

EMPOWERING DESIGN THROUGH NON-VISUAL PROCESS:
THE BLIND ADD NEW VISION TO INNOVATION

By
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Abstract

Currently, the design of products and services is focused on visual processes that exclude the other senses. The study herein presented explores the flaws of using a fully visual approach in the areas of education, product design and services. This paper also discusses the deficiencies of a first order thinking approach and presents an alternative based on second order thinking that can be used to overcome these weaknesses while at the same time nurturing innovation.

Through this narrative Rachel Magario, a blind student in the business and interaction design graduate programs at the University of Kansas, shows how she was able to overcome the mechanical limitations inherent in a visually oriented academic world. Magario explains how a project to design a tactile map taught her to look for solutions through a second order thinking approach complemented by the use of low fidelity prototypes. In this process she was able to create audio and Velcro low fidelity prototypes to fill in the gaps of research for audio and haptic design. All this was achieved through a process of observing, reflecting, imagining and building to validate hypotheses that can be approached through second

order thinking, frameworks and methods into the design process. The result is a process anchored in a human centered design that accounts for all senses and can be used to achieve success in different areas of innovation.

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Empowering Design Through Non-Visual Process

The Blind Add a New Vision to Innovation



Rachel Magario

Introduction

As a blind student working towards two graduate degrees, an MBA and an MA in Interaction Design, I have learned about the fields of business, design, and education and have had to solve many important challenges.

Design and Business share analytical and intuitive skills, and use visual graphics as a common language.

75% of new products fail at launch according to Schneider and Hall in the Harvard Business Review article, “Why Most Product Launches Fail.” From what I have learned in Operations Management, a 75% failure rate would be unacceptable.

Approximately 75% of blind college graduates are unemployed, based on the National Federation of the Blind (NFB) statistics. At the University of Kansas, 20% of incoming freshmen don't return for their second year of college. While these statistics may seem to be unrelated subjects, they actually have something in common: process.

I am interested not in the reasons for failure, but rather how to modify the design process so that people can discover information and be more successful. Information -the result of processed data - is the tool of empowerment for finding

the root cause and modifying products or services so they can create a great experience and, therefore, a successful and desirable product.

My experiences during my graduate studies have taught me that the design process has the potential to fill in research gaps for both audio and haptic fields, to promote inclusive design for multiple senses, and for the appropriate context. To me, design is all about communication. Communication is being able to present and to access information.

For the blind, the biggest challenge is being able to access data and information. But to many, particularly the sighted, access to information is still viewed as an added feature. It is not embedded as a distinct or specific step in the design process. One of my goals is to bring attention to this and correct it.

As baby boomers continue to reach middle age, the degradation of their optical vision will increase and this presents a design problem - even for those who are now fully sighted. Already, many of the elderly suffer from cataracts and vision impairments that have created entire industries to meet their needs.

Environmental conditions, such as lighting, screens, and font size as well as other physical elements, may temporarily or permanently prevent people from using a product or service to its fullest potential. From a business standpoint, this is, and will become, a larger market, one with the majority of the purchasing

power in America. Therefore, empowering design to be inclusive of all senses has never been more important.

Kerry Bodine is Vice President, Principal Analyst serving Customer Experience Professionals at Forrester Research. In her presentation at the Service Design Network (SDN) Conference, 2011 in San Francisco, CA, she said, “We have just entered the ‘Era of Experience.’”

Historically, success in business rested on those who had the manufacturing power. This was called “The Manufacturing Era.” What followed was “The Distribution Era,” where those with control of distribution systems had the power.

In the past decade, we have been living in “The Information Era” - where those who possess the power of information are in control, as witnessed by the addition of IT (Information Technology) as an important job description.

With the opening of the Internet and the free flow of information, starting a business has become simplified. Someone in Africa can sell jewelry on the Internet to customers in the United States or other countries. Information has broken down barriers that existed before the era where information ruled. This global exchange of information through the Internet has opened an entirely new form of trade and interactions, extending the traditional market.

In addition, the playing field has been leveled like never before which, in turn, has increased competition. This change has generated a need for excellence in customer service and user experience. Therefore, in this new era, those who understand the user experience and who can turn it into information, products, or services shall have the power. Hence, there has been a recent rapid increase for *interaction designers* and *experience architects* as new job titles.

An example of these new jobs is seen when we examine the difference between a PC and a Mac. In terms of technical hardware, the difference is minimal; everyone can get the same parts and build a computer. The real difference exists in the software and the experience the user has in buying, opening, and using the computer.

In the United States, blind people often have purchasing power but not usability power. Think for a second, who would buy the most expensive top-of-the-line smart phone in order to simply be able to use the phone at a basic level, ie: to make calls, use the calendar, or access the phone book? The blind use these phones due to the lack of other options. Blind users must have the top of the line cell phone in order to simply use the talking software system on such a phone. However, because it is third party software, it often affords basic functions only, such as phone, phone book, calendar, and texting. The other services that cell phone companies generally provide are not accessible to the blind, and the developers of the screen reader must keep up with the new developments to

ensure the screen reader can be updated for the blind user. These mobile screen readers can run between \$200 and \$700 on top of the basic smart phone price, particularly if they also include GPS capabilities.

Therefore, when the iPhone3GS launched with built-in talking software, (screen reader called "Voice Over"), which is fully accessible in the native applications of the phone such as weather, maps, calendars, reminders, clock, voice memo, email, texting and a whole new world of possibilities with apps, paying \$500 was worth it for the blind user, simply because of this added value.

Decision-making in business generally is correlated to a cost-versus-benefit analysis. One must answer the question, "Does the benefit outweigh the cost?" If the answer is yes, then it is an added value, and that means it is sustainable.

I have chosen to use my experience as a blind business/design student to illustrate a process which I believe to be one of the frameworks that will facilitate design in the right context and for multiple senses (inclusive). The blind DO see more than the sighted. Don't you agree?

I believe the process I had to go through in school brings a distinct personal value to the innovation process and inclusive design. I plan to share my experience in Graduate School as a blind business and design student to illustrate just how much design is dependent on sight. This is not because the

other senses offer less, but rather because there is a lack of tools to access information non-visually. If we can design products and services that can be accessed by all senses individually, we will not just be designing for the blind, but we will also bring greater benefit to those people who do not have use of a particular sense, as well as the masses. The ultimate goal is to enable everyone to participate on equal ground. Humans have more senses than just the sense of sight, yet there is almost a disregard for those other senses in today's Western society.

It goes without saying that design affects the everyday life of people, the technology and innovations that become available, and even how services could improve in the fields of education, business, and medical care, just to name a few.

The first thing I learned in design was that for a product or service to be successful, it must meet three major criteria. The product or service must:

- Be sustainable
- Be buildable
- Be desirable

If these three criteria are not met, then the product or service should be held from development or the means to meet the criteria should be created until all three elements are available. With this in mind, I would like to share with you my

experiences in the Department of Geography before I became a business and design student.

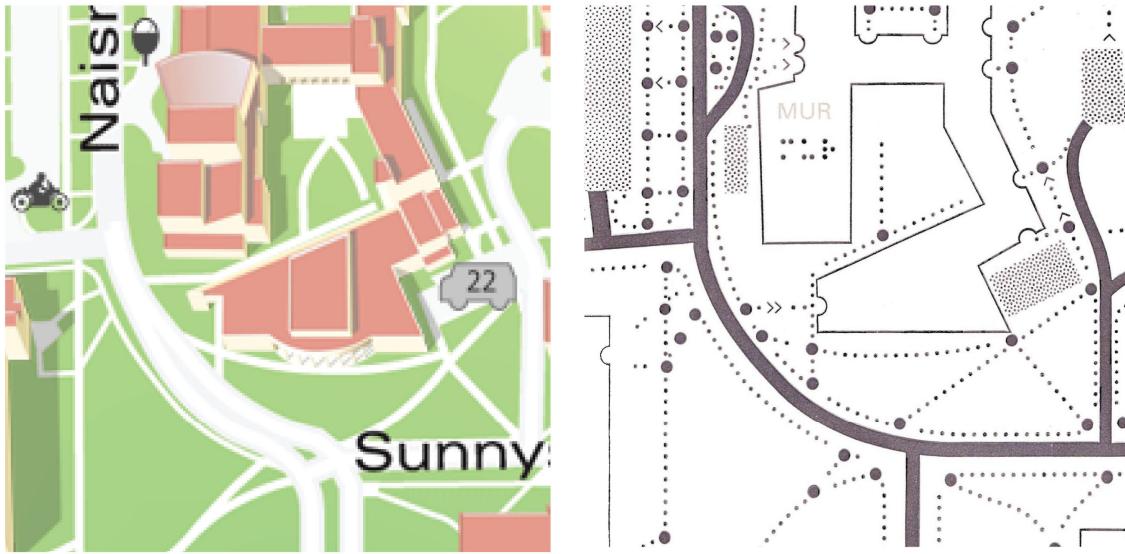
Background

In 2006, I received a grant to produce tactile maps for the blind of the University of Kansas campus. Blind students need such a map to navigate more safely and to learn more about the complicated geography of a typical college campus. The project was sustainable because it had funding, and the special equipment to generate the tactile maps was available in-house. It was buildable since it employed highly skilled cartographers, excellent cartography researchers, and a blind researcher on the team (myself). The goals, requirements, and motives of the project were all there. So, why did it fail?

