Design Gateway: Pedagogical Discussion of a Second-Year Industrial Design Studio

Section: Beginning Design Programs and Curricula

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Introduction

Most industrial design programs focus the beginning design curriculum on the learning of core design principles. These core principles are seen as not specific to any one discipline (architecture, industrial design, interior design, etc.), but rather as fundamentals germane to all design fields. These core principles focus on the analysis of built artifact (structures, products, systems) to develop an understanding of geometry, structure and composition through looking and exploring. Students develop skills in representing, communicating and analyzing what they see and experience.

These skills are nurtured in early studios. As students move into later studios, more discipline-specific knowledge and skills are integrated into their educational pedagogy. In the beginning years of design education, there is a transition from the learning of general 'core' design fundamentals to specialized principles that is inherent to their specific disciplines. As students move from abstract ideas to 'real-world' projects, they seem to have difficulty transitioning between the abstract concepts they previously learned and reality that requires application to new settings. Students perceive learned concepts as specific to a particular studio project, rather than realize that design education is a continuum of practiced principles [i]. This presents a disconnect between knowledge transfer from one studio project to the next.

The curriculum of the second-year industrial design studio at the Georgia Institute of Technology is designed to address this disconnect and help students successfully transition from the core design fundamentals to industrial design knowledge. Throughout the second year education, students engage in the making and communication of form, doing it through design exercises dealing with fundamentals as well as knowledge base, both simultaneously and repeatedly. According to Kelly, a design education that offers a component of repetitive experience encourages students to be cognizant of the iterative nature of both the design process as well as design education [ii].

This paper discusses the approach, designed by the authors, evident in the sophomore-year industrial design curriculum at Georgia Tech. While emphasis is placed on rigor, exploration and articulation of concepts throughout the studio period, this approach adopts a pedagogy connecting basic design fuandemntals learned in the freshman year with upper level industrial design studios. Product design fundamentals are offered through a series of product design modules that scaffold the introduction of new concepts with the reinforcement of previously learned ones. Individual modules follow a path of concept introduction (lecture), analysis, practice, and finally refinement. Upon completion of every module, students are required to do a 'module project' that demonstrates synthesis and realization of the learned concepts. Additionally, they do a final semester-end design project that provides for aggregation and demonstration of all subject matter learned throughout the semester. This pedagogical approach of product design fundamentals bridges the gap of disconnect between previous and future design studios and promotes a continuous layering and practice of beginning design fundamentals.

Gateway

"We do not know why, but we can demonstrate that a human being finds planes of definite and intentional proportion more pleasant or more beautiful than those of accidental proportions."

-Jan Tschichold, The Form of the Book, 1975

"Design without thinking is like a story with no plot."

-Pat Hansen, 401 Design Meditations, 2005

The curriculum of the sophomore-level Industrial Design studio at Georgia Tech is developed and viewed as the gateway into the discipline of industrial design. This gateway represents a transition from the common first-year curriculum to the industrial design curriculum. In common first-year curricula, emphasis is placed on developing students' representational skills through analysis of built artifacts. Put generally and crudely, this can be referred to as a "draw what you see" and "show that you can think" approach. At the sophomore level (or second-year studio), students build upon the analysis and representational skills developed in the common first year, but now learn to develop intent based on visual and industrial design principles. This can be referred to as a "make what you think approach." It is during this sophomore industrial design studio that students transition from "draw what you see" to "make what you think" as a driver of intent.

Pedagogy

The standard academic year at Georgia Tech is divided into two semesters. The sophomore industrial design studio comprises the two major fall and spring semesters. The sophomore ID curriculum is developed around product design and form development. Fall semester focuses on form development based on visual principles while spring semester explores product form based on industrial design fundamentals.

