Engineering and Health Impact Methods in Green Design

**Student projects**

Students will complete a solution-oriented project evaluating the tradeoffs in the net environmental health footprint of various materials or manufacturing processes. Each group will address the question of tradeoffs by considering a specific scenario.

**Format:** groups of 2-3 students (as class size dictates), each will address a different case/scenario.

**Expected time commitment:** 3 hours/week for six weeks, plus final poster session

**Learning goals:** (1) Understand and evaluate a range of environmental health effects associated with a specific choice of material or manufacturing process, (2) Gain familiarity with and effectively use a variety of tools, metrics, and information sources related to chemical/material evaluation.

**Final product:** Each group will turn in a poster summarizing the project on March 12th, one week after the final class session. It will be presented with students from the other seminars at the end of semester, 2-4pm Monday, April 30th.

**Schedule & Deadlines:**

- **Weeks of Jan 23/30** Review project descriptions and resources; submit selections through b-space
- **February 6th** Group assignments provided at class
- **February 13th** Project description, research question and annotated bibliography due
- **February 27th** Draft project report due for review with project advisor
- **March 12th** Final project report/poster due (1 week after last class meeting)
- **April 30th** Poster session
**Project Topics**

Teams of students can choose a project from one of the following three project types:

1. **Assessing tradeoffs made in the net toxic footprint of material choice.** Consider the tradeoffs between bio-based and petroleum-based materials in a specific product. Example products:

   - Plastic packaging materials (LMAS lab has compared outcomes when assessing packaging using a variety of metrics—how is chemical/material toxicity assessed? How do these tools weigh the tradeoffs in reference to bio-based plastics?)
   - Carpet with PVC vs. PVC-free (considering use of recycled vs. virgin materials; process chemistry in producing vinyl chloride monomer; choices of antibacterial agents; need for flame retardant additives). Resources from InterfaceFLOR, Healthy Building Network
   - Polyurethane foam (considering soy-based vs. petroleum-based polyols; process chemicals such as TDI and MDI; blowing agents; need depending on product function e.g., dense foam for carpet backing vs. large-cell foam for car interiors) Resources from InterfaceFLOR and Ford.
   - Alternatives analysis of adhesives & coatings used in construction (pilot for larger project with M. Wilson)

   While the analysis should consider multiple points in the lifecycle and a variety of factors (energy use, water requirements, etc), the emphasis should be on how to evaluate process chemistry and net toxic footprint by incorporating information about the health and environmental impacts of chemical and material choices. The project might be organized to make these types of comparisons for each material or substance used in the manufacture:

<table>
<thead>
<tr>
<th></th>
<th>Recycled/ recyclable</th>
<th>Virgin materials</th>
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<tbody>
<tr>
<td>Biobased</td>
<td>[health/environmental impacts]</td>
<td>[health/environmental impacts]</td>
</tr>
<tr>
<td>Petroleum based</td>
<td>[health/environmental impacts]</td>
<td>[health/environmental impacts]</td>
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2. **Develop attributes for evaluating a material’s end-of-life.** Using a specific product as a case study (e.g., wire/cable coatings, polyurethane foam, plastic packaging, carpet tiles, etc.) investigate different methods for evaluating the chemical/material impacts of a product’s end-of life. Recommendations from this investigation would help inform the development of attributes that should be used in a module for the BizNGO plastics scorecard (see below for a conceptual mock-up of the “scorecard’s framework)
Principles for sustainable bioplastics provide aspirational goals, but the Plastics Scorecard project is designing a tool for manufacturers, purchasers or assessors to determine how various materials satisfy those goals. The tool’s end-of-life category has yet to be established. Students would choose one type of material (e.g., from list under Topic 1) and investigate existing models for assessing impacts from product end-of-life and propose how to build these concepts into the plastics scorecard.

3. Investigate alternative processes/materials for one of the materials relevant to projects 1 or 2 above. This option is meant as an alternative for students with specific interest in a related issue (e.g., pesticides or alternatives to the kraft process).

Note for students who are also taking the second seminar, Toxicology for Green Molecular Design, we are happy to work with you to devise a project that will carry through the second half of the semester. This would entail choosing a material or manufacturing process (for this class) that includes 3-4 chemical compounds whose toxicological properties you would evaluate during the second half of the semester.

Resources:

Alvarez-Chavez et al. (2012) Sustainability of bio-based plastics; general comparative analysis and recommendations for improvement.

Lithner D. et al. (2011) Environmental and health hazard ranking of plastic polymers based on chemical composition. Supplemental materials to Lithner D. et al: production process of thermoplastic & thermosetting polymers. These are the original materials, summarized in her thesis, which is also interesting, but the source papers are better.

Sustainable Bioplastics Collaborative Guidelines for Sustainable Bioplastics

Clean Production Action’s Plastics Scorecard project

For PVC-related issues, see Healthy Building Network’s PVC page and the Vinyl Institute InterfaceFLOR Environmental Product Declarations www.Interfaceflor.com/epd

Tools

Nike’s Material Assessment Tool (MAT). Their revised Material Sustainability Index (MSI) is currently under peer review and should be released in 2012.

Outdoor Industry Association’s Ecolindex
EPA DfE Wire and Cable LCA:  http://www.epa.gov/dfe/pubs/wire-cable/lca.htm
Plum database http://plm.berkeley.edu
And more coming in class...