My goal was to create a safer environment for the blind user, a “tool” or device that would afford more independence and a more pleasant and accurate Wayfinding experience for both blind users as well as first time visitors to the university. I also wanted to develop a system that could be replicated in other locales, such as other university campuses or in places such as airports. In airports, most people are first-time visitors due to the frequent changes in destinations and elements inside the airport environment.

In order to create such a system or product, I needed to understand not only how maps are created but also the cognitive behavior and procedures of those using tactile maps.

First, I used the method of introspection, using myself as the primary blind user. Then I extended it to other blind users. The cartographers (sighted) were using the regular campus map as a base map. This could be printed in different sizes. The most often used size is 11" by 17". We knew it would be impossible to have the whole tactile campus map on one 11" x 17" sheet of paper. Therefore, we chose to use the standard 8½" x 11" size. After removing "noise" from the visual map, the resulting tactile map was not one page of 8½" x 11" - but ten pages. At that point, portability and convenience became an issue.



(Visual map on left, tactile map on the right)

With the cartographer's effort to maintain real-world (visual) accuracy on the map, including important elements such as parking lots, driveways, and other areas prone to accidents, it would make the tactile map too busy and illegible to the fingertip. Therefore, it was necessary to create different versions of the map to show different elements. Whenever any of these concerns was addressed in the literature, the solution was always a new gadget or some unintuitive product that required a long learning process to use or it involved too much memorization.

From personal experience, I knew that such elements were essential. This was important because a few blind students had already been in accidents, including myself, that could have been avoided with better access to important information. Unfortunately, the blind student must rely on the information sighted people filter, which is – of course – whatever the sighted person thinks is important. The blind

person can only request information about the danger, as they understand it. To know where there is danger is critical to safety.

In short, the issue is no one talks to the blind about what is needed. Often in tactile map production, cartographers design a sighted map and THEN train the blind to use that same map. While I worked with these cartographers, it was no different.

Consider this: if the campus is a new environment with different challenges, how can the blind know what they do not know? Every human has the right to all available information so they can make educated decisions.

However, creating a map that would also identify all the elements that are necessary for the safety of its blind users became the problem. Cartographers are adamant that any map requires the accuracy of reality. However, true accuracy would create “noise” and render the map illegible. Tactile maps require a kinesthetic reality rather than a visual one.

One such interesting challenge was the inability to depict subtle curves that are clearly evident in an aerial picture, but are not detected when walking blindly on the sidewalk. I call these “elusive features,” since the sighted cartographers could not grasp that such “details” are vitally important to blind navigation. The combination of these challenges led me to ask myself, what are the real and

most important factors for navigation by the blind; what are the factors that are ignored by the sighted?

I understood that the research question was wrong; the question had to match the context. We were trying to adapt to an existing map, one designed for the eye and, from that, create one to be used with the finger. Cartographers have conventions that they follow to create a visually pleasing and elegant map.

Visual communication has principles, such as what color will encase the edge of a road sign and prevent the sign's information from getting mixed in with the surrounding background, or what font size can be web legible and readable and at what height and what speed. None of these principles could be transferred to the tactile map development because very little research on haptic guidelines exists.

Research Gap

I discovered that very little about haptic and audio guidelines exist in design principles. This would become my job as I progressed in my graduate work.

I explored the idea of creating an audio map or some device that was portable and that the blind could use while walking ... and that could be managed hands-free. I found some relevant research, but the technology was not there to afford me what I needed. After all, how many gadgets could a blind person be able to use at any given time?

To put things in perspective, on average, a blind student carries at least three pieces of equipment in their backpacks in order to perform in school: a note-taker (i.e., laptop or assistive technology), a recording device, and a Braille display or a scanning device.

By fortuitous accident, I found a map of the London Subway made by Beck, an early information and interaction designer. This map consisted only of circles for the stations and the paths that linked them. In geography, this would not be considered a map but rather a cartogram, because it does not meet the standard map conventions and it does not depict an accurate (to scale) geographic reality of place.

Of course, such issues are of little consequence to the blind. This "map/cartogram" gave me (and other users) the essential geographic relationships needed to navigate the network. In addition, it was clean and had very little noise for the finger, which makes reading simple and decoding fast. Fortunately, my advisor Richard Branham, an interaction design professor at the University of Kansas, was well acquainted with Beck's work so I was able to discuss my tactile map project with him. His influence is why I moved away from Geography and came to join the design department at the University of Kansas.

New Challenge

After I joined the program in Design, I understood that producing a useful tactile map was not a geographical issue, but rather a design problem, one that could only be solved through an innovative and iterative process. It was not just a matter of showing space and information but also one of usability, which is intrinsically related to time.

I was not sure if I would be able to succeed as a design student or, after graduation, as a designer. After my undergraduate degrees, I was only able to get job offers related to government or non-profits. However, both areas had either financial or citizenship restrictions that prevented me from taking any offer. It looked as if I was going to end up as one of those 75% of blind college graduates who are unemployed. This was personally unacceptable.

I wanted to ensure graduate school would not deliver the same results. Therefore, I requested a joint program with the Business School and I was accepted.

I concurrently enrolled in the University of Kansas Business School, which has 8-week classes, and the Design Department, which has 16-week classes. All their classes have a portion devoted to learning models, theories, study cases and an applied component, consisting of projects where learned material is applied,

practiced, and adapted to the context of a specific situation. This was very different from the more theoretical approach of Geography.

My challenge was to get through school at an acceptable speed and to learn the professional language (jargon) of two distinct programs: Design and Business. More than learning the jargon, which every student has to do, I also needed to learn the visual language and ways of communication for each department, including spreadsheets, Illustrator software, and any typical presentation tools commonly used in these programs, such as Power Point. I became aware that my MBA classmates whose backgrounds were different than business also had difficulties with the vocabulary/jargon. And, I discovered that marketing people did not enjoy finance very much. But, I was not sure if the average design student struggled as much as I did.

Therefore, at the end of my design degree in 2012, as an interaction designer, I conducted a quick research project to find out what challenges and struggles my design classmates had dealt with. I collected information through interviews and questionnaires to 16 design graduate students: 4 students graduating the current year, 2 first year students, 3 part-time students and 7 graduates from previous years who were already working in design jobs.

I asked questions such as:

- What struggles did they face during the program?

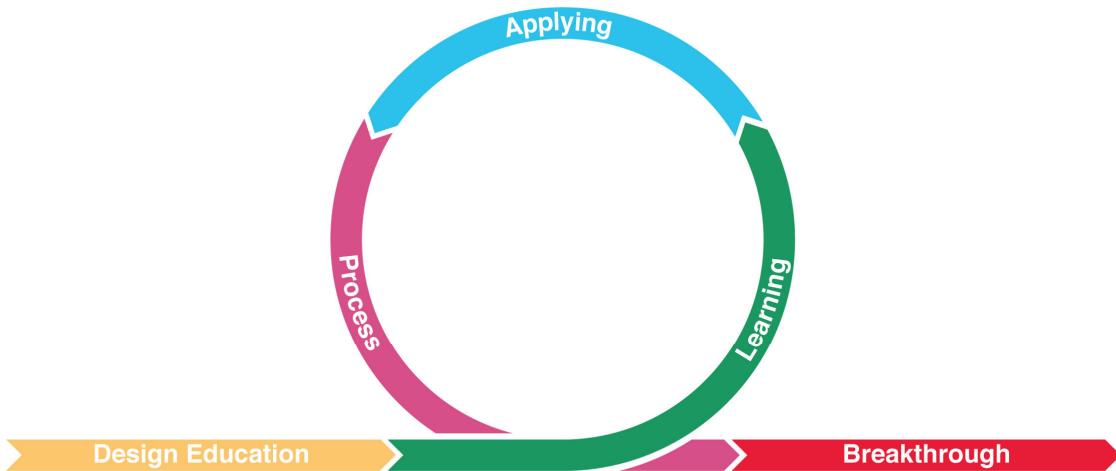
- What enticed them to come back to school?
- What did they hope to get from their degree?
- Did they feel different from others when they entered in the program?
- Did they feel superior or behind in any way?
- What knowledge did they have and what did they have to learn?

