<td>0 g</td>
</tr>
<tr>
<td>2</td>
<td>1F000.00</td>
<td>1.00</td>
<td></td>
<td>Fixtures</td>
<td></td>
<td></td>
<td></td>
<td>Supplier A</td>
<td>0 g</td>
</tr>
<tr>
<td>3</td>
<td>1F000.01</td>
<td>2.00</td>
<td></td>
<td>Base Assembly</td>
<td>Extruded Aluminum</td>
<td></td>
<td>Polished (no coating applied)</td>
<td>Supplier A</td>
<td>5,008 g</td>
</tr>
<tr>
<td>4</td>
<td>1F000.02</td>
<td>1.00</td>
<td></td>
<td>Die Cast 380 Alum. from Gordon MPG</td>
<td></td>
<td>4556</td>
<td>Polished, 316 white and BK black powder coat</td>
<td>Supplier A</td>
<td>3.112 g</td>
</tr>
<tr>
<td>5</td>
<td>1F000.03</td>
<td>2.00</td>
<td></td>
<td>Foot</td>
<td>HDPE Dupont X123</td>
<td></td>
<td>None</td>
<td>Supplier A</td>
<td>13 g</td>
</tr>
<tr>
<td>6</td>
<td>1F000.04</td>
<td>2.00</td>
<td></td>
<td>Post Extrusion</td>
<td>6061 T6 Aluminum Extrusion</td>
<td></td>
<td>Polished, 316 white and BK black powder coat</td>
<td>Supplier A</td>
<td>1,230 g</td>
</tr>
<tr>
<td>7</td>
<td>1F000.05</td>
<td>1.00</td>
<td></td>
<td>Weldment</td>
<td></td>
<td></td>
<td>Bright Zinc</td>
<td>Supplier B</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1F000.06</td>
<td>1.00</td>
<td></td>
<td>Plate connector end</td>
<td>1008/1010 CPS</td>
<td></td>
<td>Bright RoHS Compliant</td>
<td>Supplier B</td>
<td>537 g</td>
</tr>
<tr>
<td>9</td>
<td>1F000.07</td>
<td>1.00</td>
<td></td>
<td>Support plate</td>
<td>1008/1010 CPS</td>
<td></td>
<td>Bright RoHS Compliant</td>
<td>Supplier B</td>
<td>173 g</td>
</tr>
<tr>
<td>10</td>
<td>1F000.08</td>
<td>1.00</td>
<td></td>
<td>Washer plate</td>
<td>1008/1010 CPS</td>
<td></td>
<td>Bright RoHS Compliant</td>
<td>Supplier B</td>
<td>38 g</td>
</tr>
<tr>
<td>11</td>
<td>1F000.09</td>
<td>4.00</td>
<td></td>
<td>Threaded rod</td>
<td>1018/1012.5 Steel</td>
<td></td>
<td>RoHS Compliant, Zinc coated</td>
<td>Supplier B</td>
<td>526 g</td>
</tr>
<tr>
<td>12</td>
<td>1F000.10</td>
<td>8.00</td>
<td></td>
<td>Set Screw</td>
<td>4137 Steel</td>
<td></td>
<td>Black RoHS Compliant</td>
<td>Supplier B</td>
<td>16 g</td>
</tr>
<tr>
<td>13</td>
<td>1F000.11</td>
<td>4.00</td>
<td></td>
<td>Cap</td>
<td>EASF XX23 HP 22% GF</td>
<td></td>
<td>None</td>
<td>Supplier B</td>
<td>11 g</td>
</tr>
</tbody>
</table>
• Raw material information needed
  ➢ Datasheets
  ➢ MSDS
  ➢ Full chemical composition disclosure
  ➢ RoHS Compliance
# Herman Miller Supplier Data Form

## Contact Information

1. **Supplier Company Name:** 

2. **Material Manufacturer:**  
   *(if not 'Supplier Company')*

3. **Material Trade Name:**

4. **Contact Person:**

5. **Contact Information:**

## Materials

Please provide the following data for all substances/mixtures contained in the product at a concentration of at least 100 ppm (0.01%), including any catalysts, dyes, colorants or residual monomers. Please copy and attach additional sheets, if necessary to outline the complete formulation. For purchased materials/mixtures, please identify the supplier and their product name. For raw materials, please provide CAS data.

