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Photographs by Kate Krueger
Sustainable Product Design
Course Information

Course Description
Sustainable Product Design experiments with different strategies for integrating sustainability objectives in the design of products. Student groups investigate the redesign of office products to minimize material use, energy consumption, and waste generation and to maximize innovation, user satisfaction, and economic viability.

Product focus for this year is on office supplies, technology and culture. An exciting partnership with Staples, a global leader in the industry, allows for the course to integrate current sustainability challenges in office products with how technology is transforming the way that we conduct business and productivity.

Sustainable Product Design enables an interdisciplinary collaboration between Sustainability and Industrial Design. Both areas will offer their unique approach while learning and integrating knowledge from each other.

Lectures and projects incorporate strategies such as effective sustainability methods and life-cycle assessment; enhancement of product value and prolonged use; and balance between recycling, reusing and repurposing.

Course Goals
- Better understanding of effective sustainable strategies applied to product design.
- Enabling of interdisciplinary collaboration between students from GIS and CIAS.
- Creation of solutions that balance economical, environmental and social goals.
- Exploration of sustainability opportunities in the office environment, taking advantage of Staples support and sponsorship.
Teaching Team

Alex Lobos
Assistant Professor, Industrial Design, RIT
Alex is an assistant professor of industrial design and extended program faculty at Golisano Institute for Sustainability at Rochester Institute of Technology. He is always curious about how products connect users to their context and his research positions design as a tool for environmental and social innovation. He has held faculty positions at University of Illinois Urbana-Champaign, Universidad Rafael Landivar in Guatemala and ISTHMUS Escuela de Diseño in Panama. He also has done extensive work in the area of home appliances, first during his graduate studies and then as an Industrial Designer for General Electric. Alex is a Fulbright Scholar and holds an M.F.A. from the University of Notre Dame and a B.I.D. from Universidad Rafael Landivar.

Dr. Callie Babbitt
Assistant Professor, Golisano Institute for Sustainability, RIT
Dr. Callie Babbitt is an Assistant Professor in the Golisano Institute for Sustainability at RIT, where she conducts research on environmental impacts and sustainable design of emerging technologies, including consumer electronics, nanomaterials, and lithium ion batteries. She has over 30 published scholarly articles and conference proceedings on topics such as material flow analysis, life cycle assessment, sustainable design, and industrial ecology. Prior to coming to RIT, Dr. Babbitt was a Research Associate at Arizona State University. She received her Ph.D. and M.S. in Environmental Engineering from the University of Florida, and her B.S. in Chemical Engineering from Georgia Institute of Technology.

Kate Krueger
Student Researcher, 3rd Year Student, Master of Sustainable Architecture Program, RIT
Motivation for the Course

Transdisciplinary Approach
While teaching their respective courses, Callie and Alex had both experienced the knowledge gap between the technology specialists who develop sustainable design tools and the product designers who implement these tools. This gap in knowledge becomes very prominent in the field of product design, where engineers collaborate with industrial design professionals, each skilled in their own respective areas, but not aware of the tools and practices of the other. Callie and Alex recognized the need for an integrated, holistic approach to product design that would bring together the skills of both professions to create sustainable designs, so they set out to model this in the classroom by creating an interdisciplinary curriculum, implemented in a studio course for senior-level Industrial Design and graduate-level Sustainability students.

Traditional university-level training in their fields often concentrates within disciplines without providing the holistic knowledge required in the real world. Their idea is to build an integrated knowledge base for developing sustainable designs. They aimed to bridge this gap between the skills and experiences of students from these two disciplines and help them understand the social, economic, and environmental dimensions of sustainability and product design, while teaching them how to communicate in trans-disciplinary teams. Design students needed more exposure to quantitative measures so they could evaluate the impact of their decisions on a broader scale; working with the engineering students, the design students saw their product designs subjected to the methods and tools of quantitative analysis. Conversely, engineering students had to create solutions that applied the tools and requirements of good design.

The course combines instructions and collaboration through instructor-student and peer-peer mediated interactions to provide cross-disciplinary experience. Students work in cross-functional teams to identify a sustainable product problem and create a sustainable design solution for it. This peer-to-peer mediated collaboration provides a rapid immersion for students in each other’s discipline. In the process, they learn the tools and practices from each discipline from each other, with the instructors available to reinforce and scaffold learning. At the end of the quarter, students present their 3D design solutions in three-minute videos that communicate the product to an outside audience, highlighting the design innovation and sustainability concepts. In this way, students gain experience marketing their sustainable design solutions.
## Course Structure