The visual principles applied to form development in the first semester include:

- Gestalt principles of perception and two-dimensional (page) layout principles [iii, iv, v]
- Volumetric form construction (rectilinear, curvilinear and complex additive and subtractive forms) [iii, ix]
- Plane and line construction in space (planar, linear and combinatory forms) [ix]

Industrial design fundamentals applied in the second semester include:

- Materials and materiality [vi]
- Body-fit (user-focused and body integrative form development) [vii]
- Function (form semantics and communication/affordance of interaction) [xiii]
- Sustainable design (influence and exploitation of sustainable design practices) [viii]

The individual semesters are organized into a series of topical modules, each one investigating the principles and fundamentals outlined above (see fig. l, below). Each module is constructed of a series of assignments followed by a 'wrap-up' project. Module concepts are presented to students through a variety of channels: lecture, reading and/or experiencing. Assignments are given which generate day-to-day learning of module concepts. The assignments build towards projects. The module project provides students a means to demonstrate understanding of learned concepts. Students are also required to show their conceptual learning through drawings and 3d models, which requires them to explore model making materials and work in the model shop. This method reinforces thinking with hands, a traditional 'making' method commonly found in design studios. Examples of lecture, analysis, practice and refinement are discussed in the 'Module Discussion' section.

Emphasis in the sophomore curriculum is placed on rigor, exploration and iterative refinement of concepts. Other areas of instruction include: need identification, intent as a design driver (both the articulation of and manifestation thereof), concept building and development, design validation, basic presentation skills and basic model-making skills (visual and representational skills). Articulation (of intent, critique and understanding) as a form of learning is a cornerstone in this course.

Structure

As mentioned earlier, both semesters consists of subject modules which build towards a final, semester-end project. In this way, learning is composed of layered concepts where

ideas encrust each other. Every module follows a progression of lecture, analysis, practice and refinement. Throughout the semester students follow these stages of importance to design education. The basic module structure is shown in fig. 1, below:

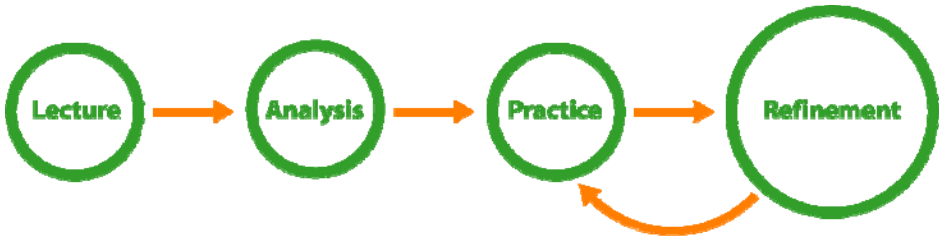


Fig. 1

Lecture is the means by which students are introduced to the module concept. Lectures can be in the form of traditional lecture and presentation or through viewing of film, readings or and/or discussions. The *analysis* phase calls for students to investigate application of the concept to real-world objects or cases. This affords the student historical knowledge and physical evidence (form) of the concept in use. In the *practice* phase, students are given assignments that call on them to develop their own formal applications of the concept. Here the students are developing intent internally and realizing that intent physically through constructed thinking and form-making. The final phase, *refinement*, refers to the module 'wrap-up' project. Here, students refine and demonstrate their understanding and learning of the concept. As fig. 1 shows, student move back and forth between *refinement* and *practice*. This movement between phases reflects the iterative nature of the design process.

The refinement projects usually last between one and two weeks, whereas the entire module will span two to four weeks, depending on the subject matter. Variations of the basic structure occur to accommodate the different characteristics of each module topic.

The entire semester is constructed of a series of modules building towards a semester-end project (see fig. 2, below). Semester projects enable demonstration of all concepts learned throughout the semester.