<table>
<thead>
<tr>
<th>#</th>
<th>Substance/mixture identifier (e.g., trade name; product number)</th>
<th>CAS number</th>
<th>Concentration or concentration range (0-1%, 1-5%, 5-15%, 15-50%, 50%+)</th>
<th>Function (within material)</th>
<th>Supplier name (if applicable)</th>
<th>Contact person and contact information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex:</td>
<td>C.I. Pigment Blue 15</td>
<td>147-14-8</td>
<td>0.50%</td>
<td>colorant</td>
<td>Acme Products</td>
<td>John Doe, (555)555-1234, <a href="mailto:jd@acme.net">jd@acme.net</a></td>
</tr>
<tr>
<td>1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This document is a declaration of the Annex B chemicals used within the manufacturer's product.

Instructions:
- Complete all of the required fields (*) on this form per the product being evaluated for BIFMA Level Certification.
- Upon completion, please return the form to the requester.

Some field names contain pop-up help boxes with further instructions. Pop-up boxes will appear when you mouse-over the field name and disappear upon leaving the field.

Please review the BIFMA Annex B (attached) and list the chemicals in the manufacturer's formulation that are at a concentration greater than 1,000 PPM.

If a product contains chemicals that are on the Annex B list, please list those chemicals, CAS#'s and % of the formulation in the chart below.

If the product does not contain any chemicals on the Annex B list, please list this as a note in the comments section of this document.

If applicable, please make comments in the "Comments" field.

Data Submittal Date*

Supplier Information

Company Name*

Company Product Description*

Company Postal Address*

Contact Name*

Contact Phone*

Contact Email*

Contact Fax

Contact Postal Address*

Additional Information

Comments

Substance Information

<table>
<thead>
<tr>
<th>Substance Information</th>
<th>Please Report Substance Information Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annex B Chemical *</td>
<td>Substance Details (up to 3 decimal places)</td>
</tr>
<tr>
<td>CAS # * (where available)</td>
<td>Description of Use</td>
</tr>
<tr>
<td>% of total material *</td>
<td>Minimum requirement from material suppliers</td>
</tr>
</tbody>
</table>

RSL ATTESTATIONS

Minimum requirement from material suppliers
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Group</th>
<th>CAS No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bis(tributyltin)oxide (TBTO)</td>
<td>OT</td>
<td>56-35-9</td>
</tr>
<tr>
<td>Short chain chlorinated Paraffins</td>
<td>HFR</td>
<td>85635-84-8</td>
</tr>
<tr>
<td>Di(2-ethylhexyl) phthalate (DEHP)</td>
<td>Phth</td>
<td>117-01-7</td>
</tr>
<tr>
<td>Di-isobutyl phthalate (DBP)</td>
<td>Phth</td>
<td>84-59-9</td>
</tr>
<tr>
<td>Di-n-buty1 phthalate (DBP)</td>
<td>Phth</td>
<td>84-74-2</td>
</tr>
<tr>
<td>Butyl Benzy1 Phthalate (BBP)</td>
<td>Phth</td>
<td>85-68-7</td>
</tr>
<tr>
<td>MethyleneDianiline (MDA)</td>
<td></td>
<td>101-77-9</td>
</tr>
<tr>
<td>C.I.Pigment Yellow 34</td>
<td></td>
<td>1344-37-2</td>
</tr>
<tr>
<td>Tris (2-Chloroethyl) phosphate (TCEP)</td>
<td>HFR</td>
<td>115-96-8</td>
</tr>
<tr>
<td>2,4 Dinitrotoluene</td>
<td></td>
<td>121-14-2</td>
</tr>
<tr>
<td>HBCD (HBCDD)</td>
<td>HFR</td>
<td>25637-99-4</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td></td>
<td>79-01-6</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Phth</td>
<td></td>
</tr>
<tr>
<td>Lead Compounds</td>
<td>Pb</td>
<td></td>
</tr>
<tr>
<td>Chrome VI Cmpds</td>
<td>Chr</td>
<td></td>
</tr>
<tr>
<td>Halogenated FRs</td>
<td>HFR</td>
<td>1163-19-5</td>
</tr>
<tr>
<td>Bis(2-methoxyethyl) phthalate (DEMP)</td>
<td>Phth</td>
<td>117-82-8</td>
</tr>
<tr>
<td>Di-n-octyl phthalate (DnOP)</td>
<td>Phth</td>
<td>117-04-0</td>
</tr>
<tr>
<td>Di-n-pentyl phthalate (DnFP)</td>
<td>Phth</td>
<td>131-18-0</td>
</tr>
<tr>
<td>Asbestos</td>
<td></td>
<td>1332-21-4</td>
</tr>
<tr>
<td>tris (1,3 dichloro-2-propyl)phosphate (TDCP)</td>
<td>HFR</td>
<td>13674-87-8</td>
</tr>
<tr>
<td>Lead (II) bis (methanesulfonate)</td>
<td>Pb</td>
<td>17570-76-2</td>
</tr>
<tr>
<td>Diisononyl phthalate (DINP)</td>
<td>Phth</td>
<td>28553-12-0</td>
</tr>
<tr>
<td>HBCD</td>
<td>HFR</td>
<td>3194-56-5</td>
</tr>
<tr>
<td>Halogenated FRs</td>
<td>HFR</td>
<td>32534-81-9</td>
</tr>
<tr>
<td>Halogenated FRs</td>
<td>HFR</td>
<td>32536-62-0</td>
</tr>
</tbody>
</table>