<table>
<thead>
<tr>
<th>Date</th>
<th>Lectures</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-Aug</td>
<td>Introduction to Sustainability (Babbitt)</td>
<td>“Timeless office” project begins</td>
</tr>
<tr>
<td>28-Aug</td>
<td>Emotional Attachment (Lobos)</td>
<td>Reading 1: Attachments with Objects</td>
</tr>
<tr>
<td>4-Sep</td>
<td></td>
<td>Studio time – concept development</td>
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<tr>
<td>9-Sep</td>
<td></td>
<td>Studio time – concept development</td>
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<tr>
<td>11-Sep</td>
<td>Sustainable material selection (Babbitt)</td>
<td>“Timeless office” midpoint review; Reading 2: Case studies</td>
</tr>
<tr>
<td>16-Sep</td>
<td></td>
<td>Studio time - explore materials tradeoffs</td>
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<tr>
<td>18-Sep</td>
<td></td>
<td>Studio time - concept refinement</td>
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<tr>
<td>23-Sep</td>
<td></td>
<td>“Timeless office” due + in-class presentations</td>
</tr>
<tr>
<td>25-Sep</td>
<td>Staples sustainability (Brian Hilton)</td>
<td>Staples Innovation Lab; “Office of the future” project begins</td>
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<tr>
<td>30-Sep</td>
<td>Systems thinking &amp; product lifecycles (Babbitt)</td>
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<tr>
<td>2-Oct</td>
<td></td>
<td>Studio time &amp; user research</td>
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<tr>
<td>7-Oct</td>
<td>Sustainable design strategies (Lobos)</td>
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<tr>
<td>9-Oct</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>15-Oct</td>
<td></td>
<td>Design proposal due</td>
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<tr>
<td>16-Oct</td>
<td></td>
<td>Studio time</td>
</tr>
<tr>
<td>21-Oct</td>
<td>Biomimicry (Krueger)</td>
<td>Reading 3: Biomimicry</td>
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<tr>
<td>23-Oct</td>
<td></td>
<td>Studio time</td>
</tr>
<tr>
<td>28-Oct</td>
<td></td>
<td>Preliminary concepts due</td>
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<tr>
<td>30-Oct</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>4-Nov</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>6-Nov</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>11-Nov</td>
<td></td>
<td>Refined concept due</td>
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<tr>
<td>13-Nov</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>18-Nov</td>
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<td>Product sustainability worksheet</td>
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<tr>
<td>20-Nov</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>25-Nov</td>
<td></td>
<td>Studio time</td>
</tr>
<tr>
<td>2-Dec</td>
<td></td>
<td>Environmental assessment workshops</td>
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<tr>
<td>4-Dec</td>
<td></td>
<td>Environmental assessment due</td>
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<tr>
<td>9-Dec</td>
<td></td>
<td>Model due; video storyboard due</td>
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<tr>
<td>11-Dec</td>
<td></td>
<td>Studio time</td>
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<tr>
<td>18-Dec</td>
<td></td>
<td>Final presentation; project video due</td>
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</tbody>
</table>
Lectures

Both sustainability and design lectures are employed to help students to enhance their design understanding and shed light on what sustainability entails both in theory and in the product design sphere. The interdisciplinary approach is key to this class. Below is a list of lectures given during the course:

- Introduction to Sustainability
- Emotional Design
- SuperNormal
- Sustainable Material Tradeoffs
- Systems Thinking + Life Cycle Design
- Design for X
- Biomimicry
Readings

Assigned Readings

Emotional Design:

Material Analysis and Selection:

Biomimicry:

Suggested Resources

Books:
- *Emotionally Durable Design* by Jonathan Chapman
- *Designers, Visionaries and Other Stories* by Jonathan Chapman and Nick Gant
- *Cradle to Cradle* by William McDonough and Michael Braungart

Publications:
- Journal of Sustainable Design - ISSN: 1367-6679
- Journal of Cleaner Production - ISSN: 0959-6526

Websites:
- Treehugger - http://www.treehugger.com/
- Inhabitat - http://inhabitat.com/
- EPA LCA - http://epa.gov/nrmrl/lcaccess/
- Autodesk Sustainability - http://students.autodesk.com/?nd=sustainable_home
- Designers Accord - http://www.designersaccord.org/
- IDSA EcoDesign - http://idsa.org/ecodesign
- Sustainable Minds - http://www.sustainableminds.com/
Project 1: Timeless Office
August 26 - September 23

Introduction
Workflow in the office focuses on efficiency and productivity. New business structures, market demands and technologies keep transforming the office environment at a continuously accelerated pace. Workflow in the office focuses on efficiency and productivity. New business structures, market demands and technologies keep transforming the office environment at a continuously accelerated pace. No matter how high-tech an office is, everyone needs supplies such as staplers, tape dispensers, paper clips, pens, etc. Unfortunately, these tools are often taken for granted and are constantly underused and replaced with little attention given to how their production, use, and disposal can impact the environment. This is a particularly important issue for businesses and manufactures that deal with high-volume, mass-produced office supplies.

Sustainable design offers an opportunity to improve both the life cycle environmental footprint and the value of these products for users in any working environment. Further, even small enhancements to the functionality or environmental profile common office supplies can have major impacts, due to the massive scale at which these products are consumed and used.

Assignment
To re-design an office product that addresses relevant needs typical of users of Staples branded products, while also offering a significant contribution to sustainability in terms of material selection and prolonged product use.

A successful development of this project will first select one of the representative products introduced on day one and then explore opportunities for sustainability, timelessness, and maximum user value. At the same time, it must consider how the selection of product attributes and materials will impact the ultimate environmental footprint of the product and potentially introduce new tradeoffs between utility, economics, and environmental performance.

Deliverables
- Full-scale prototype
- PDF file (uploaded to Mycourses) that includes:
  - 50-word design statement
  - Materials trade-off comparison
  - Pictures of the model (minimum one moneyshot and one with human reference)
Requirements

- Product to be designed will be one of products presented on the first day of class.
- No 2D sketches allowed. All development will be done with 3D sketches (paper, cardboard, foam, clay, foil, etc.).
- The proposed final design needs to be able to be reproducible in two of the following materials: metal, glass, wood, plastic or ceramic.
- Once the two candidate materials have been selected, a trade-off analysis will be applied to understand at a qualitative level how material selection affects the environmental impacts accrued at different stages of a product life cycle as well as its emotional connection to the user (i.e. injection-molded plastic optimizes manufacturing while wood ages gracefully).

