Promoting a Problem-Solving Generation

Mary Beth Privitera, Medical Device Innovation & Entrepreneurship Program, Department of Biomedical Engineering, Colleges of Engineering and Medicine, University of Cincinnati
Andy F. Loewy, School of Architecture and Design, College of the Arts, University of Louisiana, Lafayette

Introduction

In a world where marketing and profits take center stage, we seldom question our motivation as designers. In fact, design has been described as the new MBA or as the “new advertising.” The mainstream business world has come to believe that a successful design is defined by a products’ marketability not by its usefulness or its ability to improve our lives. How preposterous! Not only is this sentiment prevalent in our business sector but it has also penetrated and become very influential within the industrial design education community. After all, a teacher’s goal is to have their students become successful and if our society deems that the success of a product is dependent on its salability the tendency may be for educators to teach students how to conform to market pressures. All too often, these pressures have their roots in language and style rather then more substantive issues like functionality and usability. Substantive design speaks to problem solving and ultimately the usability of a product. It determines those aspects of a product that makes them beneficial to the user. This real-world problem solving is based on sound physics, technology, and science. As educators do we shy away from these challenging topics or view them as rigorous mountains eager to be climbed? Ideally, good design is the reconciliation of substantive design and poetic aesthetics coupled with sound functionality.

The goal of this paper is to explore the connection of the current business practices and the preparation of students for real-world practice of industrial design. As teachers, we do not negate language and style, both are admittedly a large part of the world we live in. Rather, the emphasis of this paper is about the dangers of disregarding the more important design qualities such as function and usability for a look or branding that is marketable. Style should be a vehicle for designers instead of an end in itself. The authors teach in two very different settings, in universities one thousand miles apart, surrounded by very different cultures but both have found a growing annoyance with the proliferation of products that sell but have very few other redeeming qualities. These products are “pretend design” that is they are new and different but not necessarily better.

Let us begin by asking ourselves a very basic question: As industrial design educators, are we graduating designers that fit as perfectly as possible into our present marketplace and are, therefore, better prepared to find employment or are we graduating designers who have had an enlightening experience in design school and crave the activity of design because of the inherent rewards that exist in the field? Such rewards might be as abstract as gratification from making a positive contribution to the human condition.

Obviously teachers care about how marketable their students are. We all carry around a mental list of our students that design for established consultancies or companies. We are proud of any students that establish themselves in the competitive design community. We seldom question our gauge in judging design success. Recently at a regional IDSA conference, a previous student and designer from an established electric fan company made it evident that he was suffering from what could be called “designer burnout.” His job was to update the company’s catalogue and design a new line of fan models on a yearly basis. He explained that the changes were often recycled from previous years and were mostly surface modifications such as color and ornamentation. Going from a four blade model to a three or five blade fan was far too radical for his conservative company. Here was a designer that was working for a successful company, had what is considered in the design world a successful position, was making plenty of money, but felt uninspired by his job situation.

Most of us are aware that many design positions are similar to the job of the electric fan designer where the emphasis is not on problem solving and addressing the needs of the user but rather catering to

market concerns and questions pertaining to trend and fashion. There is, on the other hand, real substantive design going on that is so stimulating and exciting that those that are involved have trouble falling asleep at night. As teachers of design, it is hoped that our students find work that is engaging and makes a positive contribution.

Everything that human beings manufacture goes through a design process. Some products are designed well where they reconcile functional considerations with usability and desires while unfortunately others are not well resolved. We should distinguish between what is designed with substance and what isn't in the hopes that as educators we sharpen our convictions as to what is necessary to teach our students to be better prepared and inspired. The almighty dollar might be very seductive and fundamental to business success but it should not be the primary concern or motivation when evaluating design quality. We should want our students to first be able to talk of the benefits or contributions their designs make and then secondly make the claim that their projects are economically viable. Certainly, economic success is part of the equation but we should be careful not to over emphasize its importance.