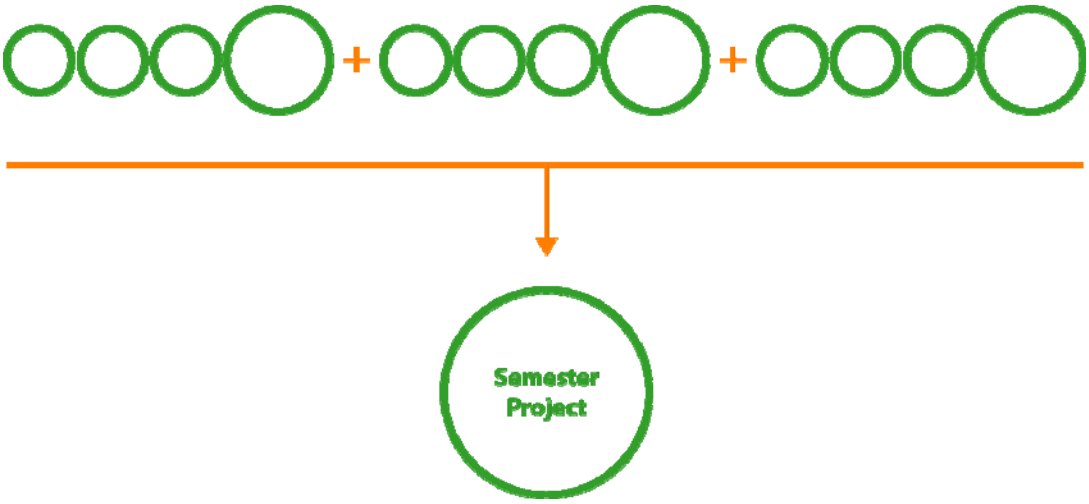


Fig. 2

This scaffolding structure allows practiced concepts and principles to build upon previous experiences. In this way, student learning of formal design concepts is reinforced with each successive module. In the next section, curricular applications of the described structure will be discussed.

Module Discussion: Fall Semester

As mentioned Previously, Fall semester modules are constructed as an introduction to form-making based on visual principles. After demonstrating an understanding Two-dimensional design, students are then introduced to volumetric compositions during the second module. Here emphasis is placed on three-dimensional construction and composition of rectilinear, curvilinear, and then increasingly complex volumes. We will discuss this second module in-depth to illustrate the structure discussed previously.

During the volumes module we take a critical look at volumes as fundamental forms and how industrial designers can translate this knowledge into a product with the following objectives:

- Understanding of Basic Volumetric Shapes and Their Composition into Complex Forms
- Exploration and Study through Modeling
- Establish and Culture of Peer Critique
- Establishing *Intent* as a Driver of Design

Discussion, reading, and exercises focus on rectilinear and curvilinear form before summarizing the project concepts into a realized industrial design product. Exercises are modeled after the lessons appearing in *Elements of Design* by Gail Greet Hannah[ix]. Due

to the character of this module, the structure involves an extra layer encompassing both rectilinear and curvilinear development:

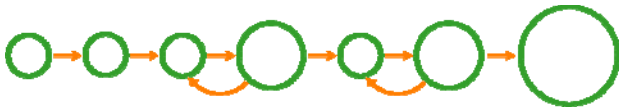


Fig. 3

The practice and refinement portion of this module begins as an exploration through modeling, first in inexpensive pink insulation foam, and finally through sanded and primed basswood models. Students begin with 50 pink foam rectilinear building blocks of various shapes and proportions. As they combine pieces in order to construct rectilinear compositions through piercing, wedging, and cradling, students develop an understanding of the relationships between dominant, subdominant, and subordinate elements and how they impact the character of the composition (Hannah 50). In this initial exercise students are restricted to arranging the pieces along perpendicular axes, but are challenged to proportional relationships of the pieces as a single element, as compared to other parts of the composition, and the proportions of the composition in its entirety. through table reviews and class discussion, students begin to understand how to effectively interpret and implement peer and instructor feedback to produce a successful composition.

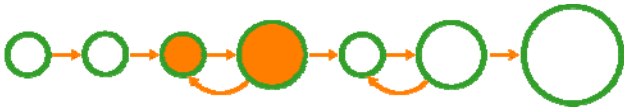


Fig. 4

During the curvilinear portion of the volumes module, students leverage the compositional language they have practiced with simple rectilinear building blocks and begin to explore the more intricate relationship of curvilinear primitives (sphere, hemisphere, cone, cylinder, ovoid, ovoid plinth, half ovoid, and round plinth). Here we layer on complexity by looking at diagonal axes, tensional relationships, and issues of balance (Hannah, 62–64).