Schedule

Monday Aug 26 – Project begins
Wednesday Sep 11 – Mid-point review
Monday Sep 23 – Project due 11:00am
Process
Finished Products
Staplers

Erika Nwankwo

Austin Gampfer

Reese Zecchin

Derek Burkhardsmeyer

Austin Fagot

Daniel Kim
Finished Products
3-Hole Punches
Finished Products
Retractable Pens

Brendan Gordon

Bijal Patwa

Abhishek Swaminathan

Barbara Kasulaitis
Finished Products
White-out Tape Dispensers

Junghwa Lee
Erika Vosbury
Bradley Reminder
Ronald Still
Finished Products
Tape Dispensers

David Engell

Annamarie Wolken

Liz Schwartz

Alexandra Bush

Sergey Selyuzhitskiy

Rachel Son

Dylan Falanga
Finished Products
Featured Project
Erika Nwankwo’s Supernormal Stapler

**Project Statement**
The Swingline Stapler is an iconic design. It is timeless, durable, long lasting and valued by all its users. The Supernormal Stapler is designed to preserve that iconic “Swingline” design, while using “sustainability” as part of that dialog. This design aims to address sustainability by carefully considering the materials and techniques used in the manufacturing process, its user needs and end-of-life scenarios.
### Material Analysis

Three stages in the life cycle for which you will compare trade-offs of your design.

<table>
<thead>
<tr>
<th>Stage 1: Extraction &amp; Manufacturing</th>
<th>Embodied Energy</th>
<th>Material 1 Benefits &amp; Tradeoffs</th>
<th>Material 2 Benefits &amp; Tradeoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relatively high embodied energy per unit volume is needed to extract material. Low processing energy to deform material once extracted.</td>
<td>Main material: Aluminum</td>
<td>Relatively low embodied energy per unit volume needed to extract material as compared to other polymers. Higher processing energy to mold material once extracted as compared to extrusion technique.</td>
</tr>
<tr>
<td>Stage 2: Product Use</td>
<td>Esthetics &amp; Durability</td>
<td>Aesthetically appealing (brushed finish), durable and long lasting, heavy weight. Fits user needs in form and function.</td>
<td>Attractive and aesthetically appealing (glossy or matte finish), not as durable or long lasting, light weight, can hold color treatments. Fits user needs in form and function.</td>
</tr>
<tr>
<td>Stage 3: End of Life</td>
<td>Disassembly &amp; Recyclability</td>
<td>Aluminum doesn't rust, degrade and can be recycled indefinitely, giving it a long low-energy lifespan. Use of limited parts.</td>
<td>Polystyrene are not easily recycled and generate waste easily. Exposed to environment and can be easily contaminated. Use of multiple parts.</td>
</tr>
</tbody>
</table>
Featured Project
Alex Bush’s Tape Dispenser

Project Statement
This tape dispenser takes a common office supply and integrates it with sustainable thinking, by twisting but not impeding on the timeless effect. The ability to take a single sheet of brushed stainless steel and fold it to create the product improves the manufacturing production and the ease of disassembly for the end user to promote recycling without limiting the durability and aesthetic appeal of the tape dispenser.
# Material Analysis

<table>
<thead>
<tr>
<th>Three stages in the life cycle for which you will compare trade-offs of your design.</th>
<th>Sustainability strategy that is important for the stage selected.</th>
<th>Material 1 Benefits &amp; Tradeoffs</th>
<th>Material 2 Benefits &amp; Tradeoffs</th>
</tr>
</thead>
</table>
| Stage 1: Manufacturing | Stream-lined production process | Total # of Steps: 3  
The material requires a laser to cut the shape out, a single welding point for the core, and no additional material. | Total # of Steps: 5 (2 for vacuum form process). The material would be vacuum formed, but the necessity of slanted edges creates a design compromise. The core would be adhesively attached, two small strips of metal are required for cutting tape, and grooves would be made. |
| Stage 2: Product Use | Product Lifespan | Stainless steel is durable, elongating the product life cycle. | PVC is less durable than stainless steel, but lighter weight. |
| Stage 3: End of Life | Disassembly & Recyclability | Disassembly Steps: 1  
It is recyclable, but not all general waste management companies recycle it. | Disassembly Steps: 3  
Post-consumer recycling rates for PVC are generally low. Sheets can be returned back to the company to be recycled. |
Project 1
Concluding Thoughts

With the design challenge to create a new, but timeless office product, students set to work immediately on 3D sketch models. As these 3D models evolved from scrap material to final models, students showed maturity in their design process and final solutions.

Successes
During Project 1, students learned about emotional design and SuperNormal design, two concepts that many students embraced and incorporated into their Project 1 design.

Throughout the project, a variety of check-ins, both official and unofficial (1-on-1 professor-student conversations, unofficial peer-and-professor-to-peer small group critiques and class-wide critiques), gave students consistent feedback and helped them hone in on their final design.

Challenges
In an assigned reading and lecture, students also learned about sustainable material selection. This topic - and the corresponding material analysis that they included in their Project 1 deliverables - proved to be challenging for most students. Furthermore, several students selected materials that would not be appropriate for manufacturing; this is a knowledge gap that future versions of the course will aim to close.