Revelations

I learned the following from my experiences and their replies:

1. Every single person struggled in some way, even if just a little.
2. Everyone felt some difficulty, either on the learning side or on the application side.
3. Everyone wanted to get a better job.
4. Analytical people wanted to be more intuitive; Intuitive people wanted to be more analytical.
5. Everyone wanted to do something different.
6. Everyone learned a lot and developed a different way of looking at design from when they entered the program.

I learned I was not that different after all. It was not the blindness that caused me to struggle. Rather, it was the lack of accessible tools that could grant me access to the process. What was different for me was that I needed to invent unique tools in order to speak the visual language, in order to design, in order to find my process and breakthrough ... like everybody else.



Graduate Design Education (Magario 2012)

I developed the Graduate Design Education graph based on the qualitative information of the interviews I conducted with my peers. Everyone went through a similar four-phase process:

- The learning phase (students were able to learn about processes), theories and models (this was facilitated by lectures), readings and research.
- Application was the phase of projects. By working on projects, students engaged in actual practice to apply the learned material and adapt methods to the contextual situation.
- The Process phase is achieved through the student's thesis development and discovery of their own design process.
- Breakthrough is when the student gains enough experience that integrative thinking becomes second nature.

My challenge was not the phases, but rather trying to participate in this process before acquiring the right tools.

At first, it felt like I was in the outside of the circle observing my peers go through the phases of the circle until I could enter and engage too. When I had the right tools to participate in the process, the struggle was almost nothing compared to being on the perimeter only observing.

As I said before, approximately 75% of blind people who are college graduates are unemployed. The percentages may be debatable depending on whose criterion is being used. However, regardless of the correct number, in my opinion, what is missing from the higher education degree experience for blind students is the lack of accessible tools to access information, learn, apply and break through efficiently and with a robust portfolio or resume. I believe design thinking has helped me to achieve this.

Design Thinking

My findings can be divided into two groups which I will illustrate through two main personas. All of my interviewees aligned with either persona and served to focus my collected information into a depiction of my reality. Both personas desired to be more in the middle of the curve, balancing their analytical or intuitive sides.

Persona 1



Hello, my name is Rose and I work in the business industry.

Rose's Background:

Received a Bachelor's degree in Business Finance

Has worked at Koch Industries for 3 years

Seeks to shift from Finance to Interaction Design

Has struggles with design software programs

Has no problem learning models and theories

Rose's Goals in the Program:

To become proficient using design software programs

To become an integrative thinker

To apply the theories and methods learned

Persona 2



Hello, my name is Kale and I work in the design industry.

Kale's Background:

Received a Bachelor's degree in Industrial Design

Has worked at Hallmark for 2 years

Seeks a job with more direction and options within design

Struggles with demanding reading and theory application

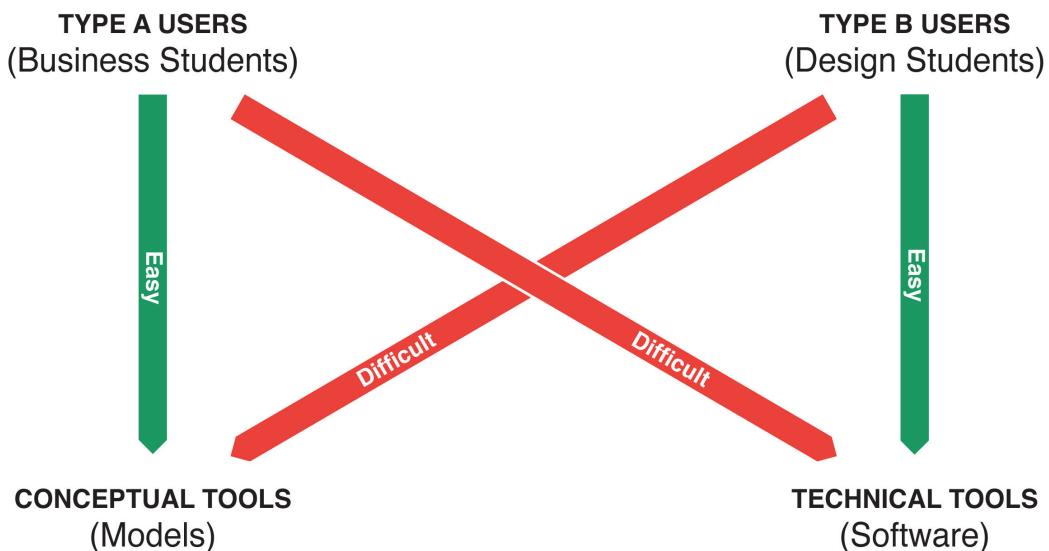
Has no problems applying methods and using design software

Kale's Goals in the Program:

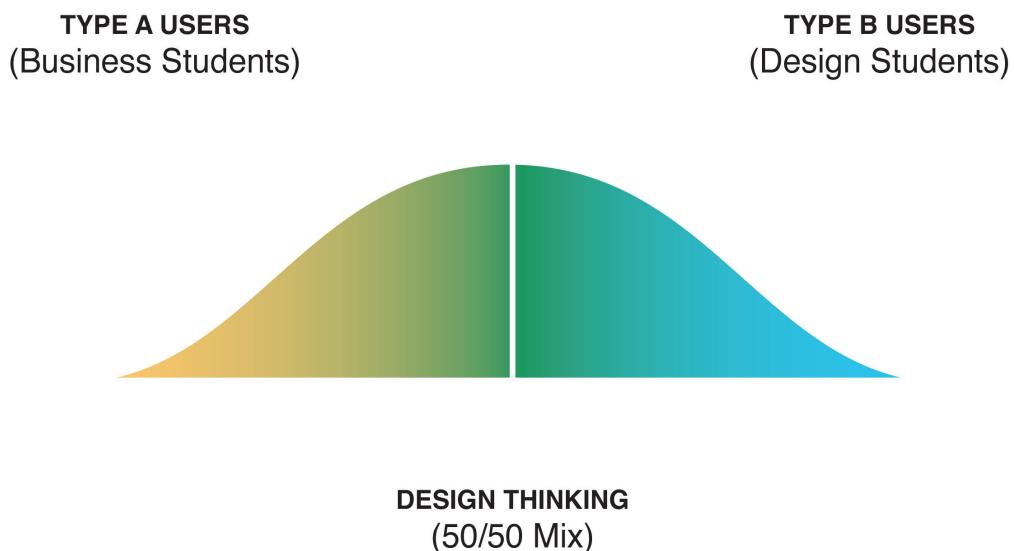
To become proficient in theories and models

To become an integrative thinker

Rose and Kale represent goals and difficulties of Type A and Type B users.



Situation through Task (Magario 2012)



Situation through Thinking (Magario 2012)

As the image above shows, because of my sight limitations I have always been in the green area of design. I fit in the middle because I am not expected by

designers to just make nice models and drawings nor by business professors to just analyze complex data sheets. However, I have found that by nature I am a design thinker, and that from the center I find that I can understand and add value to both.

The representation of my findings confirms the design thinking model of Roger Martin who argues that the merger of analytical and intuitive thinking is what improves design and generates business innovation. Martin says that it is not enough to deduce or induce, but we need a third type of reasoning, abductive.

In business, we are always trying to predict what is going to be the next trend, the next stock to go up, or which product is coming next. All products have a life cycle and, someday, they will become obsolete. So, we need to learn how to find out what is the next product and how to adapt to the complex changes of the world.

Complex Adaptive Systems



The world is not a static system: we cannot be passive observers and analyze only the simple bark of the tree. To survive in globalization we must actively participate and interact with others, and understanding complex adaptive systems is what aids us in looking at the whole forest.

A complex adaptive system is a collection of components or agents that interact, learn, or adapt within a system or with other systems. However, it is not just a collection of agents, but also the inter-relation that these agents have among each other. Understanding these relationships and the influence the agents have in the whole is at the heart of the understanding.

You see a forest and you might deduce conclusions from the whole. Or you can zoom in and start to induce from the bark of the tree. However, in a complex adaptive system, things are constantly moving, shifting, adapting, and one element might not fit in the system as you know it. If you want to go from your house to a building inside a university, you can look at the map and learn the

paths to navigate there, but you cannot predict what will happen on your way there. Many events can happen en route to your chosen destination. There could be construction and you have to adapt and adjust your trajectory. There could be an accident. If it is winter, there could be a snowstorm. Likewise, someone could have placed a trash bin right in the middle of your driveway before you left forcing you to react.

