The Pedagogy of Form versus Function for Industrial Design

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Abstract – Industrial Design is a combination of science and art. Determining the balance of the two is a preeminent challenge for teachers. The function is dominated by science/engineering principles while the form is an artistic/aesthetic expression. The teacher has a limited number of courses to present the foundational material while leaving enough courses to practice designing. This paper presents an objective summary of foundational courses, programs of study from various institutions, program evaluations by industrial experts, and a discussion about predetermining student success. A summary of accreditation requirements and how they affect the programs of study is also included.

Keywords: Industrial Design, program of study, form versus function, accreditation, right/left brain.

INTRODUCTION

The concept of art is well accepted as shapes or drawings that are created to please sight or touch. Many times art is described as a pleasing design but the work of scientists and engineers is also referred to as a plan or design, such as the design of an engine or piping system. Scientists and engineers use the word design as noun to name a device or an adjective to describe the effectiveness of a system. The term design is also used to describe a number of professional fields such as Industrial, Interior, and Architectural Design. In this sense the word design blends both meanings of art and function. "Design is often viewed as a more rigorous form of art, or art with a clearly defined purpose" [Wikipedia, 1] "In the late 1910s, the two principles of "form follows function" and "ornament is a crime" were effectively adopted by the designers of the Bauhaus and applied to the production of everyday objects like chairs, bed frames, toothbrushes, tunics, and teapots." (Wikipedia 2008) This paper concentrates on the university training of Industrial Designers/Product Designers with respect to form and function. The dilemma faced by all educators is determining, in an affordable package, what and how much knowledge should be imparted to the aspiring student to start them along their career path. Practical engineering programs, such as Mechanical Engineering, concentrate solely on teaching applied mathematics and science, like heat transfer, thermodynamics, mechanics, and fluids. Art schools teach form and aesthetics with foundational courses in shape, color and light, and drawing; and advance courses in sculpture, painting, and a host of specialized media from fabric to paper. With this training, an engineer can make an ugly blender that works great while an artist can create a beautiful blender that can't make a smoothie. So the two disciplines try to work together to blend form and function into a package that the consumer can use and admire. Unfortunately the group dynamics are often stymied by genetics. Most pure engineers are dominant left brain thinkers while truly creative artists are right brain thinkers; and mixing left and right brain dominated people is as successful as blending oil and water. The necessity of solving this dilemma triggered the mother of invention to create the field of Industrial Design/Product Design and an educational process that tries to deliver a balance of both perspectives.

Form of Product Design

Product design is driven by form in spite of the adage that "Form follows function". Product designers primarily have one customer- retail industry- and most decisions governing the retail industry are dominated by consumer sales. Consumer sales can loosely be grouped into short term and long term purchases. Short term purchases are often impulse buys based on the wow factor; this is form dominated. "Wow, that looks cool; I want one'. Long term purchases are influenced more by the reputation or prediction of how well a product will function. A refrigerator is a long term purchase and a slick looking ball point pen is "wow", impulse buy. A good argument can be made to refute this assumption because most people use the, ubiquitous ugly, but very functional, cheap pen, while virtually no one chooses to make the major purchase of an ugly, but very functional, refrigerator. So a fine balance of form and function is required to please the consumer and convince them to lay down a credit card.

Teaching how to form a product in an Industrial Design curriculum is accomplished in much the same way as an art school. The students take foundational courses in sketching, color and light, drawing technique, etc.; in fact many programs are housed together in colleges of Art and Design. Students then take a series of studio courses where they are told to innovate specific products and justify why their creations merit production during critique sessions. The products and presentation usually incorporate a consideration of function but are dominated by form. Little consideration is given to production methods or market analysis. The intent is training students how to reasonably design innovative products with a sales potential. The messy details of reality, like functional engineering, manufacturing production, and market analysis, are left to other specialists. That is how product designers are taught form. Problems occur when a product has so much form that it can't be manufactured or sold at a reasonable price. Then the balance between form and function must be adjusted.

