Aptitudes for Industrial Design
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All teachers have had students who seem to learn quickly and easily, have passion and excitement for learning, and are able to apply the principles they have been taught. These teachers have also had the opposite kind of students. What is it that allows one to excel while another struggles? My hypothesis is that the answer is aptitudes.

What is an aptitude? According to Webster’s Dictionary an aptitude is “a capacity or innate ability, a talent for learning, or a special fitness.” Certain kinds of things can be learned easily, quickly, and with more passion if the aptitude is there. Every occupation, whether it be engineering, medicine, law or design, requires certain aptitudes. The work you are most likely to enjoy and be successful in is work that uses your aptitudes.

On the other hand, low aptitude for a skill does not mean that the skill cannot be acquired. While it is widely recognized that anyone can learn any skill, if one is willing to put one’s mind to it, it is also recognized that some people are simply more adept at learning certain skills than others. It means that reaching the level of proficiency required for competent performance will probably be more difficult and time-consuming for those who lack the aptitude than it is for individuals with greater aptitude for that skill.

The field of industrial design appears interesting to many students who are trying to decide on a course of study in college. They “play” aspect involved in the creative process of designing “cool” artifacts is especially appealing. Many students make their decision to pursue industrial design based on this reason alone, without considering their aptitudes for the other aspects involved. After time they become frustrated and discouraged and struggle with their decision.

How do we help students to make more informed decisions about their “fit” in industrial design?

The first task is to understand what the aptitudes of an industrial designer are. Second is to develop a series of experiences for the aptitude. The third is to have the students experience these aptitudes in an environment that helps them decide if industrial design is right for them.

Aptitudes
To better understand the aptitudes for industrial designers I asked twenty-five designers to share their input on what these aptitudes might be. I surveyed designers in industry and education, in corporate and consulting, in transportation, exhibit, and product design. I asked each designer to brainstorm the aptitudes they thought would be most valuable to a potential industrial design student. I also reviewed the literature that talked about industrial designers’ aptitudes.

The input was fairly consistent on aptitudes a designer should have, with a few surprises. As I studied the information I saw that there seemed to be some natural groupings based on
how people think. I outlined all the aptitudes and then tried to refine them into simpler categories.

I had a number of comments, such as “will try new approaches, ability to create a number of solutions to the same problem, ability to make new combinations, naturally innovative, a problem solver.” I combined these inputs under the area of creative thinking. Responses like “good at geometry, visual thinker, builds things, curious about how things work, mechanical ability, and attention to detail,” I listed under visual thinking. The unique aptitudes that were hard to categorize went like this: “ability to accept criticism, comfortable with risk, adaptive to change, is able to handle frustration, feels what’s right, is confident.”

At first I tried to fit these items into creative thinking, but it didn’t seem right. As a part of my research I read Michael Gelb’s book, How to Think Like Leonardo da Vinci. Gelb says, “A designer must have a willingness to embrace ambiguity, paradox and uncertainty.” Having read a number of articles about tolerance for ambiguity, paradox, I decided it is indeed an aptitude of a designer. I call this form of thinking “flexible thinking.”

The aptitudes were defined under three main categories: visual thinking, creative thinking, and flexible thinking. Thinking is how we receive information, how we process information, and how we use that information. Aptitudes grow out of these ways of thinking.

To further test the validity of my conclusions about the industrial designers’ fundamental thinking styles, I tried to see if the aptitude could stand on its own. If found crossover aptitudes that seem to tie the three together. For example, tolerance for ambiguity seems to be a creative thinking aptitudes, as well as a flexible-thinking aptitude. It is a crossover point, yet it also stands on its own. There are people with a tolerance for ambiguity who are not creative, and vice versa. Intuition is thought of as a creative thought process, yet many people rely on their intuition to make decisions that are not creative. There are also overlaps on the visual side. Drawing is recognized as a visual thinking skill but also plays a strong role in creativity. Yet some very creative people are not visual, and vice versa. Curiosity is a great aptitude for a creative person, but is also visual-thinking aptitude. Some designers compensate for their lack of aptitude in certain areas, but those areas seem to frustrate them in their work. The best scenario is a design student with all three thinking styles.

**Visual Thinking**

What is visual thinking? Thinking means how we receive, process, and use information. At the simplest level, visual thinking occurs when the information we receive, process and use comes to us in the form of images. The simplicity should not be underrated. “The words of language as they are written and spoken, do not seem to play any role in my mechanism of thought,” said Albert Einstein. It suffices to mention the likes of Einstein as a visual thinker to convince us of the value of visual thinking.