In response to the challenges students faced, future iterations of this project could incorporate a greater amount of coaching around materials selection and analysis, as well as require students to provide a rough draft of their material analysis and incorporate feedback into their final material analysis.
Project 2: Office of the Future  
September 25 - December 18

Introduction
The office environment is becoming highly “wired” and dependent on many information and communication technology (ICT) devices for connectivity, information sharing, productivity, and economic growth. These products are also capable of far-reaching impacts across the office system; for example, alternative printing and document management devices may change the consumption of paper and other consumables, while mobile products may decentralize working environments and change employee commuting patterns. However, core business functions will still require products that facilitate human interaction and the interface between electronic and hard copy (printed) media and information. These products must be developed so they enable sustainable business transformations while not introducing new environmental impacts due to their manufacturing, use, or disposal.

Staples Inc. is the world’s largest seller of “office products,” which include office supplies, furniture, technology, and business services, which ensure that the operation of everyday business runs smoothly. Staples also has a vision to be a trusted global source for research and education that advances the sustainability of doing business and to make the general business environment more sustainable for workers, the public, the environment and the economy. Towards this goal, they are seeking novel and innovative design concepts that emphasize products and processes that enable businesses to be competitive in the marketplace while reducing their environmental footprint.

Assignment
To design an innovative solution for “the business of the future” - a concept that responds to emerging trends around the office and offers sustainable solutions to merging traditional business functions and high mobility as well as digital and analog content. This solution can focus on a specific product, user behavior, or a whole system as well and should align with Staple’s philosophy on sustainability.

The project will be done in teams of 3-4 students. Students from different disciplines/levels represented in the class should be represented evenly across all teams. Each team will be responsible for further defining the direction of the project assignment, based on their research into office environment and business needs. Teams also need to define clear responsibilities for each team member, so that everyone is clear on the contribution of individual students.
**Deliverables**

Monday October 7: Empathy video observations
- 2-minute video that narrates findings and insights from empathy experiments and observations.

Wednesday October 16: Design Proposal
- Brief description of concept to be developed
- User needs to be addressed
- Eco-design strategies to be applied

Wednesday October 30: Preliminary Concepts (individual team crit)
- A minimum of 3 concepts that show potential at addressing the needs that the team identified previously.
- Concepts will be presented in 2D (sketches or renderings) and 3D (full-size mockups).

Monday November 11: Refined concept (in-class presentation)
- PDF presentation
- Needs to communicate how the concepts address user needs, form, function, user experience, responsiveness to business environment and sustainability innovation
- Concepts will be presented in 2D (sketches or renderings) and 3D (full-size mockups).

Wednesday December 4: Assessment of Environmental Impact Improvement
- Explanation of the sustainability objective selected and the eco-design strategies employed.
- Justification of whether the objective was met through the design process,
- Brief discussion of life cycle tradeoffs and any business-design-sustainability tradeoffs that were encountered.

Monday December 9: Final Model
- Refined mock-up, used to communicate proportions, scale and interaction with user.
- Model does not need to be fully functional but it does need to be able to communicate important physical/mechanical features.

Monday December 9: Video storyboard
- Visual sequence of the video’s narrative

Wednesday December 18: Final Deliverables
- Process book detailing concept overview and development, as well as summary of the environmental impact assessment.
- 3-minute video that tells the story of their design solution in a dynamic and engaging way, particularly emphasizing how they meet Staples goals and the user needs as well as achieve sustainability outcomes.
Process
MATE
Smart, Adaptable Lighting for the Home Office

Project Team
• David Engell
• Brendan Gordon
• S. Adam Stoker
• Hui Sun
• Derek Burkwardsmeier

User Needs
The team, tasked with creating the home office of the future, began their project by researching and identifying the following key user needs:
• Time management
• Work space
• Shelter from distractions
• Communication & interaction

Initial Concept
A system of products that both stand alone as well as work together to create an environment that allows for a better, more productive work experience when working from home.
• Room sensor: monitors, records and adjusts to the user's work habits.
• Desk lamp: Integration with room sensor to actively change user's environment.
• Work desk: mobile, transformable, versatile and multifunctional work desk.

Initial Sustainability Goal
Minimize the embodied energy of the products.
**Concept Development**
Eliminate the work surface as the future of home office and focus on the impact of lighting on user behavior and energy consumption.

**Developed Sustainability DfX**
Reduced energy consumption during product use phase.
MATE
Final Design

Final Design
- Lamp imbued with duality, incorporating ambient and task lighting.
- Lamp base with inductive charging technology.
- Smart app tie in, allowing users to control lamps from their phone and track energy use.

Final Sustainability DfX
Reduced energy consumption during product use phase.
MATE Final Video
To view the MATE final video, visit http://youtu.be/gfh2rjycPeY.
MATE
Sustainability Analysis

Sustainability Goals
- Reduce the use-phase lighting energy consumption of the home office worker.

Design Strategies
- Introduce mobility and task lighting into the lighting scheme
- Include a smart device interface, to help users track energy use and control lighting.

Sustainability Analysis Methods
- Comparative analysis between a baseline system and the MATE Staples System of use-phase energy use
- System components:
  - Baseline system: ceiling fixture (3 CFL bulbs), desk lamp (1 CFL bulb), table lamp (1 CFL bulb), floor lamp (1 CFL bulb).
  - MATE Staples System: ceiling fixture (3 CFL bulbs), 4 MATE lamps (12 LEDs total in the lamps & 1 LED in the charging base).
- Functional unit:
  - Lighting requirement: 500 lux (lumens/sq. meter) in a 10 sq. meter room
  - Time analyzed: a year of work (7.525 hours/day * 5 work days/week * 50 weeks worked / year = 1181.25 hours total)

Energy Use Calculations
Use-phase energy use calculations indicate that the MATE Staples System requires less energy and produces more lumens than the baseline design.