Historically the industrial design education community is not precocious when it comes to the issue of substantive design. The American industrial design profession was spawned during the Great Depression. Manufacturers desperate to spur the economy emphasized 'appearance design' to boost sales. As industrial design became more recognized as a profession, academic institutions started to include it as a program of study. At this time, industrial designers were thought of as "stylists." Since the 1930s industrial design has undergone some fundamental changes. It has become much broader in scope and has found diverse applications within areas of manufacturing. Today, industrial design has taken a greater interest in and emphasized the user and problem solving to a much greater extent. Having said this it should be noted that many of these ideas were around in the early days of the profession. Henry Dreyfuss (1904–1972), the first president of the Industrial Design Society of America, was not a stylist, made numerous contributions to the disciplines of human factors, ergonomics and anthropometrics. In 1955, Dryfuss wrote a book *Designing for People*. It remains a classic of the design field to this day. Even though the Dryfuss viewpoint existed, the predominant view during these early times was that industrial designers created a skin over the product that made the design more marketable. In recent times, we have become inventers and problem solvers that are also trained to make inventions aesthetically pleasing so that they will appeal in the marketplace.

Unfortunately our academic institutions are steeped in tradition and change more slowly then the fast-paced commercial world. Currently, much attention has been given to the practice of industrial design by the business sector. While we lead the charge at trend setting and branding, if we are to maintain the momentum gained then we, as educators, need to reconsider our curricula to include the ever changing broadening practice of industrial designers. It is our responsibility as teachers to guess the direction society will take and prepare students for their future. The companies that are challenged these days are companies that are unable to visualize and anticipate the future. There is a major acceleration in product design change in recent years and with the high tech industries influence there is no indication that it will slow down. In order to survive designers and companies will have to change at a much faster pace then they ever done before and academic institutions will have to prepare students for the new world in which they will be designing. The new emphasis will be on how designers evaluate and tackle problems in addition to the current pedagogy on style, brands, and trends.

Substantive Design

In defining substantive design we have developed a list of traits concerning the process of design. We engage ourselves in substantive design when the design

- solves a user problem.
- is innovative in nature.
- is inspired from user observation.
- has social value or is sensitive to culture, race, gender, age, or creed
- captures an unexpected positive presence.
- deals with issues of sustainability and universal design.

For a design project to be substantive, it must include at least one of the previously listed traits. As teachers, it is our responsibility to encourage and guide students so that they understand the value and rewards of designing substantively. An informed design project inspired through research based on ethnographic and comparative explorations allows the designer to make better design decisions. The designer becomes a facilitator by making sense of information and not creating arbitrary style that is based on nothing more then a fleeting trend.

Both authors teach at academic institutions where their programs are relatively young and because of this have had the privilege and opportunity to help shape the students' learning environment. One author teaches sophomores and the other teaches juniors and seniors. Their teaching methods and techniques have similarities in spite of their students' different stage of educational development. This demonstrates the importance of a strong foundation and repetition in the curriculum. The following is a description of some of the techniques and project descriptions that have helped guide our students in the direction of substantive design through problem solving.

Starting with a Problem as a Jumping-Off Point

We have frequently asked our students to begin a design project by identifying a user problem as a jumping-off point. The idea is to allow the class to have a degree of commonality between projects but at the same time not be too restrictive, leaving ample room for creativity and interpretation. An example might be a category of products like hand tools. Each student comes up with a tool and a user problem associated with it. This topic is introduced in conjunction with Donald A. Norman's book *The Design of Everyday Things* to the class. Besides relating some of his examples, examples of an observed design problem from previous experiences are provided. Often we come across design problems and typically dismiss a problem as either being too difficult to remedy or often we blame our human-ness instead of the product. Many people feel mechanically inept because a particular product doesn't work for them. If analyzed it usually becomes evident that the product is at fault. When this game of "find the design problem" is played, students become motivated. Everybody comes up with examples of frustrating everyday problems that they have encountered. As designers this activity of finding flaws in design is both fun (it makes us feel good to know better) and it is very educational. If we are not aware of the flaws that a product can have, how can we expect to design the object without flaws? We ask our students to come to the next class with two examples of design problems that they have experienced in a design product lately. They have had no difficulty with this assignment. The following are examples of problems that my students used for their design project. One student came up with a problem that we all know too well. What do we do with the last of the peanut butter or jam that is left over after we have all but emptied the jar? Some of us throw out the jar, some use a spoon or knife to get to it, and some use their finger. This student very correctly decided that this was a societal problem that had to be remedied. She spent her six weeks designing a universal utensil that would be an effective tool to get the last of the peanut butter out of the jar. Another problem a student identified is the old hairbrush problem. We have all seen hair brushes with tangled, matted hair at the bottom of the brush and we all know how hard these brushes are to clean. This student's problem was to design a hairbrush that didn't have this problem. Once a student is committed to a tool and user problem, the student becomes involved and half the battle is won—a social or user need has been identified. The other half of the battle is the design dance or journey that is different for every designer and every project. The goal of this journey is to design a beautiful solution for the identified user need.