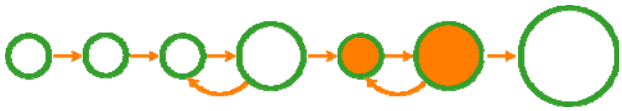
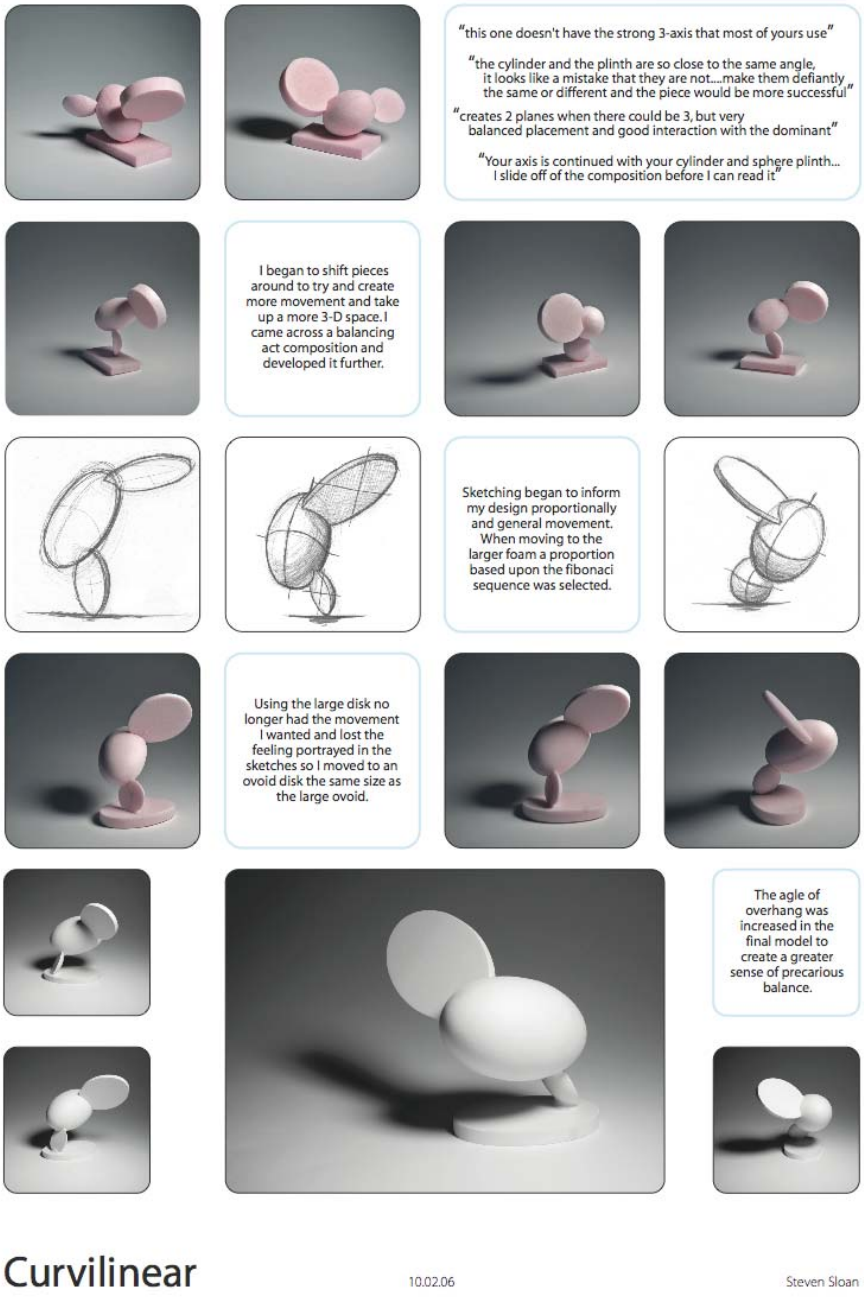


Fig. 5



Fall 2006. Documentation of pink foam study models, peer feedback, design statment, and final curvilinear composition.