Annual energy use results:
- Baseline system: 86 W at 5000 Lumens
- MATE Staples System: 74 W at 5040 Lumens

Energy Cost Calculations
The use-phase energy cost calculations also indicate that the MATE Staples System would have a lower annual energy cost than the baseline system. Annual energy cost results:
- Baseline System: $21.36
- MATE Staples System: $18.38

Conclusion
Due to the narrow scope of the project’s DfX, this analysis does not consider the impact of any other product life cycle stages (extraction, manufacturing, transportation, end of life). The impact of product materials were also not analyzed. To fully understand the impact of the MATE Staples System, all life cycle stages must be analyzed.
Hingeback
Multifunctional Work Surface

Project Team
- Dylan Falanga
- Erika Vosbury
- Bijal Patwa
- Brad Reminder

User Needs
The team, tasked with creating the home office of the future, began their project by researching and identifying the following key user needs:
- Environmental transition from home to work
- Organizational storage
- Multifunctional space & furniture
- Distractions

Initial Concept
To develop a system that eases the transition between home and office that increases productivity and mental focus.
- Room divider: to help user transition from home to work
- Laptop bag: converts into a stand to allow user to work in any location in the house
- File storage system: cut down on clutter
- Projector: displays user’s schedule, encourages productivity

Initial Sustainability Goals
- Dematerialization,
- Use of rapidly renewable materials,
- Limited number of different materials to reduce manufacturing steps & enhance recycling at end of life
Concept Development
Focus on creating a multifunctional piece of furniture that converts from a piece of home furniture to a work space (i.e. a convertible ottoman).

Developed Sustainability DfX
- Multifunctionality
- Dematerialization
Hingeback Final Design

Final Design
Chaise lounge that converts to reveal a hidden workspace.

Final Sustainability DfX
- Multifunctionality
- Dematerialization
Hingeback Final Video
To view the Hingeback final video, visit http://www.youtube.com/watch?v=v0wL4CyFNuA.
Hingeback
Sustainability Analysis

Sustainability Goal
• Reduced embodied energy

Design Strategies
• Multifunctionality: by combining functions into one piece of furniture, the Hingeback allows users to purchase just one piece of furniture, instead of multiple pieces.
• Dematerialization
• Durability

Sustainability Analysis Methods
• Comparative analysis of the embodied energy, price and weight of the Hingeback system and three home or home office products that together are functionally equivalent to the Hingeback
• System components:
  • Baseline system: Steel Dillon Desk Euro Style, Steel Structure Lifting Chair, Steel Calligaris Even Bench
  • Hingeback System: the Hingeback
• Functional unit:
  • Work surface
  • Work seating
  • Lounge seating

Embodied Energy Calculation:
Embodied energy calculations indicate that the Hingeback System requires a lower embodied energy than the baseline system. Embodied energy results:
• Baseline system: 2,759.84 MJ
• Hingeback System: 1,673.52 MJ

Weight Calculations
Weight calculations also indicate that the Hingeback System would have a lower weight than the baseline system. Weight results:
• Baseline System: 207 lb
• Hingeback System: 125 lb

Price Calculations
Consumer price calculations indicate that the Hingeback System would have a lower price than the baseline system. Price results:
• Baseline System: $1,131.99
• Hingeback System: $400

Conclusion
The Hingeback System offers numerous sustainability benefits, but also tradeoffs. For one, disassembly would require numerous steps. Furthermore, because of the niche market for this product, the Hingeback’s second life is limited.
Clutch Case
Multifunctional Carrying Case for the Mobile Worker

Project Team
- Erica Nwankwo
- Calvin Au
- Rachel Son
- June Lee

Initial Concept
A customizable, modular working platform to allow users to stay organized, create their own experiences and maximize their level of work efficiency.

Initial Sustainability Goal
Reduce energy required during the production stage through product dematerialization.

User Needs
The team, tasked with creating the mobile office of the future, began their project by researching and identifying the following key user needs:
- Limited working platforms
- Distractions
- Environmental ergonomics
- Limited access to electric plug-ins

User Empathy Video

Product Research
Concept Development
Customizable multi-functional carrying case that combines three products into one:
- Laptop surface
- Flat writing surface
- Carrying case

Developed Sustainability DfX
- Dematerialization
- Multi-functionality
- Durability
Clutch Case
Final Design

**Final Design**

Multifunctional laptop bag, which functions as a:

- Carrying case
- Ventilated laptop surface
- Smooth writing surface

**Final Sustainability DfX**

- Dematerialization
- Multifunctionality
- Durability
Clutch Case Final Video

To view the Clutch Case final video, visit http://youtu.be/zd6q6P1Q8f0.
Clutch Case  
Sustainability Analysis  

**Sustainability Goals**  
- Reduce the lifecycle impacts of the Clutch Case.  
- Clutch Case: hardshell + fabric laptop briefcase  
- Functional unit:  
  - One laptop bag  

**Design Strategies**  
- Dematerialization: In designing the laptop surface, unnecessary materials were eliminated to provide for the ventilation panel. In addition, slot holes were made to give way for the inner bag handles. Side panels were also eliminated as they did not serve a major function. Each material was designated for a specific function; the soft inner bag (neoprene & nylon) cushions personal items while the hard shell (ABS* plastic) provides structural support.  
- Multifunctionality: 3 products (laptop & writing surface and carrying bag) were merged into one product.  
- Durability: Using ABS plastic enhances durability of the product and allows its long lifespan.  