The aptitudes I chose to examine under the heading of visual thinking are the ones that the survey pointed out and that I felt were most pertinent to the industrial designer: 3D visualization aptitude, visual language aptitude (sketching, drawing, doodling), mechanical aptitude, and aesthetic aptitude.

**3D Visualization Aptitude**
Investigations into the development of spatial [visual] skills have led to theories that divide the ability to visualize into retaining images and the ability to transform these images. Each of these areas has subsets. I believe the following to be most relevant to the aptitude of 3D visualization and the industrial designer, in descending order according to difficulty.

1. The ability to remember and compare images in your imagination
2. The ability to orient 3D objects mentally (e.g., to rotate the object in your mind)
3. The ability to place oneself in an environment and move about that environment mentally
4. The ability to mentally deconstruct and manipulate components of a 3D object (e.g., manipulations like unfolding a 3D object into a flat pattern, make cross-sections through an object, or explode an object’s parts in a logical way, to modify and reassemble elements within an object mentally)

**Visual Language Aptitude**

Another aspect in the visual-thinking aptitude is visual-thinking language—drawing, sketching, or doodling. The designers in my survey mentioned a number of skills, such as natural drawing ability, drawing talent, visual communication, and sketches. I believe that sketching is a skill that can be taught, and students can learn if they have aptitude for visualizing form. Sketching seems to come more naturally to visual thinkers. This natural ability comes from a visual thinker’s desire to express thoughts and the ability to see things accurately in one’s mind. It is the language used to record and communicate ideas, usually to one’s self, and at times to others. Sketching is closely tied to our ability to see, think, and imagine. Sketches help to clarify and amplify thinking, particularly when the individual is engaged in the process of solving a problem.

**Mechanical Aptitude**

An important aspect of visual thinking is that one can perceive the whole, the parts, and their relationship to each other. It means a visual thinker has "the ability to see visual shapers as images of the patterns of forces that underlie the functioning of machines."³ "Spatial concepts go hand-in-hand with mechanical ability."⁴ Mechanical ability is not only curiosity and understanding how things work, but also the desire to build things. Tool making and tool using depend heavily on high-level visual processing.

Basically, mechanical ability means that one can understand mechanical principles, devices and tools, and the everyday physics that make them work. One also has the ability to reason and understand the direction of movement of gears in a system of gears. In addition, one can see the pattern of moving parts in engines and machines.⁵

The most consistent aptitude noted on the survey was "curiosity about how things work." Curiosity is a desire for learning or knowing, to be inquisitive, the impulse that leads one to wonder and ask, "Why?" But more than that, it is the motivation to discover the answers. Curiosity is a desire to learn about anything.
Aesthetic Aptitude

A number of survey responses were related to sensitivity to form, feel for color, and a natural design sense. Design principles of proportion, balance, color, shape, interest, emphasis, and craftsmanship can be taught, but some individuals have an aptitude for them. The aesthetic aptitude is recognizable in many of the assignments. The power of the aesthetic aptitude is that it brings form and organization to the chaos of creative thought. Again, design principles can be taught, but some students seem to have a natural aptitude.

Creative Thinking

After reviewing 22 definitions of creativity, P. K. Welsh found significant levels of agreement of key attributes of the definitions. She proposed the following from her review of the literature:

“Creativity is the process of generating unique products by transformation of existing products. These products, tangible and intangible, must be unique only to the creator, and must meet the criteria of purpose and value established by the creator.”

Creativity is a quality that is highly valued, but not always well understood. Those who have studies and written about it stress the importance of a kind of flexibility of mind.

It is possible to teach and develop one’s ability to think creatively. Some seem to have a natural aptitude for creative thought.

I have focused on three aptitudes mentioned in our survey, which I think are most applicable to industrial designers: the aptitude for problem finding and defining; the aptitude for combining and connection ideas; and the aptitude for perceiving things in an un-habitual way.

Aptitude for Problem Finding

Naturally creative people have the ability to see things in the context of the whole and also focus on the details. This was mentioned a couple times in the aptitude survey. This skill is essential in problem finding and defining.

In the minds of many investigators, the relationship between creativity and problem solving is a very close one. Problem solving has to make a distinction between problem finding and problem solving. One is divergent thinking or hypothesis generation, the other is convergent thinking or hypothesis testing. Creative abilities such as fluency, flexibility, and originality are in reality indispensable components of realistic and complex problem solving behavior.