Function of Product Design

Most engineers love to solve design problems. They have been trained in school and by experience to optimize a set of parameters for the best solution to virtually any situation. Industrial Engineers use forecasting algorithms to determine how much toothpaste "Acme Inc". should make each day. Civil Engineers can design the least expensive bridge and Mechanical Engineers can specify a diesel engine that will deliver the best possible fuel economy. These skills are very specialized, take years of mathematically governed training, and tend to lean towards an introverted work style. On the other hand, Industrial Designers primarily solve a stylistic or innovative problem that is consumer driven; the optimization requires a large amount of human interaction. The design not only has to look good but it also must be reasonably feasible and cost effective. So, how much functional training do Industrial Design/Product Designers require, and how is it delivered? Many programs of study include a course that teaches students about the properties of different materials such as wood, metal, and plastic. This course usually incorporates training about the ways to shape or process the material, thus the common title, Materials and Processes. The focus of this research is the determination of other formal courses that impart functional training to Product Designers. Most schools allow students to learn functional information on an as-needed basis as part of design studios. These findings follow along with an attempt at quantifying the effectiveness of the graduates.

Components of Industrial Design Curriculums

Industrial Design/Product Design programs resemble one another with common themes of courses. Degrees are offered primarily as Bachelor of Science, Bachelor of Arts, or Bachelor of Fine Arts. This research does not investigate the characteristics of advanced degrees. All programs begin with a series of courses that teach design foundations.

Foundations courses present a litany of topics such as: drawing, painting, visual literacy, two-dimensional design, structural elements of art, the principles of visual organization, the psychological effects of visual decision making, color theory, historical/psychological aspects of design, principles of three dimensional design, and design vocabulary. Subsequent courses specialize in drawing, graphic design, digital imaging, web page development and manipulation, one or more courses covering Materials and Process, Computer Aided Drafting and Design, and a series of Studio courses specializing in product development.

Program of Study Constraints

Each university has unique constraints for their programs of study. The primary constraint is built around eight, fifteen hour, semesters or one hundred and twenty hours of course work. A portion of the training is reserved for general studies, courses not specific to the major. This accounts for three semesters or forty-five hours of course work. General studies are composed of math, science, social science, and art. The balance of course work is devoted to the major study with a fair amount of freedom depending on the institution. Each department area has to make a convincing case for acceptance of the major courses. The program of study is fine tuned and updated on a regular basis. This check-and-balance helps to guarantee that graduates will be proficient in their career but only to the extent of the teacher's expertise.

Accreditation Requirements

The primary accreditation for Industrial Design programs is with the National Association of Schools of Art and Design, NASAD. NASAD accredits twenty two programs from Ceramics to Woodworking with Industrial and Interior Design in the middle [NASAD, 1]. An edited version of the requirements for Industrial Design follow: Industrial design is the professional service of creating and developing concepts and specifications that optimize the function, value, and appearance of products and systems for the mutual benefit of both user and manufacturer. Industrial design involves the combination of the visual arts disciplines and technology, utilizing problem-solving and communication skills. When an institution is adequately staffed and equipped to offer specialized courses in industrial design and related areas, the offering of a degree with a major in industrial design is justified.

Curricular structure, content, and time requirements shall enable students to develop the range of knowledge, skills, and competencies expected of those holding a professional baccalaureate degree in industrial design. Studies in industrial design comprise 30-35% of the total program; supportive courses in design, related technologies, and the visual arts, 25-30%; studies in art and design history, 10-15%; and general studies, 25-30%. Studies in industrial design; supportive courses in design, related technologies, and the visual arts; and studies in art and design histories normally total at least 65% of the curriculum.