**Sustainability Analysis Methods**  
- Simplified Life Cycle Assessment, comparing the Clutch Case to the baseline design of a fabric laptop briefcase  
- System components:  
  - Baseline: fabric laptop briefcase  

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**Material Extraction Score**  
*Higher score = more sustainable*  
- Baseline: 6 (3 different materials)  
- Clutch Case: 7 (2 different materials)  

**Manufacturing Score**  
- Baseline: 7  
- Clutch Case: 8  

**Use Score**  
- Baseline: 10  
- Clutch Case: 11  

**End of Life Score**  
- Baseline: 3  
- Clutch Case: 5  

**Total SLCA Score**  
*Higher score = more sustainable*  
- Baseline: 26  
- Clutch Case: 31
Aria System
Luggage for the Modern Mobile Worker

Project Team
- Anne Sherman
- Reese Zecchin
- Zak Clark
- Liz Schwartz

User Needs
The team, tasked with creating the mobile office of the future, began their project by researching and identifying the following key user needs:
Luggage that provides:
- Content management and organization
- Physical and informational security
- Durability
- Adaptability to evolving needs

Initial Concept
A durable bag that offers adaptability, assists in work efficiency - with cues to assist in organizational efficiency - and helps alleviate the common physical difficulties of the mobile office.

Initial Sustainability Goal
Design for lifetime usage with replaceable or repairable parts, design better organization that may reduce the purchase of redundant products that are lost or forgotten, design for manufacturing (lessening the amount of power or material required), a choice of low impact materials (weight, lifecycle, end of life, etc), and/or better reuse/disposal/recyclability, which may include ease of disassembly.
Concept Development
A system for mobile office users to maintain organization in a variety of travel situations, with a focus on universal design.

- Level 1: Color-coded organization system with stickers, RFID stickers & stand-alone products
- Level 2: Integrated luggage system with integrated color-coded organization system & an electronics case, briefcase & toiletry bag

Developed Sustainability DfX
- Dematerialization
- Disassembly & recyclability
- User behavior: ergonomically-designed to allow user to walk more; organization system reduces travel product purchase redundancy
Aria System
Final Design

Final Design
Luggage:
- Lightweight, durable and repairable
- Ergonomic
- Integrated RFID organization system
- Customizable solutions

Final Sustainability DfX
- Extended lifespan
- Dematerialization
- Recyclability
- User process optimization
- Social innovation
Aria System Final Video

To view the Aria System final video, visit http://www.youtube.com/watch?v=rGNuTnrJRAg.
Aria System
Sustainability Analysis

**Sustainability Goals**
- Reduce embodied energy and product waste.

**Design Strategies**
- Lifetime usage
- Disassembly & recyclability

**Sustainability Analysis Methods**
- Comparative analysis between two base cases and the Aria System analyzing product recyclability, component parts, embodied energy, and price.
  - Base Case 1: Moulded polycarbonate and woven polyester carry-on. Product lifetime 10 years.
  - Base Case 2: Stamped aluminum and injection moulded carry-on. Product lifetime 80 years.
  - Aria System: Stamped aluminum and injection moulded recycled PET carry-on. Product lifetime (80 years).
- Functional unit:
  - Carry-on luggage for a lifetime (80 years)

**Recyclability**
Base Case 2 & the Aria System were found to be more recyclable than Base Case 1. Recyclability results:
- Base Case 1: 0%
- Base Case 2: 100%
- Aria System: 100%

**Component Parts**
The Aria System would have fewer component parts than the two baseline systems. Component parts results:
- Base Case 1: 29
- Base Case 2: 41
- Aria System: 26

**Embodied Energy**
The embodied energy analysis includes both the original product & replacements or repairs needed to reach a lifetime of 80 years, and indicates that the Aria System has the lowest EE analyzed. Embodied energy results:
- Base Case 1: 496 MJ (original product) + 4,467 MJ (repairs) = 4,963 MJ
- Base Case 2: 835 MJ (original product) + 1,000 MJ (repairs) = 1,835 MJ
- Aria System: 297 MJ (original product) + 1,131 MJ (repairs) = 1,428 MJ

**Lifetime Price**
Over its lifetime, the Aria system would have a similar overall cost as Base Case 2, but much lower overall cost than Base Case 1. Lifetime price results:
- Base Case 1: $2030
- Base Case 2: $750
- Aria System: $750
Adaptable Conference Space
Flexible Workspace for the Distributed Office

Project Team
• Abhishek Swamithan
• Annemarie Wolken
• Barbara Katsulaitis
• Raianna O’Toole

User Needs
The team, tasked with creating the distributed office of the future, began their project by researching and identifying the following key tenant needs:
• Privacy
• Adaptability
• Ease of use

Initial Concept
A secure, mobile, modular office system that is quickly and easily packed and transported, allowing for necessary moves with minimal disturbance of the work day.

Initial Sustainability Goals
• Durability
• Material Reduction / Ease of Manufacturing
• Reduction of Packaging
• Recyclability

User Empathy Video
Concept Development
Modular conference table with privacy screens.

Developed Sustainability DfX
• Durability
• Material Reduction / Ease of Manufacturing
• Reduction of Packaging
• Recyclability
Adaptable Conference Space
Final Design

Final Design
- Configurable conference table with privacy dividers & plug-in projection screen.
- Electrical outlets and USB ports integrated into center of table.
- Storage space for the screen, dividers, and support blocks located under the tabletop.