**Banned Substances**
<table>
<thead>
<tr>
<th>Detail</th>
<th>Color</th>
<th>Score</th>
<th>Print Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUR</td>
<td>Yellow</td>
<td></td>
<td>Foamex Natural</td>
</tr>
<tr>
<td>PUR</td>
<td>Yellow</td>
<td></td>
<td>High Density Polyurethane</td>
</tr>
<tr>
<td>TPU</td>
<td>Yellow</td>
<td></td>
<td>Icorene</td>
</tr>
<tr>
<td>TPU</td>
<td>Yellow</td>
<td></td>
<td>Lai 3855</td>
</tr>
<tr>
<td>TPU</td>
<td>Yellow</td>
<td></td>
<td>Lai 185</td>
</tr>
<tr>
<td>PUR</td>
<td>Orange</td>
<td></td>
<td>2082 Isocyanate</td>
</tr>
<tr>
<td>Adhesive</td>
<td>Red</td>
<td></td>
<td>Polyurethane reactive easy adhesive</td>
</tr>
<tr>
<td>PUR</td>
<td>Red</td>
<td></td>
<td>5538R/116T</td>
</tr>
<tr>
<td>PUR</td>
<td>Red</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Specialty Composites Inc.</td>
<td>Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPU</td>
<td>Red</td>
<td></td>
<td>Polyurethanes TPU</td>
</tr>
<tr>
<td>Adhesive</td>
<td>Not Assessed</td>
<td></td>
<td>Polyurethane Multipurpose Adhesive, white</td>
</tr>
<tr>
<td>Adhesive</td>
<td>Not Assessed</td>
<td></td>
<td>Polyurethane Reactive Adhesive TS-115 HGS</td>
</tr>
<tr>
<td>Adhesive</td>
<td>Not Assessed</td>
<td></td>
<td>Polyurethane Reactive (PUR) Easy 250 Adhesive EZ250120</td>
</tr>
<tr>
<td>Adhesive</td>
<td>Not Assessed</td>
<td></td>
<td>Diversitak CI-6631 Two Component water Based Spray Adhesive</td>
</tr>
<tr>
<td>FR</td>
<td>Not Assessed</td>
<td></td>
<td>Gulbrandsen CP2 Fire Retardant Additive</td>
</tr>
<tr>
<td>Finish</td>
<td>Not Assessed</td>
<td></td>
<td>Superior Finishes Sequoia 444-Clear-XX WB Polyurethane Clear Coat</td>
</tr>
<tr>
<td>Finish</td>
<td>Not Assessed</td>
<td></td>
<td>ICA OP385 Polyurethane Black for Noguchi Topcoat</td>
</tr>
<tr>
<td>Finish</td>
<td>Not Assessed</td>
<td></td>
<td>ICA PC34 Paste for Polyurethane Black for Noguchi Topcoat</td>
</tr>
<tr>
<td>ISO</td>
<td>Not Assessed</td>
<td></td>
<td>Bayer Mondur TD Isocyanate PUR component</td>
</tr>
<tr>
<td>Iso</td>
<td>Not Assessed</td>
<td></td>
<td>BASF Lupranate T80 Type 1 (TDI)</td>
</tr>
</tbody>
</table>
Material Chemistry

- **Green**
  Little or no hazard; acceptable for use; reviewed by MBDC. No Banned RSLs.