Essential Competencies, Experiences, and Opportunities

a. A foundational understanding of how products work; how products can be made to work better for people; what makes a product useful, usable, and desirable; how products are manufactured; and how ideas can be presented using state-of-the-art tools.

b. Knowledge of computer-aided drafting (CAD), computer-aided industrial design (CAID), and appropriate two-dimensional and three-dimensional graphic software.
c. Understanding of the history of industrial design.
d. Functional knowledge of basic business and professional practice.
e. The ability to investigate and synthesize the needs of marketing, sales, engineering, manufacturing, servicing, and ecological responsibility and to reconcile these needs with those of the user in terms of satisfaction, value, aesthetics, and safety. To do this, industrial designers must be able to define problems, variables and requirements; conceptualize and evaluate alternative; and test and refine solutions.
f. The ability to communicate concepts and requirements to other designers and colleagues who work with them; to clients and employers; and to prospective clients and employers; this need to communicate draws upon verbal and written forms, two-dimensional and three-dimensional media, and levels of detailing ranging from sketch or abstract to detailed and specific.
g. Studies related to end-user psychology, human factors and user interface.
h. Opportunities for advanced undergraduate study in areas which intensify skills and concepts already developed, and which broaden knowledge of the profession of industrial design. Studies might be drawn from such areas as engineering, business, the practice and history of visual art and design, and technology, or interdisciplinary programs related to industrial design.
i. Easy access to computer facilities; woodworking, metalworking, and plastics laboratories; libraries with relevant industrial design materials; and appropriate other work facilities related to the major.
j. Opportunities for internships, collaborative programs, and other field experiences with industry groups.
k. Participation in multidisciplinary team projects.

These eleven essential competencies can be loosely divided into three groups based on form, function, or both. Competencies a, e, g, and h are based primarily on product function, b and f are based on form, and c, i, j, and k develop for form and function. This analysis would seem to suggest that accredited programs of study in Industrial design should contain a substantial amount of course work devoted to functional training. But, this is not the case based on a review of numerous programs.

Programs of Study

This section lists the functional courses of various industrial design programs. The bulk of the coursework in program areas teach form. Only functional coursework is listed to simplify the reporting process because so few functional courses are included in most programs of study.

Georgia Tech: Four courses: Introductory Physics one and two Materials and Processes. This program has the most functional based coursework of the programs reviewed. Savannah College of Art and Design: One course: Manufacturing and Assembly Technology. Arizona State: Three courses: General Physics one and two, Materials and Design one. Auburn: One course: Materials and Technology. University of Kansas: five courses, Plastics, Physics one and two, metals, and Hands on Steel. Massachusetts College of Art: two courses, Materials and Processes one and two. Kendall College of Art and Design: one course, Materials and Processes. Montclair State University: two courses, Materials and Processes one and two. Rochester Institute of Technology, one course, Materials and Processes one. This is a partial list of programs but serves as a fair representation of typical programs of study for Industrial Design programs.

Evaluation of University Effectiveness

Design faculty from Appalachian State University met with the design team at Bosch Siemens Home Appliance, BSHA, for a day in the fall of 2007. A long discussion was held on the required competencies for successful employment of incoming Industrial Design graduates. The companies' designers agreed very closely with the competencies required for accreditation by NASAD. Similar discussions were held with the design group from IRWIN Tools, a Rubbermaid company. The IRWIN designers were asked about the appropriate educational balance between form and function. The four designers unanimously agreed that a deep knowledge about the function of products is required for designers to be successful. Both of these companies are utilitarian in nature. Their products have a high degree of functionality. A questionnaire was emailed to a number of design firms: "I am doing Industrial Design education research and would like to ask you a question about the balance between form and function. Do you think ID grads have the right balance between form and function, education or could they use more of one or the other; and if so, what deficiencies have you noticed that we should address. The question was designed to be unbiased and open ended to yield the broadest response. The design firms were selected from the Industrial Design Society of America's website. The responses varied but have reportable similarities.

Designers fall into three job category types, researchers, gear heads, and artists. Researchers spend a lot of time working on innovative new ideas; gear heads work on improving existing products or fine tuning new products, and the artistic designer concentrates on how the product will look. Some university programs specialize in one or more of these areas. Large design firms will employ a mix of design talent while small firms have designers who have to perform all of the functions. Furthermore, the design specialization tends to be more innate then learned. The bent toward innovators, gear heads, and artists is more genetic than learned. This put quite a twist on the pedagogical research for shaping a design program curriculum. Rather than trying to mold students with a specific blend of knowledge educators should present all the knowledge and then allow the students to flourish in their natural choice. This research moved to a different area of trying to determine the student's preference and helping to direct them into the best course of study. The first step in this process is determining if students are right or left brain dominant.