So long as there are living beings inside a system, the system will be alive and unpredictable. Educators understand students, engineers understand products and what must happen for a building not to fall, architects understand about the environment they want to create, and businessmen understand the numbers, timing, and requirements of an operation. But who looks at the whole system?

Interaction designers do.

Understanding a system is not just breaking down the parts of a tree or of a human body. If you have all the chemicals that go into a human body in the correct proportions, you still do not have the human body. It is not enough to understand a tree in the forest and not understand how that tree interacts with other trees in the forest or with the soil and with the air and the sun and the climate.

How do other systems within a system affect the whole? For example, maybe tourists stepping on a type of soil of the forest might be affecting the soil which, in

turn, affects the plants that depend on that soil, and therefore affects the insects that depend on those plants. In short, we live in complex often interactive/interdependent systems that are ever shifting and adapting.

Are you lost yet? Whenever I talk about this concept, the word in most people's minds is "overwhelmed." Regardless of the word that comes to mind, the truth is that we live in a system and we are affected by it – whether we realize it or not. That system is not just the sum of its parts. It is not just a matter of observing and understanding each element. We need to understand the connections and the interactions that link the elements of the system together. If not, we render the system useless.

Think of a car. If you take the passenger seat out, the car can still run; but if you take the engine out, the car is useless. So, the passenger seat is not necessary? Of course it is. It serves a purpose to carry a second person in the car, but it could be replaced with something else. However, the engine constitutes the major part that makes the system run.

Complex versus Complicated Systems

In a complex adaptive system, agents are intrinsically woven together. It is like a web, if you remove one strand the whole system is affected in some way. In a complicated system, it is assumed that the elements of that system are totally

independent from each other so that the removal of an element should not affect the other elements or the purpose of the system. The world has living beings, and not all of them are equal (some are blind and not completely useless). Therefore, the world will be always adapting, learning, and interacting in an unpredictable way; and we should not ever think of systems as just a complicated piece of technology.

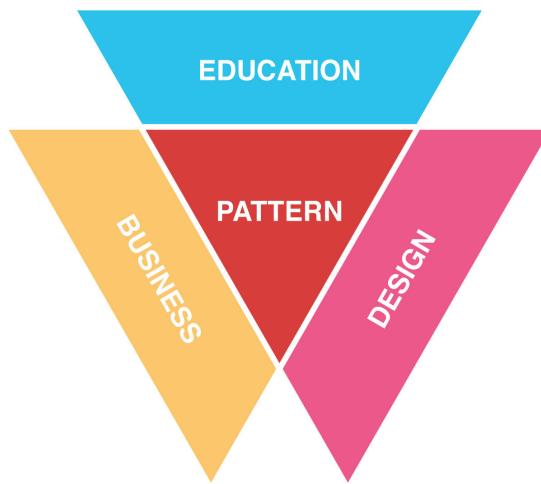
We cannot disassemble a clock and look at all its parts as the whole system. The clock also exists in an environment with agents that use it for different things, under different environments, such as indoors and outdoors, and those elements are interacting and affecting the clock. The same is true for the world today. Different countries and different languages did not always affect other cultures as dramatically as it does today. Now, thanks to globalization, we have a broader access so socio-cultural interactions have a stronger impact in the system.

If you take out the passenger seat of the car, it is less complicated but not less complex. However, if you take the engine out, it becomes less complex ... but useless. *This is often how we deal with users in a system.*

Let's look at education in today's economy. Regular teachers or professors cannot rely solely on a special education teacher or the disability services of a university to teach a person with disability. But, at least today's American educational system allows for inclusion.

However, the way disability is managed by many is as if the person with a disability is simply an element that does not belong to, or is external to, the system, and so it must be somehow shaped to fit into the system. Usually the person with the disability is looked at as an independent element that can be placed or removed from the system at any moment without causing any impact in the overall complexity of the system. It is as if the educational system is treated or viewed as complicated, rather than complex. This system is alive and deals with living elements; it is a complex adaptive system. It is filled with people who are an intrinsic part of the system, and, therefore, is unpredictable.

The professors I had who adapted and created new ways to teach me also created results and techniques that benefited sighted students. The Franklin planners that are widely used today were originally developed for students with learning disabilities. Today they are a common item in most, if not all offices. I believe that by treating all users (sighted, blind, and others with disabilities) as part of the system, we can learn more and open ways to innovation.

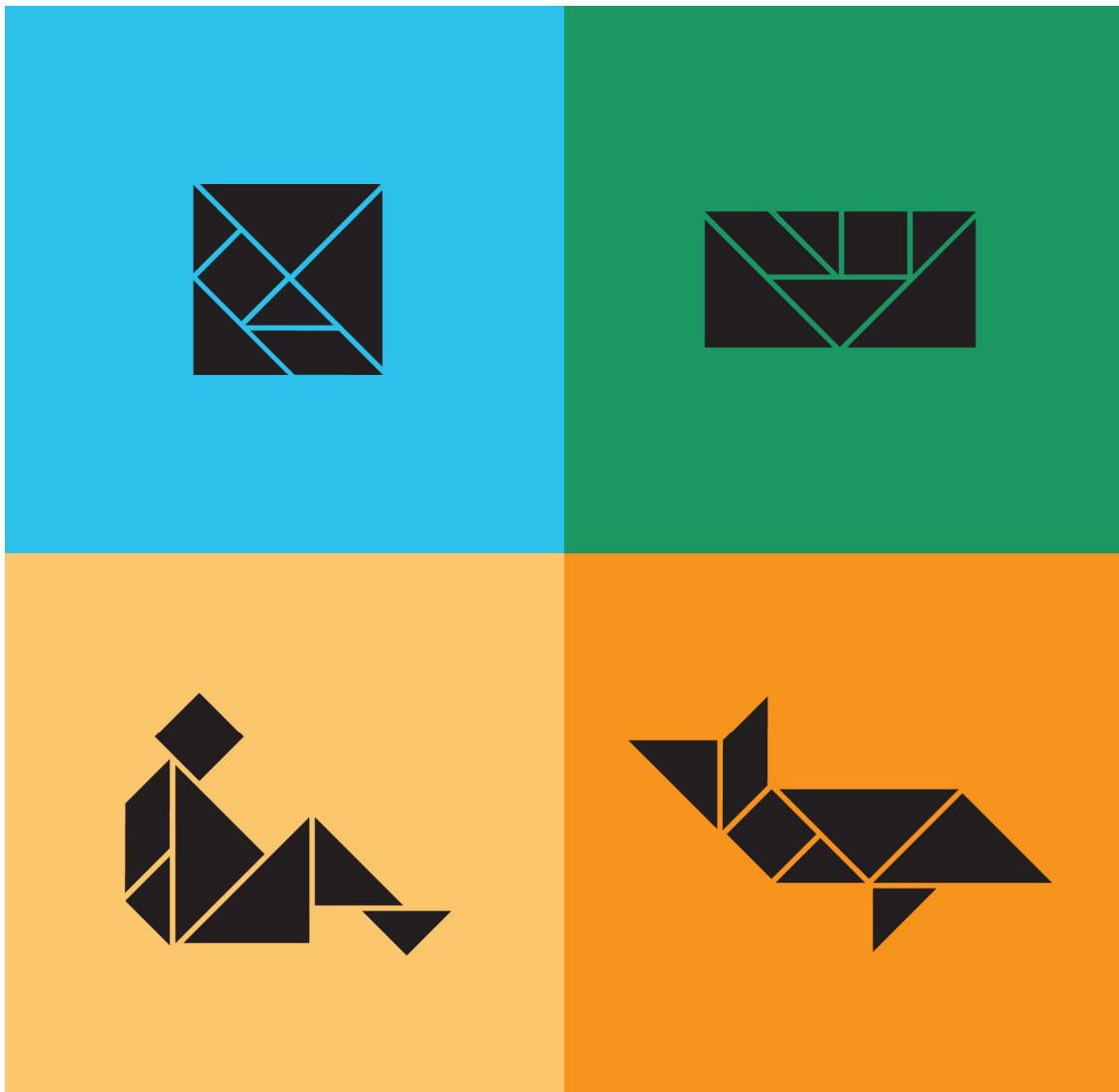


Pattern Thinking (Magario 2012)

As shown in the figure above, education, business, and design have in common the need to recognize patterns in order to foster repeatability. Remember, in developing a tactile map, I wanted to create repeatability. I wanted a system that could be used on other campuses because, without systems, we cannot develop new ideas or start to understand what our desired outcome might be.

Businesses want the same thing. They want to be able to repeat good results. Education is no different. It is a “business” and its product is education and graduates. Our educational system needs to be able to produce one good student after another because that is what constitutes a good program. Similarly, designers are trying to improve products. To achieve repeatability it is vital to understand systems and recognize patterns.