There is a difference between presented and discovered problems, and creativity is associated with discovering, finding, recognizing, defining, or refining a problem. I believe that design is about finding the right question, answers are easy if you know the question. I have found in my research a number of authors who agree with this idea. Biccar S.
Randhawa says, “My answer is that the question is the more difficult to find and, hence, the more important. It is relatively easy to learn what to do after one has a question.”

Robert J. Sternberg adds, “Problem finding involves, one might say, thinking about what to think about.” “The formulation of a problem is far more essential than its solution,” said Albert Einstein. John Dewey expresses the same idea: “A problem well stated is half solved.”

The Aptitude for Combinations and Connections

“The ability to relate and to connect, sometimes in an odd and yet striking fashion, lies at the very heart of any creative use of the mind, no matter in what field of discipline,” says George J. Seidel. Thus, creativity is the ability to see connections and relationships where others have not. The ability to think in intuitive, nonverbal, and visual terms has been shown to enhance creativity. Creativity is the ability to make “combinations of previously unrelated structures in such a way that you get more out of the emergent whole than parts you have put in.”

A common misunderstanding equates creativity with originality. In point of fact, there are very few absolutely original ideas. Most of what seems to be new is simply a bringing together of previously existing concepts in a new way.

Aptitude for Un-habitual Seeing

According to Woodrow Wilson, “Originality is simply a fresh pair of eyes.” And William James says, “Genius in truth means little more than the faculty of perceiving in an un-habitual way.”

Experience can be a detriment to creativity because we stop searching. Einstein explained, “Remember that good ideas are the greatest obstacles great ideas have to overcome.”

Flexible Thinking

James L. Adams, in his book Conceptual Blockbusting, says that one block to creativity is fear. “The fear of making a mistake is, of course, rooted in insecurity, which most people suffer from to some extent. Such insecurities are also responsible for the next emotional block, the ‘Inability to tolerate ambiguity, an overriding desire for order, and no appetite for chaos.’ I am not suggesting that in order to be creative you should shun order in all things. The solution of a complex problem is a messy process. Problem solving is bringing order to chaos.”

There are a number of aptitudes associated with flexible thinking. The three I chose to focus on are those most closely associated with the survey: tolerance for ambiguity, intuition, and adaptable to change.
Tolerance for Ambiguity

Some people believe that there is only one right answer and that ambiguity must be avoided whenever possible.

Tolerance for ambiguity refers to the capacity to withstand the uncertainty and chaos that result when a problem is not clearly defined or when it is unclear how the pieces of the solution are going to come together, or whether they will come together at all. When you are involved in creative work, groping along in unclear situations is commonplace. You can go through long periods of time, in which you are trying to get the idea, but it just doesn't quite emerge, or it doesn't emerge the way you would like it to.

The ability to handle ambiguity is a critical skill which many students lack and which our educational system's methods neglect. For designers to feel satisfaction in their careers, they much have a tolerance for ambiguity. Individuals differ by nature in their tolerance of ambiguity. A degree of tolerance can be learned, but it helps to have some aptitude for it.

Aptitude for Intuition

Intuition, as an aptitude, allows a designer to make decisions in which there is a high level of uncertainty, there is little precedence, variables are not predictable, facts are limited, time is limited, facts don't make the way clear, and it is necessary to choose from several plausible ideas. According to Weston H. Agor, intuition is not a guess. Good intuitive decisions are based in part on input from facts and experiences, combined an integrated with a well-honed sensitivity and openness to other right-brain clues.

Aptitudes for Change

Designers seem to have a natural desire to change things, to make things easier, better, or just different. They have visions of what things could be like. They conjure up scenarios of the future. Francis Strickland points out the power of this tendency he states "Individual metaphors can be a very powerful catalyst for change due to the vivid mind pictures they create -capable of dramatically highlighting inadequacies of the old and the advantages of the new much faster than a persistent logical argument. The designer is not resistant to change because they know that change brings new problems and designers like to solve problems. George E. Oliome describes this in his book, The Change Resisters, "The innovative-minded person has a different set [of arguments] from the stability-minded one. For one thing, being innovation-minded starts one off with the presumption that as one pressed ahead into new things, the unforeseen problem will occur, but can be solved. The innovative person will move into new areas without full knowledge of the problems or how they might be solved."

The Experiences

The experiences were designed by adapting more established aptitudes tests to meet specific industrial design aptitudes. This was the best way to formulate and experience quickly and have confidence in its validity. Some of the experiences combine a number of aptitudes into one experience. A number of the aptitude experiences were more formal, like a test. Some
of the experiences were more like a game. Unfortunately, the scope of this paper didn’t allow for any description of the experiences.