The Affordance Principle

The "affordance" principle is extremely instructive and valued and can't be overemphasized in an industrial design class. The concept was first recognized as a principle and coined as a noun by psychologist James J. Gibson in 1979:

"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I

mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment..."
(*The Ecological Approach to Visual Perception*, p.127 by James. J Gibson)

The concept was then introduced to the design world by Donald Norman in 1988:

"When used in this sense, the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used. A chair affords ("is for") support, and, therefore, affords sitting."

And

"'Affordances' are a characteristic of an object which makes it obvious how that object will be used…"
(*The Design of Everyday Things*, p. 9 by Donald Norman)

The concept of 'affordance' allows the students to question the relationship of the user to the product and it is through this questioning that they begin to comprehend the complexity of this relationship. They start to develop an understanding for the numerous environmental and innate factors that play a role in influencing the user/product experience. Why and how humans behave with products in the way that they do are very important questions. The concept is closely linked to a product's usability and is an excellent way of introducing the relationship between perception and function. The quality of an 'affordance' can be attributed to everything from actual hard empirical measurements to an emotional response of the color or form of a product. The term 'affordance' includes both the world of poetics and the world of science and engineering. After all human are concerned and influenced by both and it is important that the industrial design student recognizes this.

Mentally Active Drawing

It is very important for a designer to have the ability to convey his thoughts and ideas in a drawing. In fact, there are not a lot of reasons for designers to draw if it's not to communicate or resolve thoughts. It is possible to have good observational drawing ability without the ability to communicate thoughts and ideas well. Over the years of observing students draw we have found that the most informed drawings are those that are drawn to clarify thoughts, issues or problems. When a project is drawn for the purposes of illustration or appearance rather than to resolve a problem it will no longer convey active ideas. We differentiate between these two types of drawing by calling the problem-solving drawing "active" and the other where the drawing becomes an illustration, "passive." An "active" drawing occurs when we are either trying to explain something, understand something or resolve a problem either to ourselves or to others. A "passive" drawing is a drawing in which problems and resolving design issues are not being considered. Instead it is a drawing that shows us what the project looks like. Clearly, these two types of drawings, "active" and "passive", serve two very different purposes. "Active" drawing as we have defined it is an extremely important design tool. It is the method that designers resolve problems either by themselves or with others. It is a communication skill that is extremely important and is often the catalyst that furthers design solutions. We've all witnessed wonderfully informed, thoughtful drawings that are drawn on napkins or scraps of paper, because there was an urgency to get an idea across either to oneself or to others and that was all there was to draw on at the time. We have found that the best way to get students better at what we call "active" drawing is to create a situation that requires "active" drawing. There are many stages in the design process that can become opportunities for "active" drawing. The more a designer practices this skill the better they become.

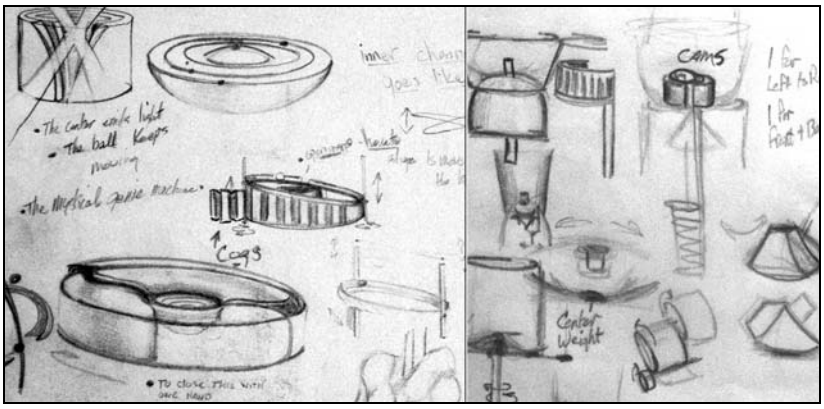

Figure 1. Mentally active drawings by David Leonard.