SECOND ORDER THINKING

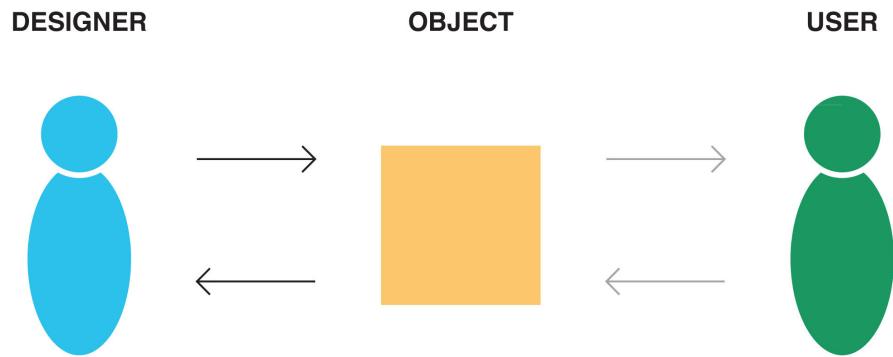


(Endless possibilities of anagrams)

In order to innovate, we must understand systems and recognize patterns. The “how” to recognize patterns is the complicated part. Some professionals resort to

statistics and quantitative information to identify patterns. While there is a value in quantitative data, there is a tremendous gap in recognizing qualitative patterns.

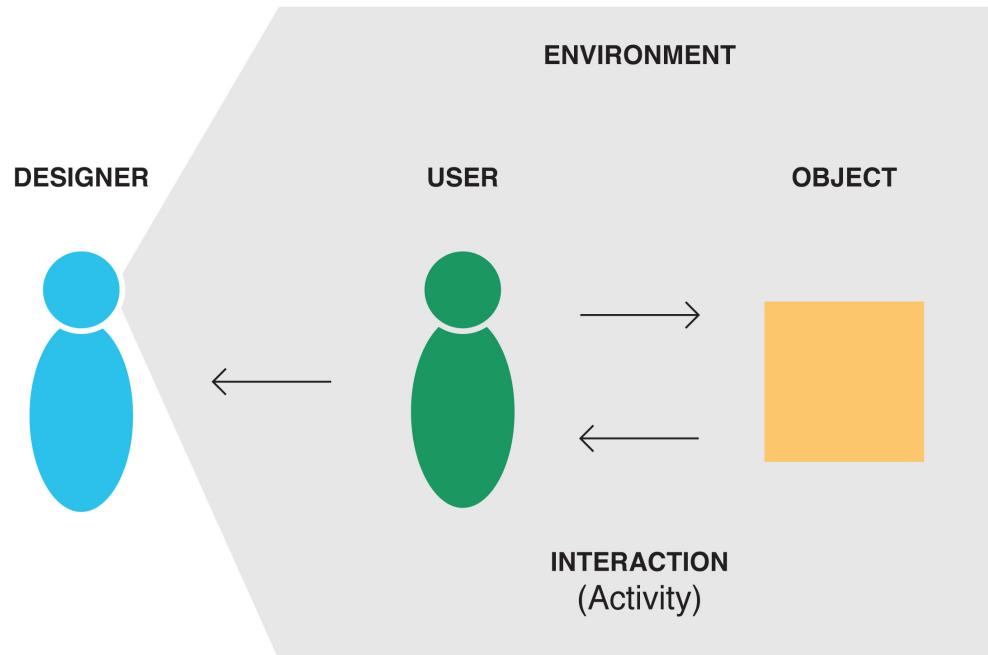
To understand “second order thinking,” we must understand “first order thinking.” As my geography adviser once noted, “The blind often see patterns faster than the sighted. They are not confused by irrelevancies or ‘noise.’” (Robert McColl)



First Order Thinking (Magario 2012)

In first order thinking, a designer or a group of designers are so focused on the object (product, service, or system) they are designing that the user and the interaction of the user with the object, often gets lost and ignored, thus bypassing any form of real analysis.

Sometimes the user is perceived through the data collected via software. However, the object is still the main source of perceived information.



Second Order Thinking (Magario 2012)

On the other hand, second order thinking is crucial for design thinking. When designing an object (product, service, or system), the designer or group of designers observe the users as the lens to look for the patterns of interaction and discover information both about the user and the object. The second order thinker recognizes that the interaction between object and user or users takes place in an environment. Therefore, all of the elements involved have an influence on each other as well as adapting and modifying the final activity. Second order thinkers have a broader range of information to use in innovation.

During my academic experience I have classified the professors I had into three groups:

- First order thinkers
- Out-of-the-box wannabes
- Second order thinkers

The first group was first order thinkers, those professors who focused only on the object. They required me to turn in the same output as everybody else.

Regardless of tools, time, and skills, I needed to produce that output. These were the professors who could not think outside the box and accepted only presentations made with Power Point and scantron answer sheets for multiple choice test answers.

This approach forced me to become more resourceful, to learn how to find help, and increase my leadership and management skills. However, I would never knowingly or voluntarily choose this approach because the time and resources that it cost me slowed me down in getting my degree. In addition, this approach unnecessarily diverted my time and energy from the main focus of my research.

The second group of professors I had was the out-of-the-box-wannabes. These were the professors who would minimize the requirements to make it less complicated for me, thus losing sight of the main objective of their class. These professors recognized that I had difficulties, and since they did not know how to compensate for that, they would allow me to do what I could without pushing me or working with me to find a way to learn. They did not understand that I also

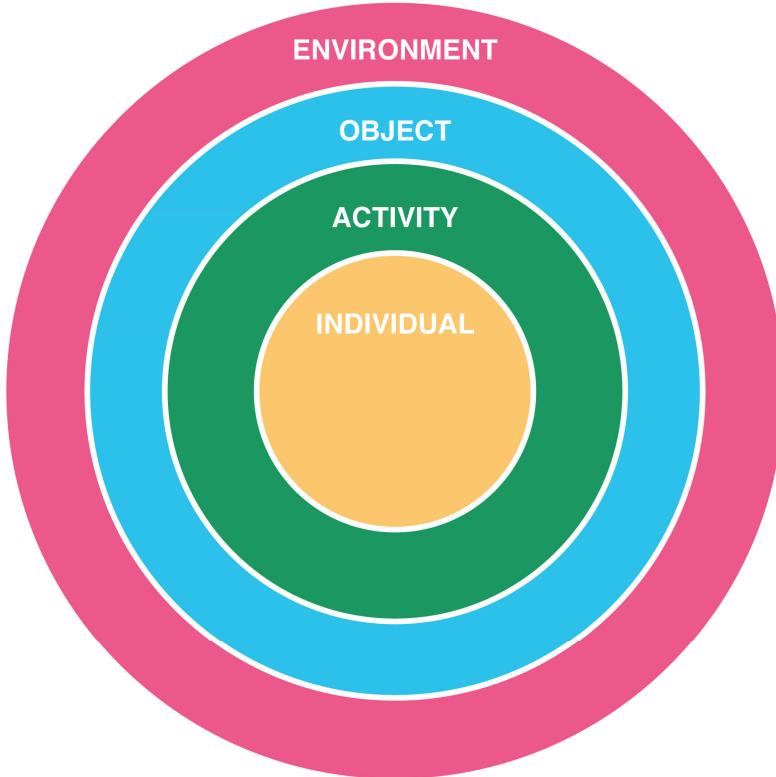
needed to be effective in communicating with sighted and blind alike. Their method of out-of-the-box thinking was simply to lower the standards of the product they expected.

The third group was the second order thinkers. These professors observed my process of getting things done and, using their expertise, worked with me to design the requirements they expected of me. They minimized my mechanical difficulties and increased my ability to fulfill their learning objectives. Those were the most difficult and demanding professors during my academic career because they would adapt the requirements to force me to truly learn.

For example, in my statistics class, the professor did not request that I run the data on statistical software that was not accessible to my screen reader. Instead, he required me to understand what kind of graph output certain data would generate. I was required to draw and interpret certain trends and have an in-depth knowledge of the statistical material. My statistics professor traced all his slides on my foam board ahead of time so that during class I could follow all his slides haptically. These second order professors took the extra time to give me the tools that I needed, but at the same time they had higher expectations of me because they recognized my potential. In addition, they shared the characteristic of being good listeners and observers.

AEIOU model

(A=activity E=environment, I=individual, O=object, U=understanding)



A-E-I-O-U Situation-based Design Framework (Branham 2011)

This model is an excellent framework to observe the situation through second order thinking because it gives a holistic understanding of what is happening. Hypotheses act as lenses when tested through different frameworks. The AEIOU model affords a comprehensive view of the interaction of the user with the object in the environment, unlike other models that often leave the activity or the environment elements out. When the hypotheses are applied to a model in an iterative process, the information collected eases the synthesis process and uncovers the innovative solutions, product, or services.