Final Sustainability DfX
- Material & space reduction
- Reduction of packaging
Adaptable Conference Space Final Video
Adaptable Conference Space
Sustainability Analysis

**Sustainability Goals**
- Reduce space and material requirements.

**Design Strategies**
- Dematerialization

**Sustainability Analysis Methods**
- Comparative analysis between a baseline system & the Adaptable Conference Space (ACS) System analyzing shipping, material, use-phase & end of life impacts. System components:
  - Baseline system: One 48” x 66” conference table; four 24” x 30” individual desks; one 48” x 64” projection screen
  - Adaptable Conference Space system: One 48” X 66” table with screen storage; zero individual desks; one 24” x 32” screen; two 18” x 42” dividers.
- Functional unit:
  - Meeting space and workplace for four people

**Material Requirements**
Overall, compared to the baseline design, the ACS System reduces the materials required for the functional unit. Material results:
- Individual desks: 100% reduction
- Table: slight material addition (screen storage)
- Screen: 75% reduction
- Dividers: addition

**Space Allocation per Worker**
On a square footage per user basis, the shared office system promoted by ACS reduces the amount of space required for each worker. Square footage per user requirements:
- ACS: 43% square footage reduction

**Recycled Materials**
The ACS system would provide a market for low-quality post-consumer recycled paper, while the baseline system would be constructed out of virgin wood.
- Baseline system: virgin wood.
- ACS: table top would be made from 100% post-consumer recycled paper and petroleum-free resins.

**End of Life Recyclability**
Recycling for the ACS system would be more limited than for the baseline system.
- Baseline system: the recycling infrastructure for wood is well established.
- ACS: the recycling infrastructure for fiber based composites is limited; however research shows potential for separation of resin and fibers, enabling future material recovery.
Distributed Office
Collaborative Tools for the Distributed Office

Project Team
- Daniel Kim
- Sergey Selyuzhitskiy
- Nicole Slauson
- Austin Fagot

User Needs
The team, tasked with creating the distributed office of the future, began their project by researching and identifying the following key tenant needs:
- Privacy
- Security
- Collaboration
- Versatility

Initial Concept
To encourage collaboration and also create privacy part of our design concept is a modular cubicle with wheels and adjustable partitions. Users can move the office space where they feel most private or secure and also be able to have visual and sound barriers. When they can or want to collaborate with other workers they can move or transform their desk appropriately.

Initial Sustainability Goals
- Multifunctionality
- Compact design
- Lightweighting
- Reduction of packaging

User Empathy Video
Concept Development
- Box seating: moveable and flexible.
- Display binder: a modular space for drawing, tacking, and projection

Developed Sustainability DfX
- Dematerialization
- Lightweight
- Common materials among products
- Modular
Distributed Office
Final Design

**Final Design**
Seating:
- Seating for groups of 2 or 4.
- Provides a work surface at a closed state.

**Idea Book:**
- Multifunctional collaboration board, organizer and projection screen.
- Can act as a space divider.

**Final Sustainability DfX**
- Dematerialization
Distributed Office Final Video
To view the Distributed Office final video, visit http://youtu.be/_Z2gnmIQasQ.
Distributed Office
Sustainability Analysis

Sustainability Goal
- Reduce material requirements.

Design Strategies
- Dematerialization
- Multifunctionality

Sustainability Analysis Methods
- Comparative product weight analysis between a baseline system and the Distributed Office system.
- System components (Idea Book & Baseline)
  - Baseline system: 3 whiteboards, 3 corkboards, 6 aluminum frames, 6 aluminum shelves, 24 wheels, 1 mobile projection screen.
  - Distributed Office Idea Book: 3 whiteboards, 3 corkboards, 4 aluminum frames, 1 aluminum shelf, 6 wheels.
- System Components (Seating & baseline):
  - Baseline system: 2 seats for 2 people each, 4 side tables, 1 work bench surface, 1 work bench table
  - Distributed Office Seating: 1 seat for 4 people, 4 side tables, 1 work bench surface

Material Weight Calculations
Weight calculations indicate that both of the Distributed Office products are lighter than the baseline systems.
Weight results (baseline whiteboard vs Idea Book):
- Baseline whiteboard system: 680 lb
- Distributed Office Idea Book: 511 lb
Weight results (baseline seating vs DO Seating):
- Baseline seating system: 171 lb
- Distributed Office Seating: 129 lb
Weight results (overall):
- Distributed Office Idea Book: material weight reduction of 169 lb from baseline
- Distributed Office Seating: material weight reduction of 42 lb from baseline
- Distributed Office System: material weight reduction of 211 lb from baseline
The Hive
Modular Workstation for the Corporate Office

Project Team
- Alexandra Bush
- Austin Gampfer
- Becca Freund
- Ron Still

User Needs
The team, tasked with creating the corporate office of the future, began their project by researching and identifying the following key user needs:
- Space for privacy & collaboration
- Space adaptability
- Efficient use of space

Initial Concept
A modular office desk system that provides space for privacy & collaboration, is customizable, and is durable.

Initial Sustainability Goals
- Durability
- Material reduction
- Reduction of packaging

User Empathy Video
Concept Development
Modular, adaptable workstation that provides the necessary balance between privacy and collaboration.

Developed Sustainability DfX
- Extended product lifespan
- Reduction of packaging & shipping
The Hive
Final Design

Final Design
Modular, adaptable workstation that provides the necessary balance between privacy and collaboration.