- **Yellow**
  Low to moderate hazard; acceptable for use; reviewed by MBDC. No Banned RSLs.

- **Purple**
  Full formulation and RSL/BIFMA Annex B attestations. Internal review. No Banned RSLs.

- **Red**
  High hazard; should be phased out as soon as possible.

- **Orange**
  Incomplete data; no indication it is problematic but a complete assessment is not impossible.
<table>
<thead>
<tr>
<th>Material Description</th>
<th>Material - Print</th>
<th>Material ID#</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXX Table Veneer Top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETG Assy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Assy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Extrusion</td>
<td>6061 T6 Extruded Aluminum</td>
<td>2559</td>
</tr>
<tr>
<td>Foot Casting Small</td>
<td>Die Cast 380 Aluminum From Gordon MFG</td>
<td>456</td>
</tr>
<tr>
<td>Foot</td>
<td>HDPE Dupont X123</td>
<td>555</td>
</tr>
<tr>
<td>Post Extrusion</td>
<td>6061 T6 Aluminum Extrusion</td>
<td>384</td>
</tr>
<tr>
<td>Weldment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plate connector end</td>
<td>1008/1010 CRS</td>
<td>223</td>
</tr>
<tr>
<td>Support plate</td>
<td>1008/1010 CRS</td>
<td>223</td>
</tr>
<tr>
<td>Washer plate</td>
<td>1008/1010 CRS</td>
<td>223</td>
</tr>
<tr>
<td>Threaded rod</td>
<td>1018/1020 Steel</td>
<td>538</td>
</tr>
</tbody>
</table>
Screening - 1st Look for Banned Substances

- RSL Attestation signed
- No Banned restricted substance groupings
  - Halogenated Flame Retardants (HFRs)
  - Heavy Metals (Arsenic, Cadmium, Cobalt, Chrome VI, Mercury, Lead)
  - Phthalates
Screen Against Lists
Screen with 3rd Party Assessors – Optional

[Logos of MBDC, NSF, and TOXSERVICES]

Herman Miller
Decisions

• Based on risk and exposure process
• Based on knowledge
• Based on feedback from Consultants
• Based on BIFMA Chemical of Concern risk/exposure study
Products Designed “Free Of” Not Enough
Plants

Soil
Nutrients

Animals

Decomposers

Manufacturing/Assembly

Product

Materials

Customer Use

Source: GreenBlue
Fiberglass
Products Made to Last
A Modular Approach to LCA: The Process and Results Applied to HP’s Imaging Products

Tom Etheridge, PhD
WW LCA and CF Program Manager, HP
The Motivation

Why assess environmental impacts of HP’s Imaging Products Portfolio?

1. Product Improvement
   • Help HP scientists focus development on environmental performance early in the design process with guidance from environmental analysis that spans the product line

2. Produce EPDs

3. Earn 3 critical EPEAT 1680.2 optional points

4. Proactive approach to potential regulatory and ecolabel requirements

5. Customer demand
   • Match customer needs with the appropriate printing devices
   • Understand how optimizing printing habits can lower personal environmental impacts (duplex printing, reduced power consumptions, etc.)
The Challenge
How to get solid environmental information that spans HP’s multi-billion dollar Imaging portfolio?

**Breadth of portfolio**
- 10,000+ Imaging products from consumer-level InkJet printers to department class, high-speed LaserJet multifunction devices.

**Complexity**
- Ever evolving portfolio due to customer and regulatory demand. Complex devices, sold in more than 100 countries with global supply-chain of components.

**Expense**
- Prohibitively expensive to do an LCA from scratch for even a representative cross-section of the portfolio.