The AEIOU model has been a great influence in the development of my Design Process. However, one model alone is not sufficient for a truly complete view. We must always have a set of models, methods and techniques to complement the analysis of a situation. Therefore, two other models that have strongly influenced my research and design process are “Activity, Theory, and Experience Innovation.”

Designing For the Activity

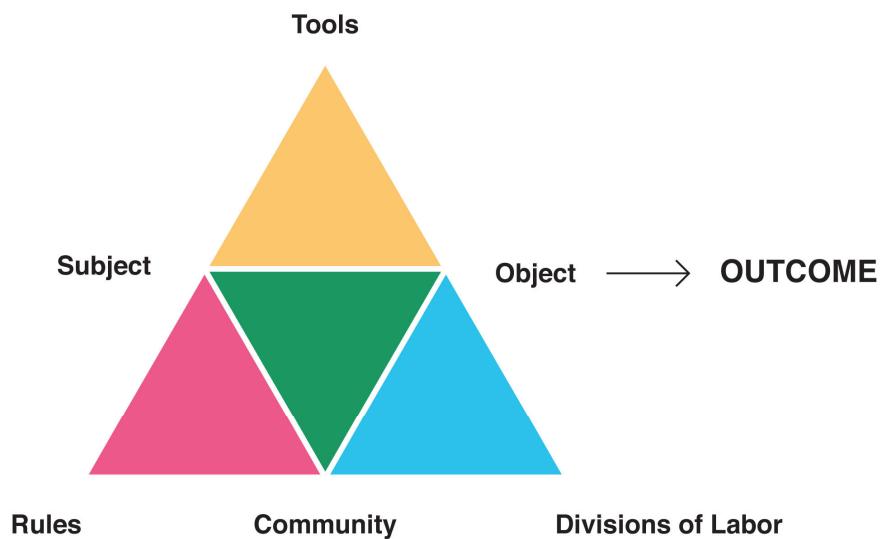
In order to truly design for the experience, we must go beyond human-centered design. It is vital to also understand the activity (interaction). To understand the activity we must understand the context. We must understand the subject and its interaction with the object, basically using second order thinking to understand the action. As I mentioned before, the AEIOU model gives an excellent platform to observe the activity as well as the environment. However, the Activity Theory model adds a social component that complements the depth of my Design Process.

Activity Theory

The activity theory model does not consider the environment. However, it goes into depth in the activity hierarchy and the relationships of all its components.

Understanding the activity is based on the interaction of the subject and object.

The activity consists of three hierarchical elements. The top of the hierarchy is the relationship between the activity and its motive. The next level consists of the action, which is driven by its goal. The third level is the operation, which is controlled by the conditions.



Activity Theory (Vygotsky, et al 1930+)

This model gave me a more holistic view of how to observe a situation. It was the first model to teach me rules, community, and division of labor, which are crucial elements necessary to understand activity within a society. Furthermore, it gave me a more complete understanding of the relationship of tools to the overall activity.

Rules of Design

Understanding and research through a second order approach and observing complex adaptive systems are what gives us the rules about what actually is happening. Those rules then evolve and the right questions are discovered, questions that can lead to the patterns, needs, constraints and new ways for a final redesign.

There are four rules of Design according to Hasso Plattner: human, ambiguity, re-design, and tangibility:

- Human rule - all design activity is social in nature
- Ambiguity rule - design thinkers must preserve ambiguity
- Re-design rule - all design is re-design
- Tangibility rule - making ideas tangible always facilitates communications

Such rules allow us to guide the research and the hypotheses we are pondering. Observation through a set of evidence-based frameworks, design methods, and rules outcomes is an evidence-based design.

Human Rule

The human rule was a fact that was true in all my research. Much of the research I read about blind people or navigation without sight left the social

component out. It is easy to dissect a product or map. However, understanding what the social influences are towards that product is made possible only by observing the environment and the social cultural system the individual or object lives in. And, it should not be one that forces the blind only to learn or adapt.

Social networking, collaboration, and the wisdom of the crowds have become a common practice in different organizations today, thereby impacting people's everyday life. Since most of these exchanges are virtual, there is a lack of usability for non-visual interaction. Therefore, to improve the social experience, we must include the other senses as part of the design process. Why not start with blind people who understand both audio and haptic senses the most? We can no longer treat the world as a simple system only for the sighted. It is complex and the interactions are the key; it is alive and unpredictable. Therefore, the efficiency and the ability to communicate are critical for positive social interactions.

One such example is evident through Facebook. If someone writes to me in a chat on Facebook and they have seen me chatting before but now I don't reply, they might think I am ignoring them. It never crosses their mind (nor are they aware) that when Facebook updates, the accessibility to the screen reader sometimes goes away. The truth is that the sighted do not have to know that because they are not screen reader users. However, it has an impact on the social interaction. Those who are aware of the problem understand and might

pity me; but those who don't know often get mad at me. In either case, the result is my social marginalization.

For most people, Facebook is only entertainment. However, there are other social networks that are used for academic and professional purposes where marginalization would have a detrimental effect on the people marginalized, since all interactions are social in nature.

Imagine I telecommute to my office. I have a deadline-driven job where team collaboration is vital for delivery. However, I have no access to the internal chat because it is not designed to be fully accessible for a screen reader. How would not being able to use the chat affect my social interaction and inclusion on a team? One of the most prized skills of an MBA candidate is their soft (social) skills, because those are often not trainable skills like the software and management skills. I could have all soft skills possible, but if the technology is not accessible, it would result in social marginalization again.

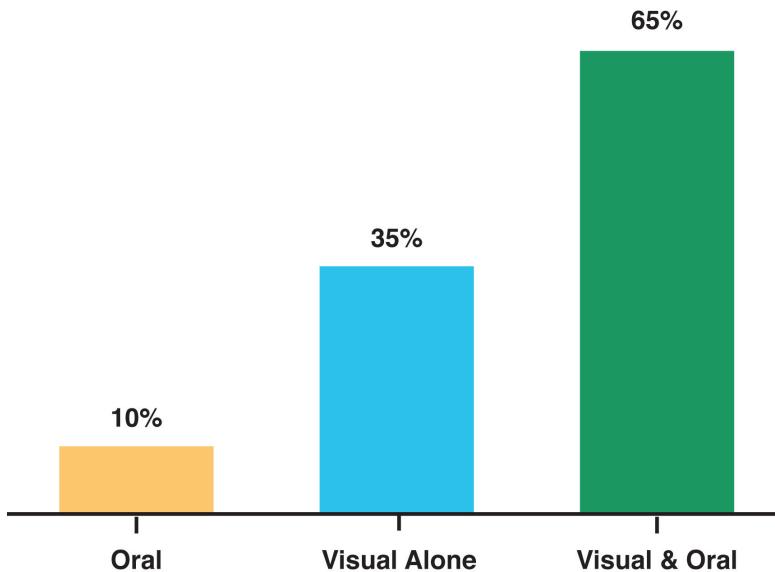
Tangibility Rule

The tangibility rule really brings the understanding that without making things tangible, it is hard to communicate. This is why I needed to find ways to communicate with both sighted and blind users.

A handful of my “out-of-the-box Wannabe” professors used to tell me I did not have to do things the same way as everyone else, and that if I chose to, I could do audio presentations only. I had two conflicts with that information. First, audio tools were not easily accessible; and secondly, communication is not just sounds. Such a solution is treating the communication system as complicated, not complex. How successful would I be in teaching or persuading my audience about an idea I was proposing if I just talked? I would be--the question is how successful. In addition, how effective would I be by showing a black screen to a person who cannot hear what I say?

According to my persuasive speech communications class, the retention rate of verbal-only presentations is approximately 10%. By contrast, an audio AND visual approach results in 65% retention. Therefore, a combined approach always is more effective for communicating as shown in the Retention of Information graph.

RETENTION OF INFORMATION



Although controversy about the exact percentages exists, depending upon the school of thought in communications, everyone agrees that a combined approach always is more effective. Also, in education many experts agree that having various ways to display the same information supports different learning styles and promotes inclusive, effective learning. Assuming this is true, why would I want people to understand and remember only 10% of what I am saying or presenting?

A professor once compared audio presentation with communicating in a foreign country. He argued that if I went to a different country I would still be able to communicate without being fluent in the language of that country. That is

absolutely correct. I can send a simple and direct message with a basic vocabulary and be understood. However, this is just the ability to use the words that will communicate a message in its right context without added features. It is like designing a web page and having the functionality and the HTML in place before the style sheet. In another country, with limited use of that foreign language, offering a limited verbal exchange would be a matter of effectiveness. Besides, foreigners will often resort to body language and gestures to complement their communication. However, using limited resources when you manage the language and the tools are at your disposal is unwise and unsatisfactory.