The ‘wrap-up’ project for the volumes module is to design and model product forms that relied on principles of volumetric composition while reinforcing Gestalt principles. In one version of this exercise students design a set of salt and pepper shakers. The goal is to introduce the traditional design process using visual and perceptual principals under the following parameters.

- Objects should highlight important three-dimensional principles and be composed to visually suggest interaction, such as wrapping, nesting, wedging, hugging, and kissing.
- Individual forms must be able to stand and be evaluated on their own. Minimum Dimension: four inches; Maximum Dimension: twelve inches
- Form should offer a strong visual langage of function and suggest human human interaction.

Students establish design intent and through iterative drawing and modeling arrive at a final design direction.

Fall 2007. Photographs of salt and pepper shakers.

After the completion of the volumes module, the semester continues with a visual and physical exploration of linear and planar compositions. Students begin to understand how lines, edges, and surfaces move through and activate space. Again there is an emphasis on thinking and skill building through three-dimensional modeling, and students are challenged to create well-crafted wire and planar styrene models as they further their understanding of form communication in a spatial context.

As thier form-making skills develop, students are ultimately able to produce product forms that are sculptural and visually engaging. The final project for the semester challenges students to synthesize this knowledge to design and model a seating device in three weeks. They are evaluated not only on their ability to proceed from design statement to a final product form, but also in their craft in modeling and their visual and verbal presentations. Below are examples of some of the scaled seating device models.

Fall 2007. Photographs of seating devices.

Module Discussion: Spring Semester

The second semester builds upon form development skills learned in the first semester. Industrial Design fundamentals are layered on top of form basics to establish competency in communication of intent. Spring Semester Objectives:

- To provide an overview of form making process based on *Industrial Design principles*
- To develop expertise in advanced drawing and modeling techniques related to 3d form making
- To familiarize advanced visual and verbal presentation techniques

We chose the topics of materiality, usability, function, and sustainability for their relevance and applicability across the discipline if Industrial Design. These topics also lend themselves to being taught at level of depth and complexity that can be mastered by second-year design students. Our intention is to introduce to give a high-level overview of each topic, but we allow and encourage student to investigate the design topics in depth to augment their personal understanding for later studio courses and employment situations. Our rationale for keeping it high-level are both logistical and pedagogical. There is not time to cover these topics at a expert level of understanding given the context of studio and the time allotted during the semester. Additionally we noticed that the deeper we delved into each topic, students were more prone to focus solely on one design topic/issue at a time rather than layering their understanding of each with their understanding of form.

Spring semester's materiality module focuses on materials and materiality and physical context. This seems to be a natural segue from the fall semester as students had begun to work with various materials in the modeling their seating devices. Students begin by examining material properties and perceptions of Material families (polymers, wood, textiles, metal, ceramics, and glass) as a group research project. Then, they explore material manipulation and joinery techniques that are appropriate to use at a modeling level.

The wrap-up project asks the student to design a mood evoking lighting device around a simple incandescent/compact fluorescent light cord. They were asked to celebrate the joinery of the piece and alter the light transmitting properties of chosen materials.

The second module introduces the human side of Industrial Design with a discussion of body-fit and human factors. Our objectives are to:

- Understand how form relates to the human body
- Exploration and Study through Modeling
- Experiential Information Gathering
- Utilize *External Intent* as a Driver of Design

As an introduction to this topic we rely heavily on selected readings including Denis Diderot's *Letter on the Blind for Those Who Can See*[x], Chapter 2 of Dreyfuss' Designing

for People, *Joe and Josephine*[xi], and *Taylor's Principles of Scientific Management*[xii] to establish a case for human-centered design. We also view Tim Burton's *Edward Scissorhands* as a theatrical example of how "others" are perceived and to illustrate the trade-offs in ability that wearable objects cause.