The Experience Laboratory
To test this research in a real environment a laboratory was needed. Rochester Institute of Technology offers a freshman introductory course in industrial design. The class met for three hours every Friday afternoon for ten weeks, with an enrollment of twenty-four students from a number of different majors. Seven students were declared industrial design majors, eight students were graphic design majors, three were illustration majors, one was a fine arts major, one an information technology major, one an engineering major, one a photography major, and two deaf students from NTID (Nation Technical Institute for the Deaf). The male and female mix was exactly even—12 females and 12 males. The class were introduced to industrial design and the aptitude that industrial designers need to succeed in the profession. The class was not told of the purpose of the research in order to help them stay objective about the experiences.

The Evaluation
The evaluation was based on two models of aptitude evaluation. Some of the assignments averaged a quantitative of the class. The rationale behind the averaging of the experiences is that all these students, except three, were in the College of Imaging Arts and Sciences. Most had some visual arts background. The averaging would be less acceptable if we had a completely random group. Each student could evaluate his or her experience with the rest of the others in the class. The evaluations were anonymous so that students could see where they fit in the class as a whole, but not in relation to a specific student. Each quantitative evaluation was presented to the class after the experience was complete.

The second evaluation method is more subjective. The students were asked to process how they felt about the assignment. Was it easy? Was it fun? How did you do? The last day of class the students were interviewed individually. Their evaluations were reviewed and discussed and they were given an opportunity to express their feelings about the class.

The evaluation interviews verified the concept of aptitudes experiences and student ability to self-evaluate their fit in industrial design. The students who did well on the aptitudes were excited about industrial design. Other students who were looking into industrial design decided they didn’t feel they had the aptitude for it. Twenty-two of the students evaluated made decisions that matched what the research showed. Only one student who didn’t do well thought he would still like to try industrial design. I have chosen five students to profile as models for evidence to support the hypothesis.

Student One, an illustration major, took the class because of an interest in changing to industrial design. The student’s father owns a business that has developed several products and has used industrial design consultants. The father was excited about his child’s interest in industrial design. Student One’s comments in the evaluation said she enjoyed the class and it helped her make the decision to stick with illustration. Student One’s aptitudes showed she was good at visual languages and weak with 3D visualization and creativity. The student recognized these weaknesses and verified them in the final evaluation. When asked what aptitudes were weak the student said, “being creative and thinking outside the box. My products would be pretty but wouldn’t work, and the human factors would be weak.” When
asked if the experiences in the class helped make a decision about industrial design. Student One said, “Yes, it did. I would be interested in going into [industrial design] but I don’t think I would do well at it.”

Student Two is also an illustration major. The evaluations of the experiences showed good visual language and aesthetic aptitude but not 3D or mechanical aptitude. The student expressed the same in the final interview evaluation: “I think I did pretty average. Some things, like the sketching, I did well on because of my experience, but in the actual constructing of 3D objects and mechanics, I didn’t do as well.” She admitted, “I realize that I’m better as an illustrator, although ID would be a neat career choice.” Other comments about aptitudes were: weak in 3D, building things, visualizing objects in space, and creating “original” ideas.

Student Three was a graphic design major. The evaluations of all the experiences were high. The student did well on visual thinking, sketching, mechanical, and creativity. Half way through the class the students, “The class helped me and answered all my doubts.”

Student Four, an industrial design major, had studied engineering and had already decided to make the switch. The evaluation showed good 3D visualization skills, creativity, and high tolerance for ambiguity. Student Four said, “I have already switched in from engineering and it [the class] just reaffirmed my decision.”

Student Five, a graphic design major, had an interest in changing to industrial design. The evaluation of the experiences showed average ability in 3D thinking, creativity, and poor mechanical ability. Student Five said that the class helped him understand industrial design better and will help make a decision, but he was not ready to decide yet.

The Conclusion
The evaluation of the students was the most exciting aspect of the research, perhaps because it was the main unknown. The concern was that the students would not be able to self-access their aptitudes accurately, even when presented with the experiences. The preconceived notion was that the students would rationalize that the experiences did not apply to them, or were not a fair assessment, or they could do better next time. The amazing thing was that the evaluation coincided almost exactly with the aptitude results.

The conclusion is that we can help students recognize their aptitude for industrial design early in their schooling and that students can use the experience in the class to evaluate with accuracy their own fit in the field of industrial design.

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