Understanding this helped me to discover that my presentations could be even more effective by adding kinesthetic methods. My second order professors encouraged me to explore my acting and improv skills to create more powerful interactive presentations. Although this is an unorthodox method, I found examples of similar presentation methods in some of the design conferences I attended.

In addition, these professors also gave me an environment where I could try tapping into the other senses we all have. I made up for the lack of visuals by using a combined approach of haptic, audio, and a sense of smell to convey ideas. The feedback I got from my audience was that these were some of the most powerful presentations they had ever experienced. I was really happy with

such positive feedback. It is unfortunate that I have not attended any presentation with similar ideas in the design or business worlds. However, my personal experience shows that this is a very effective method.

Usability

Usability is broken into three criteria:

- Effectiveness - can it be used?
- Efficiency - how long does it take to perform one or more tasks?
- Satisfaction - how positive is the experience for the user?

If we are using these criteria as rules of usability, then we can look at this example:

As design students, everybody primarily uses Adobe products, such as Photoshop and Illustrator. I can open those software programs, and I can even read the menu bar. However, the main working area is completely inaccessible to me. Since I have to use a screen reader, I cannot edit or do any work in these programs. Therefore, effectiveness does not exist; these tools are inaccessible for the blind.

Another product we use extensively at the University of Kansas (and I suspect at most universities) is the Blackboard Learning System. I can log in to the system. I can read the name of the folders, download *.doc files and click on links.

However, I cannot read PDFs inside the system. But, the PDF format is the standard for the higher education and industry, and accessing them is critical. Blackboard, then, is accessible but not really usable for the blind. It is effective only in the sense that I can be inside and read the content. But, because I am a screen reader user, I cannot use it efficiently ... which makes it functionally useless.

Perhaps if I had only 10 files per week to download, I would be able to manage. However, when dealing with 50 files per week or more, the system is prone to crashing, so it requires a large amount of time to navigate. It takes a sighted person an average of 15 minutes to choose and download all the necessary items for a class. Being a screen reader user, it could take me up to two hours for the same amount of material, especially if the files are in different folders and sub folders and I do not know exactly each file name I am looking for. In addition, the search bar was removed from the last version I used. This results in zero satisfaction, since many times I could not access what I needed nor was I able to participate in discussions, since those required real time reading and back-and-forth participation. Because I have to use a screen reader, I would typically fall 10 to 15 comments behind since the browser would need to refresh and I would have to go back to get through each visible line. Marginalization happens again; schools can bypass the discussion requirement for me as a student, but that affects the learning process and the social interaction of a

student. Therefore, imagine how would this affect a job performance in the real world.

Tired of dealing with the mechanics of everyday Unusability, I do not waste my time with such tools. Instead, I focus on learning how to find resources that ease my process and afford me extra energy to devote to my real goals. This is no different from the behavior of a sighted person. The difference is I often get marginalized in the process, goal, or social interaction altogether because the system cannot afford non-visual interactions.

Having only the desire for a better job does not make that happen. There are the sustainable and buildable components to any goal. The viability of getting a job in the private sector for people (even foreign students) with an MBA and a degree in interaction design is very high because there is the need for design thinkers with global awareness. In addition, interaction design is a fairly young field, but it is growing rapidly.

Therefore, I think, being the only totally blind student with both degrees, I should not have any problem finding a Job. My concern, unlike my classmates, is the usability of the system where my job will be. Furthermore, I am concerned about being able to perform with satisfactory speed and produce the same or better quality in comparison to my sighted colleagues. This is key because if my performance does not bring enough or more benefit than a sighted person, how

can I add value to the company? Would I be an unsustainable and unfeasible employee to a company?

For consulting or marketing companies that do both design and marketing, time is precious. People must work under a billable project and perform in billable hours. In classes, it was ok for me to take longer and learn well. But that is probably not true in the real world.

For me, usability of information is as important as accessing information. Therefore, I have made it my goal to learn through experience rather than dealing with tools that added little value to my goals.

The learning and applications in both the business and design programs have the objective of providing knowledge and experiences so students can perform once they're out in the real world. As a blind student, my challenge is that I am able to learn, but I still need to be able to perform at a satisfactory pace in order to be competitive in the sighted world market place.

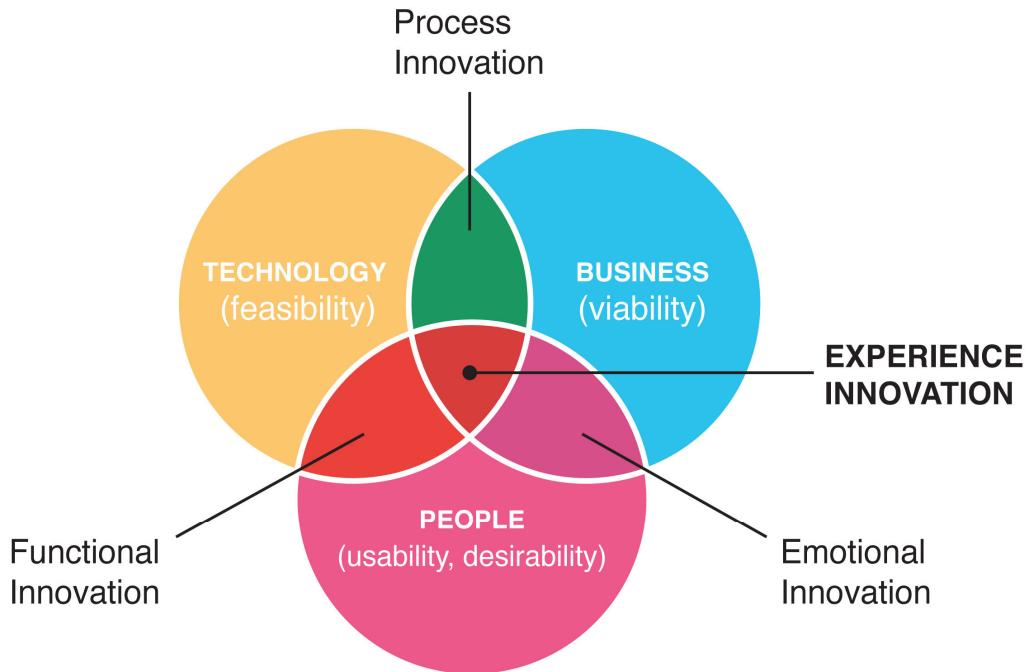
For this reason, I decided to start managing how I go about learning. There was no point trying to learn all the things I could not do. There was also no point in my trying to use PowerPoint and Illustrator. I could find others to do that for me, simply by telling them what I wanted. I learned how to manage my time and their time. I also worked to understand the various principles, so I could decide how

the project would be designed or directed. It also was good practice for promoting team building and workflow. The joint program (Design and Business) became an extension of this learning application. I would learn management on the business side and try to apply it on the design side. In the same manner, I would learn innovation thinking on the design side and try to apply it in the business projects. Today I am much more confident than when I started the program, especially in terms of my performance in the "real world." My only reservation at this point is the fact that it will take real life experience to truly evaluate my performance.

But, I am certain of the value I bring (value added) to the table - or a team - because I know how to "Design Think."

Experience Innovation Model

The experience innovation model describes an inseparable relationship between business, people, and technology. This model uncovered the relationship of sustainability, buildability and desirability. All humans have desires and needs, and businesses, whether non-profit or not, must have sustainability to remain viable. Technology allows for feasibility for building objects that afford interactions.



Design Thinking – Experience Innovation (Larry Keeley 2009, Tim Brown 2010)

The design program has taught me about this concept. However, the links that hold the three together were the real discovery for me: emotional innovation, process innovation, and functional innovation. I could personally relate to this model since I became frustrated every time I did not have access to information.

Nevertheless, after understanding that these links are what holds the experience innovation together, I had the missing part to guide my research. My frustration was part of the emotional innovation. Now I just had to look for the process so that the function could unfold.

Under my design process, innovation requires frameworks and second order thinking in order to find the right hypotheses, to find the rules and evidence, and to govern the concept creation. Second order thinking is like the highway, the foundation, and the way. The frameworks are like the different places that the highway can take you to. The methods are the vehicles you can run on the highway. Like cars, we can choose methods from different types, models, brands, and sizes that will fulfill different needs. To me, one of the most powerful methods of applying second order thinking is low fidelity prototyping. Prototyping can be used for every type of design, from a simple lunch box to very complex architecture.