Brainstorming

An exercise at the very beginning of a design project is to break up into small groups and brainstorm following the guidance and advice found in *The Art of Innovation* by Tom Kelly. There is a chapter that explicitly discusses successful brainstorming sessions. This method is further bolstered with the showing of Nightline's episode with Ted Koppel called "The Deep Dive" that is essentially a five day brainstorming session in which the IDEO design group develops a new shopping cart. It is clear in this video how much this group makes use of "active" drawing. It gives our students a first hand experience at what a good brainstorming session is like. The film is put together in a way that is so experiential, our students feel like they participated in the actual IDEO brainstorming session. By the time they have their first brainstorming assignment they have a pretty good idea of what brainstorming is about. Three of the most important rules are: one, not to judge other students' ideas; two, a large quantity (maybe as many as 100 per hr.) of diverse, seemingly disconnected (anything goes no matter how crazy) ideas are preferable to a few well grounded thoughts; and three, to build on other peoples ideas. These rules create an environment that is conducive to "active" drawing. We supply the class with boards to tack ideas onto, sticky notes, colored markers, plenty of paper and tell them to break up into groups and get to work.

Figure 2. Visual dump sheet from a brainstorming session.

The board that they create from their brainstorming session becomes a collection of ideas that might be interconnected or hardly connected depending on the dynamics of the group. It is a visual dump sheet that represents the thought interactions of the group. The next assignment is to take this dump sheet, to prioritize the information relative to its importance to their project, organize the information and then to create a board that substantiates a direction, or communicates ideas to the rest of the class. This board is not about the actual design of the product; it is about the direction that the student will take in the design process. Because there is a lot of thought that goes into this selection process the drawings that make up this board itself tends to be an "active" drawing.

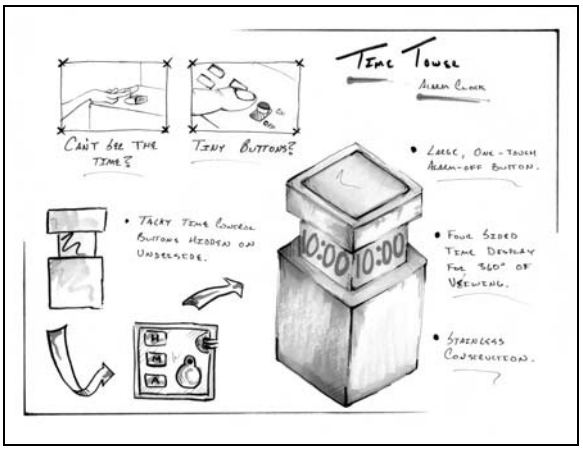

Figure 3. Board by Matt Curtis inspired from a brainstorming session indicating a design direction.

Hands-On Model Building as a Means for Discovery (Quick and Dirty Models)

Students are encouraged to build models of their design problem ASAP. These models are focused and students are required to pre-determine what is it that they want to know about their project. For example, does the issue that needs resolving relate to form, ergonomics, structure or mechanics? If there are ergonomic concerns then the right model would be a model that relates to the human body and so on. In order to efficiently problem solve, designers should get into 3D as early as possible. Proving the concept of a design is increasingly important and utilizing 'quick and dirty' methods to communicate a design principle is paramount. The image below depicts early explorations of a means to attach vessels to synthetic grafts. Our first model was built with barrettes and a plastic cup then quickly followed by some paper clips, fabric and paper.

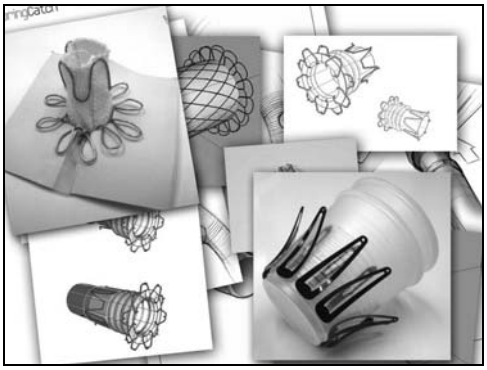
Figure 4. Quick-and-dirty models.

A Real-World Multidisciplinary Approach

At the University of Cincinnati's Medical Device Innovation program starting with a problem is facilitated through physicians and scientists. This real-world approach brings both social responsibility and problem solving thinking to the forefront. It requires that the design team, consisting of biomedical engineering, industrial design and business students, conduct a thorough analysis of the design problem, including the science behind the problem (disease or tissue properties). In this instance almost immediately industrial designers can feel intimidated with the amount of information provided by the research and the seemingly unsolvable design problem. The aha moment for them is when they realize that they are not alone in this feeling and that the biomedical students feel exactly the same way. The figures below show the collaborative workspace for design teams. Certainly this team effort affords a more complete solution to the problem but it can also be a slow and tedious process and requires the support of additional faculty from the respective team member areas.

Figure 5. A collaborative design team at work.