Final Sustainability DfX
- Multifunctionality
- Extended product lifespan
- Reduction of packaging & shipping
Hive Final Video
To view the Hive final video, visit http://youtu.be/97hjuz4vgww.
The Hive
Sustainability Analysis

**Sustainability Goals**
- Reduce the embodied energy of an office system.

**Design Strategies**
- Adaptability
- Multifunctionality
- Standardization of fasteners

**Sustainability Analysis Methods**
- An Economic Input Output-Life Cycle Assessment of a baseline system and the Hive system.
- Functional unit:
  - Workspace for 10 people
- System components:
  - Baseline system: 10 (2 rows of 5) 6’x6’ square cubicles with 3 walls (1 shared between two cubicles), 2 small collaboration spaces, 1 utilities room
  - Hive System: two pods of 5 6’x6’ hexagonal workspaces (total of 10) with 4 walls (1 shared between two cubicles), 2 small collaboration spaces, 1 large collaboration space, 1 utilities room

**Cost Calculations**
Cost calculations reveals a lower cost for the Hive than the baseline system.

Cost results:
- Baseline system: $52,827.20
- Hive System: $41,033.60

**Embodied Energy Calculations**
The embodied energy calculations also indicate that the embodied energy of the Hive would be lower than that of the baseline system. Embodied energy results:
- Baseline System: 317,381.56 MJ
- Hive System: 246,526.56 MJ

**Square Footage Calculations**
The Hive requires more space than the baseline system. However, it is important to note that the Hive also allows for a large collaboration space, while the baseline system does not. Square footage results:
- Baseline System: 1,394 SF
- Hive System: 1,800 SF
Project 2
Concluding Thoughts

For Project 2, students were tasked with working in teams of 4-5 to create an innovative solution for the “business of the future.” Each team was assigned a specific type of office or business - corporate, distributed, mobile, home.

User Research
To understand their office type’s users and their needs, teams immediately dove into user research using a variety of techniques: surveys, interviews, site visits and more. This user research vitally informed each team’s focus and end product.

Integration of Sustainability & Design Students
Due to the course’s student mixture, many teams included both industrial design undergraduate and graduate students and each team included a student with greater training in sustainability (including Golisano Institute for Sustainability PhD and Master students, as well as students from Golisano Institute for Sustainability’s Master in Sustainable Architecture program). The integration of sustainability-trained students into project teams helped foster the integration of sustainability goals and design strategies into most teams’ design processes and allowed for fruitful peer-to-peer mentoring on sustainability issues.

Sustainability Coaching
What we learned from students’ struggles with Project 1’s material tradeoff analyses was that most students needed more coaching on a) integrating sustainability goals into their design projects early in process; b) using sustainability tools effectively; c) understanding sustainability issues in general. To truly teach about sustainability in this interdisciplinary setting, the teaching team cannot simply provide content; instructors must guide students through this complex topic.

The student researcher implemented a series of team check-ins to discuss project sustainability goals and help guide students toward a more mature understanding of sustainability. Extended conversations with professors leading up to the Sustainability Analysis were also implemented to help coach students on how to measure or estimate the impacts associated with their designs.

At all project benchmarks, students were required to identify sustainability goals. Furthermore, each team was given a chance to update their Sustainability Analysis with professors’ suggestions.

By requiring that sustainability be an integral part of teams’ projects, providing students with helpful sustainability content, and incorporating more intensive sustainability mentoring, the course helped students gain a deeper understanding of sustainability and analysis.
Reflection

New Product Category
This year marked a shift in product type for the Sustainable Product Design course. The course has - in the past - focused on electronic products and Information and Communication Technologies (ICT). It was very interesting and refreshing to address a different category such as the office environment and to understand similarities and differences in terms of sustainable design. This offered a great opportunity to understand the universality of the eco-strategies covered in the course.

Multidisciplinary Course
The multidisciplinary nature of the course is one of its primary strengths - and also a major challenge. Students tend to have a hard time understanding the objectives and technical knowledge from other disciplines. While this course integrates different perspectives and allows for students to develop a cross-disciplinary experience, it can limit the pace of the project or how far each discipline can go in its own area. Still, feedback from students and project results always show that students appreciate this challenge and learn a lot from interacting with one another.

On-Demand Lectures
The course featured on-demand lectures, providing students with design and sustainability information when they needed it (i.e. a lecture on sustainable material selection as students began to assign materials to their project). This seemed to work well.

Design + Sustainability
The more intensive integration of design and sustainability during the team project - including cross-disciplinary teams, sustainability conversations, and sustainability project requirements - reinforced students’ sustainability knowledge, challenged students’ misunderstandings and pre-conceived notions, and helped push students’ sustainability understanding to a more mature place.

Staples
Staples’ engagement in the course and feedback from Staples Industrial Designers provided students with vital insights regarding design, product manufacturability and sustainability. For future projects, students would benefit from greater interaction with the course’s industrial partner.

Team Dynamics
As is typical with any group project, during Project 2, some teams gelled and excelled and others struggled.

Project Brief
The project brief for Project 2 was vague, and, as a result, some teams struggled with defining their
Looking to the future

The teaching team will examine a few potential changes to the course, listed below.

Schedule Adjustment
There was potentially too little time for Project 1 and too much time for Project 2. The schedule will be adjusted accordingly.

Business Perspective
Future versions of the course will incorporate the business perspective regarding sustainability through industrial partner engagement, a lecture, or a reading.

Disciplinary Ice Breakers
The teaching team will investigate the potential of introducing disciplinary ice breakers, to help each cohort enter into the other’s knowledge space, as well as incorporating small, in-class activities to help students learn complex topics and new skills.
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Golisano Institute for Sustainability

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