**Leverage**
- Need a flexible and modular model that could cover other imaging products (e.g., InkJet and scanners).
What is LCA

- **LCA is a robust, rigorous, ISO-recognized tool for assessing the environmental impact of a product over its entire lifecycle**

- **Incorporates input from all stages of a product’s life**
  - Materials
  - Manufacturing processes
  - Distribution routes
  - Energy consumption
  - Consumables
  - Disposal

- **Requires defining a Functional Unit**
  - For HP’s imaging products the functional unit is 1000 printed pages
Model Structure – From Cradle to Grave

Production
- Component and subassembly manufacturing
- Printer assembly

Distribution
- Distribution to consumers
- Assumes distribution to US market (for EPEAT)

Use Phase
- Power
- Paper & cartridge production, transport & disposal / recycling

End-of-Life
- Transportation
- Re-manufacturing / reclaiming materials
One LCA to Rule Them All

Completed an extensive LCA that defines the process for all printers

LCA of LaserJet Printers for EPEAT Verification

Background report
The Challenge at the Printer Level: Product Complexity
The Solution = A Modular Approach

Initial Models Built for LaserJets

**Hardware**
- LES Print engine
- Skins
- Paper handling
- Scanner
- Fax
- Wireless
- Power supply
- Keypad
- Document feeder
- PC boards
- Etc.

**Consumables**
- Paper
- Cartridges
- Fuser
- ITB
- Energy

**Other**
- Transport (all nodes)
- Packaging
- End-of-life
- Functional Unit
- LCA-specific life phases

Models Added for InkJets

- Printheads
- Cartridges
- Printbar (Pagewide Array)
- Printhead assembly
- Ink delivery system
The GaBi Envision Tool: Design for Environment

A web-based tool that allows the user to modify input parameters for all components

- Covers all printer components, consumables & inputs
- Includes all LCA phases
- Generates ISO-compliant Environmental Product Declarations (EPDs)
- Flexible! Allows modules to be added for future products
Model – Best available background data

• Collection of BOM information on
  • Mechanical parts
  • Electrical components
  • Electro-mechanical systems
• Mapping of observed components to existing datasets
• Modeling with representative components (127 datasets) based on size, materials and production processes
The Environmental Product Declaration (EPD)

A document that summarizes the LCA output in a standardized format

Reports 9 ReCiPe (H) midpoints

Results presented graphically and in tabular form

Life cycle phases are broken out in the appendix

Intended to allow relatively quick comparison among products

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Multi-Function color laser printer for large departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Speed (ppm)</td>
<td>35 ppm</td>
</tr>
<tr>
<td>Intended Use</td>
<td>Office Use</td>
</tr>
<tr>
<td>Product Lifespan</td>
<td>5 years</td>
</tr>
<tr>
<td>Range of Applications</td>
<td>High-volume printing and faxing of documents in color</td>
</tr>
<tr>
<td>Product Specifications</td>
<td>NA</td>
</tr>
<tr>
<td>Introduction Date</td>
<td>11/1/2012</td>
</tr>
<tr>
<td>Functional Unit</td>
<td>The functional unit has been defined as printing 1000 pages in accordance with the Energy Star Typical Electricity Consumption test procedure and the reference PCR.</td>
</tr>
<tr>
<td>Scope of Validity / Applicability</td>
<td>The EPD is representative for the HP laser printer model M7752+ sold as a stand-alone unit (not as part of managed print services), and reflecting default out-of-box settings for duplexing, energy savings, and print quality. The EPD and the reference PCR are applicable for printer sale and use in the North American market. Differences between product environmental product declarations are not guaranteed as valid basis for comparison between products of different manufacturers.</td>
</tr>
<tr>
<td>Product System Description</td>
<td>This EPD describes the lifetime use of the laser printer, including production of all materials and components, assembly in the final configuration, delivery to the customer, use of the product, and expected end-of-life scenarios. All packaging, in-box accessories, and all consumables (paper, toner cartridges, replacement parts) are considered, including associated end-of-life treatment. Printing is considered the main function of the product, and the impacts of other functions (scanning, copying, etc.) are not considered.</td>
</tr>
</tbody>
</table>
Comparison of OJ Pro X576dw With Comparable Laser Printers:
Fractional View Assuming 100k page life

M570dn Color Laser MFP

- Cartridges: 10%
- Paper: 33%
- Electricity: 32%
- Printer Production: 14%
- Fuser LLC: 5%
- ITB LLC: 2%
- Transport to Recycling: 0%
- End-of-Life: -1%

OJ Pro X576dw Color Ink MFP

- Cartridges: 18%
- Paper: 36%
- Electricity: 21%
- Printer Production: 14%
- Transport: 1%
- Fuser LLC: 5%
- ITB LLC: 3%
- Transport to Recycling: 0%
- End-of-Life: -2%