Right-Left Brain Tests and Characteristics

Little was known about right and left brain functions until the late 1950's and early 1960's when some significant research was conducted by Roger Sperry. This work earned Sperry a Nobel Prize for Medicine in 1981. He concluded that "The left hemisphere is the one with speech, as had been known, and it is dominant in all activities involving language, arithmetic, and analysis. The right hemisphere, although mute and capable only of simple addition (up to about 20) is superior to the left hemisphere in, among other things, spatial comprehension - in understanding maps, for example, or recognizing faces" [Horowitz, 3]. Teachers can determine a right or left brain through a serious of question that discover character traits.

Right Brain Traits: When given a task or assignment, they want to know why it's important because they like the big picture. They don't need "to-do" lists — they like to wing it! They prefer molding clay into pottery over Sudoku puzzles because it is more creative. When shopping for a new car, they pick what looks best, rather than what drives best because they are into aesthetics. When traveling, they like impulsive adventure. Why plan it all out and ruin it? Because they are visual, they prefer textbooks to lectures. They can remember a person's face but not necessarily his name.

Left-Brain Traits: When given a task or assignment, they don't always need to know why it's important. They get a great deal of pleasure in creating "to-do" lists and checking off each item as it is accomplished. When shopping for a new car, they look at fuel efficiency and crash safety ratings over aesthetics. When traveling, they like to have the itinerary completely planned down to the last detail. Because they respond to verbal cues, they prefer lectures to textbooks. They are good at remembering names [Life Script, 4].

Right brained occupations: forest ranger, wildlife manager, beautician, politician, athlete, artist, craftsman, and actor/actress. The right brain functions in a non-verbal manner and excels in visual, spatial, perceptual, and intuitive information. The right brain processes information differently than the left brain. Processing happens very quickly and is nonlinear and nonsequential. The right brain looks at the whole picture and quickly seeks to determine the spatial relationships of all the parts as they relate to the whole. This component of the brain is not concerned with things falling into patterns because of prescribed rules. On the contrary, the right brain seems to flourish dealing with complexity, ambiguity and paradox. At times, right brain thinking is difficult to put into words because of its complexity, its ability to process information quickly and its non-verbal nature. The right brain has been associated with the realm of creativity.

Left brained occupations: lab scientist, banker, judge, lawyer, mathematician, bacteriologist, librarian, and skating judge. The left brain is associated with verbal, logical, and analytical thinking. It excels in naming and categorizing things, symbolic abstraction, speech, reading, writing, arithmetic. The left brain is very linear: it places things in sequential order -- first things first and then second things second, etc. If you reflect back upon our own educational training, we have been traditionally taught to master the 3 R's: reading, writing and arithmetic -- the domain and strength of the left brain [Douglas Anderson, 5].

Conclusion

This on-going research project found that most Industrial Design programs in the United States are heavily centered on teaching product form and give little attention to product function. This is true for programs accredited and unaccredited by NASAD in spite of NASAD's competency requirements of a significant coursework of a functional nature. Design firms agree that recent graduates from many Industrial Design programs lack sufficient training in the functional aspect of products. The recommendation of this research is the inclusion of additional coursework concentrating on how products function. This research also brought out the necessity of understanding about the left/right brain characteristics of design students. Potentially successful design student must have a strong right brain with its creative nature and concentration on form. One challenge for design teachers is helping student train their left brain and develop an appreciation for the functional aspects of product design.

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Biographical Information

David Domermuth is a professor at Appalachian State University. He has been teaching for 22 years. His career began in metals manufacturing and has shifted to furniture and now Industrial Design. David teaches the engineering aspects of product design. He has three degrees in Mechanical Engineering and has lived abroad for five years. His primary hobby is road biking with 30 years of riding in the Appalachian Mountains.

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