Next the Students conduct a six-hour experiential research experiment called Altered States. We ask students to literally put themselves in someone else's shoes for six hours. Their task is to attempt to replicate the every day life experiences of someone with a different physical condition. An example of some of the states explored are pregnancy, clubfoot, partial hearing loss, woman with large chest, broken arm, wheelchair bound, change in stature, arthritis, etc. Students experienced a change in social acceptance, a change of mobility and ability, and frustration with the environment. While no student can wholly empathize with those in different permanent physical states, through this short exercise students begin to gain perspective on the diversity in human conditions and how hose condition impact our interaction with designed objects.

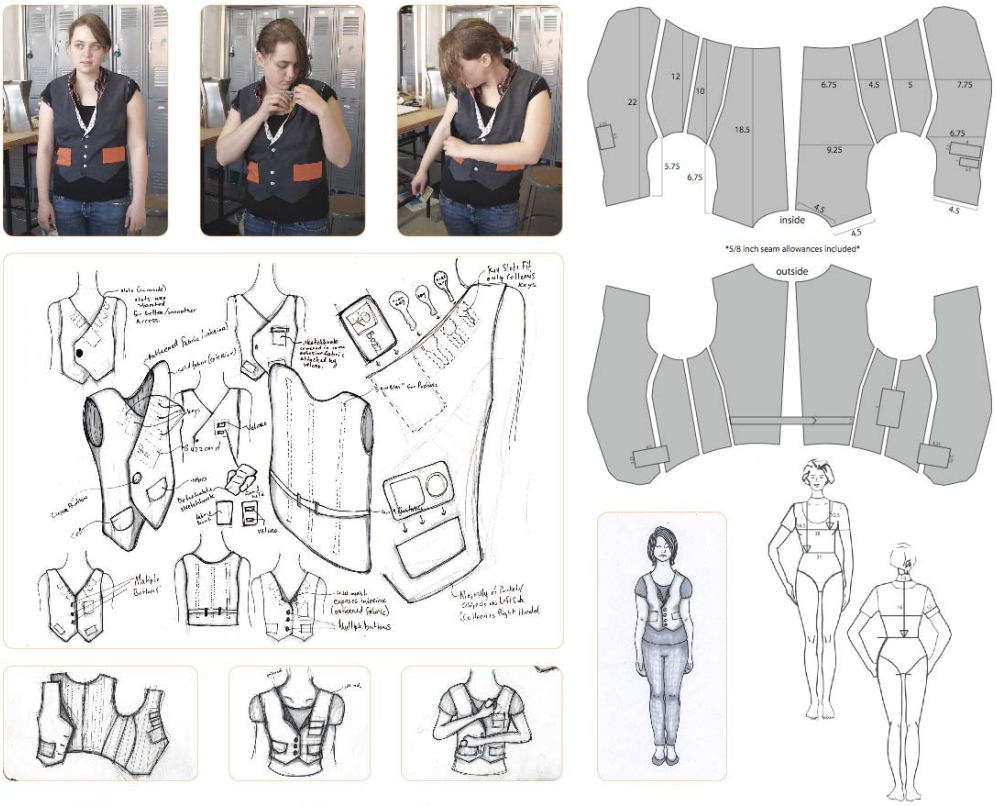
Spring 2008. Documentation of *Altered States* Exercise.

The wrap-up project for human factors module is a project called *Enable/Disable* initially developed by Prof. Beth Tauke at the University at Buffalo. This project questions the influence of body on man-made form, the importance of body-fit to attain enablement and the important lesson of design consequences related to design action. The student pair up into class and become each other's client and designer. After conducting an interview to understand each other's lifestyle/habits, preferences/dislikes, things they do well/poorly, so on and so forth, students develop a client-driven brief. This brief results in a wearable device that enables their "client" to do something that they have always aspired to do (i.e. being a super hero, swim in the ocean without fear, dunk a basketball, be more organized, etc.). They must also:

- Develop and Utilize Body Measurement Strategies and Recording Techniques
- Build a Custom-fit Prototype
- Demonstrate Understanding of the Enabling and Disabling Attributes of the Device.