M551dn Color Laser SFP

- Cartridges: 4%
- Electricity Use: 1%
- Printer Production: 31%
- Paper: 61%
- Transport: 1%
- Spitoon LLC: 0%
- LLC 2: 0%
- Transport to Recycling: 0%
- End-of-Life: -2%

Bottom Line
The printing contribution for the comparable LES products remains at least 64% of the total carbon footprint of the page
Results – Lifetime GWP for LaserJet Portfolio

Consumables:
- Paper
- Cartridges
- Fuser
- Image Transfer Blanket

Consumables:
- Paper
- Cartridges
- Fuser
- Image Transfer Blanket
Results – GWP per 1000 Printed Pages for LaserJet

Areas of focus:
1. Consumables for all classes
2. Power for Small Team and Desktop Classes
3. Production for Small Team and Desktop color models
The HP Printing Fleet (excluding paper)

GWP (kg CO₂ eq./1000 printed pages)

- End-of-Life
- Electricity Use
- Consumables
- Transport
- Production

- Department Color
- Department Mono
- Workgroup Color
- Workgroup Mono
- Small Team Color
- Small Team Mono
- Desktop Color
- Desktop Mono
- IPH
- IIC
- PageWide

Laser

Ink
Benefits – Progress and Learning To Date

Progress

- Completed LCAs:
  - 156 LaserJet products spanning the entire portfolio
  - 18 InkJet products spanning the entire print engine portfolio
  - 5 Scanner products spanning the entire portfolio

Learning

- Consumables remain the greatest source of environmental impact for printing
  - Work with customers to help them print more efficiently - duplexing
  - Work to reduce cartridge impacts through material design and reduction where practical
- Power consumption and production are still significant impacts for lower-end LaserJet products
- InkJet portfolio has lower impact than LaserJet overall
Benefits Overall

LCAs enabled HP to become the first IT company to publish its complete carbon footprint.

Opens the door to comprehensive design for the environment.

Cut cost and time to produce EPDs and earn EPEAT credits with modular approach.

Meet customer demand.
Corporate-Level Environmental Reporting

Our Carbon Footprint, 2014

Supply chain
41%

Operations
5%

Products and solutions
54%

Total emissions
49,067,700 tonnes CO₂e

Supply chain GHG emissions
17,600,000

Operations GHG emissions
1,552,600

Products and solutions GHG emissions
26,300,000

Materials extraction through manufacturing
500,000

Facilities
115,100

De minimis***
De minimis***
De minimis***

Capital goods
300,000

Transportation fleet
200,000

Product use****

Upstream energy production
1,700,000

Commercial air travel
800,000

Product end of life

Transport

Buildings leased to others

Employee commuting

Investments

↓20% reduction goal
Reduce our first-tier manufacturing and product transportation-related GHG emissions intensity† by 20% by 2020, compared to 2010

↓20% reduction goal
Reduce total GHG emissions from our operations (Scope 1 and Scope 2) by 20% by 2020, compared to 2010 levels

↓40% reduction goal
Reduce the GHG emissions intensity of our product portfolio‡ by 40% by 2020 compared to 2010 levels‡
Our Water Footprint, 2014

Supply chain: 25%
- Supply chain consumption: 23,296,000 cubic meters
  - Direct consumption
  - Indirect consumption: 60,811,000 cubic meters

Operations: 7%
- Operations consumption: 7,431,000 cubic meters
  - Direct consumption
  - Indirect consumption: 15,391,000 cubic meters

Products and solutions: 68%
- Products and solutions consumption: 176,960,000 cubic meters
  - Indirect consumption—electricity for product use
- Total water consumption: 330,883,000 cubic meters
  - Indirect consumption—paper use: 46,194,000 cubic meters
Thank you

Tom Etheridge
tom.etheridge@hp.com
Thanks for joining us!

For more information about the GC3: www.greenchemistryandcommerce.org
Upcoming Events

Advancing Green Chemistry: Barriers to Adoption & Ways to Accelerate Green Chemistry in Supply Chains
Thursday, July 23, 2015  |  12:00 PM EDT

11th Annual GC3 Innovators Roundtable
May 24-26, 2016  |  Burlington, VT

For more information about the GC3:
www.greenchemistryandcommerce.org