Discussing Products When There Isn't One Yet

Solving problems generally means that there isn't a predicate product that has the same functionality and therefore the use of the product from start to finish must be explored to avoid leaving a part of the problem out. For example in industry, often a design team will choose to solve only part of the design problem to later release a new improved version. While this has merit in that it provides immediate profit for the company, using storyboards to identify challenges within the design solution can be an invaluable tool. Below is a storyboard image of a surgical procedure for the above vessel to graft connection product. It was used by the design team to communicate with the surgeon the steps of the proposed procedure. While this is far from having the actual device to test in an animal lab, it was certainly faster and cheaper. In addition, the physician was able to identify challenging areas.

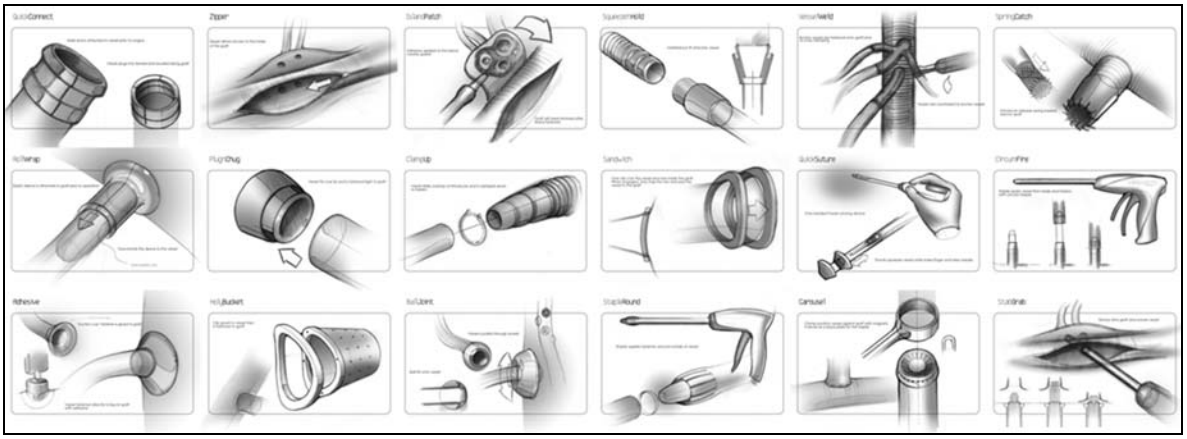

Figure 6. Storyboard image of a surgical procedure for vessel to graft connection.

Conclusion

Great designs share characteristics that seem simple yet are complete, they are functional, familiar and elicit an emotional response, they also appear timeless yet innovative. The practice of industrial design is ever changing to include not only the design of products, but also to the design of process and transformation.

A traditional curriculum of industrial design is heavily focused on the tangible aspects of design, that is, the curriculum is largely focused on developing skills. It is applied practice based within where students gain knowledge and skills. Increasingly discussions of social awareness and responsibility are happening in education but somehow get lost when rubber meets the road for individual designers once they leave the hallowed halls. By promoting a problem-solving generation of industrial designers we may instill a

sense of purpose and provide courage not to accept next years fan model but to provide solutions to humanitarian and environmental problems.

As teachers of design, we should believe in and inform our students of the great potentials that design has to offer regarding the betterment of the human condition. We should evaluate design based on criteria that we can clearly relate to substantive user traits rather then only a superficial look or trend motivated by a profit biased business world.

References

Bang & Olufsen: Design Driven Innovation, Harvard Business review, Sept. 2006

http://www.core77.com/reactor/01.07_backlash.asp Beware the Backlash: A rising tide of disaffection towards design By Kevin McCullagh

http://www.businessweek.com/innovate/NussbaumOnDesign/archives/2007/01/advertising_mee.html

Gibson, J. J. (1977). The theory of affordances. In R. E. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Innovating through design, published and written by the Harvard Business review, Dec. 2006

Kelly, T. (2000) *The art of innovation: Lessons in creativity from IDEO, America's leading design firm*. New York: Doubleday.

Kuniavsky, M. (2003) *Observing the user experience: A practitioner's guide to user research*. San Francisco, CA: Morgan Kaufmann Publishers.

Laurel, B. (2003) *Design research: Methods and perspectives*. Cambridge: MIT Press, 2003.

Norman, D. A. (1990) *The design of everyday things*. New York: Doubleday.

Pulas, A. J. (1983) American design ethic: A history of industrial design. The MIT Press.