The third module asks the student to examine issues of functionality, usability, and form semantics. They develop a vocabulary and understanding of user interaction, and evaluate existing products based on visibility, feedback, proper affordances, natural constraints, mapping, and appropriate mental models.[xiii] The question becomes, "How does from communicate function, purpose, and operation?" for the wrap-up project, *Take a Mulligan,* students propose a redesign for an object that functions poorly. We introduce storyboarding, task mapping, and concept sketching as tools to communicate user experience with an object in two-dimensional format.

The final spring semester module addresses sustainability and product lifecycle. Our goal is to build an awareness of the responsibility of industrial designers as the producers of consumable goods and their impact on the environment and economy. The emphasis is on understanding the complete product lifecycle and to understand that sustainable practices can and should be a holistic approach to product development. Students working pairs to design and prototype a product made entirely of reclaimed materials, which communicates its sustainable nature, and extends the life of the constituent materials.



Spring 2008. Documentation of *Enable Disable* Project.

The goal of the final project for Spring semester is to synthesize the four industrial design modules—material properties, alteration, and joining methods; body-fit and user-centered product solutions; form semantics and task analysis; and designing for sustainability and understanding of product lifecycles. The students are introduced to ethnographic research methods and strategies to record and present qualitative data. The project is structured as a three to four week group project that ultimately yields individual product solutions. In the end, students have to articulate their design decisions through a verbal and visual presentation to faculty and members of the design community in a formal critique. Student groups are given the option to find a design opportunity in one of the following contexts: transportation, occupation, recreation, or domestic. After identifying an opportunity for design intervention, the groups develop a project brief that's common goal is to develop a form-based product solution that addresses our four design topics as evidence of their understanding. Their deliverables for this final project are:

- The Group Brief
- Individual Design Statements
- Evidence of Form-development Through Drawing and/or Modeling,
- Primed, Sanded White Model of Final Product Form (Ideally Full-scale)
- Computer model (Solidworks) Illustrating Product Details, Finish, and Context

Evidence

Evidence to support success of the discussed pedagogy exists in several forms. The breadth of student projects completed within each module has been encouraging. Students demonstrated understanding of industrial design principles and manifestation of form-making principles in "real-world" objects. Also, students developed the ability to articulate intent as well as provide insightful and critical peer feedback. Additionally, it was found that assigned reading material, when completed, reinforced learning of class objectives.

In the initial year of implementation, however, several failures were observed. The level of in-depth form exploration waned during the second semester as noted student apathy increased. Interim presentations (of major projects) were not taken seriously unless student involvement was forced. Also, visual communication skills (sketching ability) were lacking. Finally, a need for greater accountability of assigned readings was needed.

To address the initial failures, several curricular evolutions were put in place. Form evolution within projects has been emphasized as a graded element. This has resulted in more thorough exploration of form development. Implementation of quizzes has been successful as a gauge of participation and to hold students accountable for reading material. Additionally, a dedicated sophomore-level sketching course was created as a required element to address the demonstrated poor drawing habits. Anecdotal evidence suggests this has been fairly successful in increasing students' visual communication skills. Finally, a studio culture of peer review was created through table discussions and peer review.

Conclusion

The structure herein discussed is one in which a series of modules scaffold the introduction of new concepts with the reinforcement of previously learned ones to build student understanding of beginning industrial design fundamentals. The first semester builds upon skills learned in common first year studios with visual thinking related to product forms and, in turn, the entire second semester builds upon form development concepts based on product design thinking. In that way, industrial design fundamentals are layered on top of form basics to establish competency in communication of intent and realization of product ideals.

Spring 2007 (Above), Spring 2008 (Below). Documentation of Final Project.

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