Prototyping

Prototyping or model building is a method to build and test a product or service before the product is approved for production in large quantities or before the service comes into being. For centuries, if not millennia, product engineers have used this method. Prototypes can be subdivided into low fidelity and high fidelity prototypes. A high fidelity prototype is a product that comes close to the actual final product both in terms of appearance and function.

The disadvantage of a high fidelity prototype is that it can entail a very involved process to build. This is both costly and time consuming. Typically, only one or two such prototypes are produced before the final product goes to the market. This fact makes high fidelity prototyping less widely used for all areas of design

or research. Typically, only companies with a large budget and technology-driven companies are able to take advantage of the benefits of such prototyping.

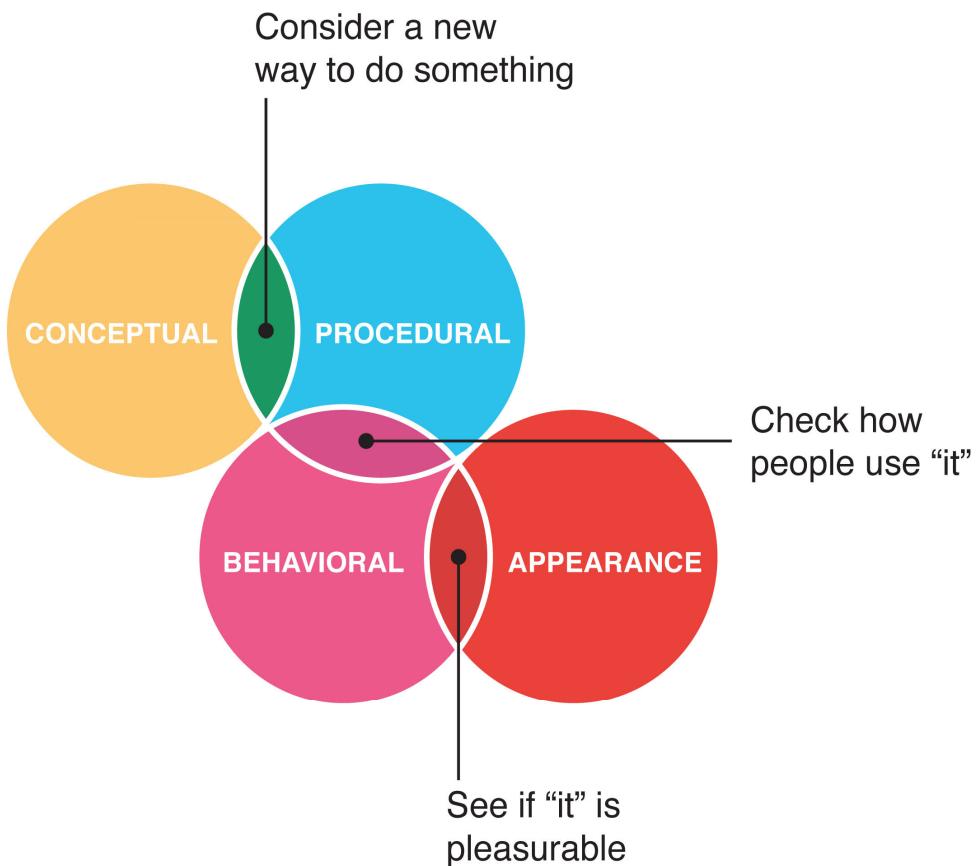
Low fidelity prototyping, on the other hand, has opened doors in many fields, especially in interaction design. Because it is low cost, you can reuse it several times and collect information rapidly and in various activities and areas.

Sharon Poggenpohl, from the Institute of Design, in her article, “Design Moves,” suggests that in order to sustain an interactive and iterative process, development questions, prototypes, and observation strategies must go hand in hand. She proposes four stages of prototyping:

- Conceptual
- Behavioral
- Procedural
- Appearance

The Conceptual stage has the objective of forming an idea, and it is usually used by the design team to brainstorm since it is very abstract. However, the Behavioral stage will give true information directly from the user who will make use of the concept being designed. It is usually the conceptual ideas on paper or computer simulations (prototypes) that reveal behavior and address specific questions. In this stage, the prototypes might not look like the actual object that will result from the design process. The Procedural stage aids in the organization and logic of the concept being designed and helps in clearing

confusion and redundancies and points out missing elements by testing the users through sequences, time or holistic models. In the Appearance stage, the prototypes are more high fidelity - closer to the actual final product - and they set the physical qualities of the object.



Overlaps between four kinds of prototypes (Poggenpohl 1998)

Both the conceptual and behavioral stages are early in the design process followed by the procedural towards the middle of the process and finally appearance in the end.

I got really excited about this idea because, as a blind person, appearance was not my forte. One could even say it is irrelevant to the blind. However, that is untrue, since aesthetics are closely guided by the behavioral and procedural stages. I could not do the flashy presentations and other things my classmates could. On the other hand, I was good at conceptualizing and observing behavior and procedure. Most people told me that looking at the user or the community first was a backward approach because I am starting from the end of the flow. However, I believe that second order thinking is just a different way to look at the situation, and prototyping was the method for solving some of my usability and accessibility issues.

This was one of the first meaningful articles I read in the program of design. And, not understanding prototyping very well, I interpreted this as a model to be applied in design in general and not just in the method of prototyping.

I also had been part of the Interactive Theater Troupe at KU. In Interactive Theater, we perform scripts from real life situations. These are usually outlined in a script with the intent of promoting a healthy conversation about a difficult topic, such as racism or sexism in the work place. We also use improvisation acting to practice leadership or managerial skills. Interactive theater is used for different goals in different places. However, at the University of Kansas, its main goal was to deal with social justice issues and promote multicultural understanding. What we do with scripts, in fact, is a way of prototyping behavior. We can observe how

others will respond. And, to practice a new way of handling a situation, we can prototype, simulate, or model it through acting. Therefore, I learned that prototyping is a lot more than just creating products, systems, and services. Prototyping is also a way to create visions and experiences.

In this area of my experience, I saw a lot more potential to prototyping. As a blind student, I was struggling to have accessible tools for my classes. After about a year, I could begin to understand the vocabulary and language used in the schools of design and business. However, I was still struggling with the tools. I could observe to a certain extent, but I could not perform fully yet. If you are learning a language, such as I did when I first arrived to the United States, or as any student would when studying abroad, just having the vocabulary to understand what others are saying is not enough. You still have to learn how to read, write and understand what is behind the context.

Prototype Tool: the foam board

Eventually, I created what I am calling the readable-writable foam board. The name should be clear. I used to carry around a piece of rubber, either 8½" by 11" or 11" by 17". I used this piece of rubber under a piece of paper where someone could draw or write something so that I could read it by feeling the indentations left in the paper because of the rubber underneath. However, this tool was too bulky and not very efficient. It also collected all the dust of the table

where I used it. It would fold inside the backpack and was too complicated when having to switch pages since I had to slide the rubber from under the paper I was writing or drawing on, place it back away from the board, get a fresh sheet of paper from under the rubber, and then slide it back.

Recently I found a commercially available clipboard that has an integrated paper compartment and I placed a foam sheet over it. Now I can efficiently open the compartment, put the sheet over the foam, pull a blank sheet of paper out and in two steps I am going again with my real task. The foam creates a surface on which I can use a pen to write and the lines then become clear to feel without having to exert effort.



In this process I had two prototypes. The second one gave me a better product conceptually, behaviorally, and procedurally. It was also more usable because I increased my efficiency threefold when compared to the first prototype. What used to take me six seconds now took me an average of two. Of course, once we have the concept, behavior, and procedure in place, the appearance comes

naturally. I also had a better-looking product, easy to handle and carry, but also aesthetically pleasing and not different from what others used, which afforded me a more positive social inclusion.

Additionally, when I use the same color of foam sheet as the clipboard, most people cannot tell the difference between my board and theirs.

RouteMe

Now, back to the issue of tactile maps. When I joined the design program, I wanted to design a mobile device that would substitute for the campus tactile map, but innovation and prototyping was not possible for a student without a budget or programmers. I would have had to go back to school and study computer science to make this happen, and that was not viable at the time.

However, in 2011, I joined a class project with people who were interested in mobile applications. Our project for the Methods Class was trying to create something for the parking department of the University. Through a second order thinking approach, we were able to discover that the area of greatest user need was related to indoor navigation on campus. People could find their way onto campus, but finding rooms and buildings was where the gap existed. A design opportunity was available. In addition, we now had new technology with a platform for applications for Android and iPhone. I was very interested in this project because now my device for campus navigation could be created and

tested. Here, a new technology met business and user. This is how RouteMe was born.

RouteMe was an indoor navigation app for mobile phones to guide students and visitors to classes or other destinations. We used several methods of cognitive mapping and user testing for Wayfinding. However, I will touch only on those tests related to my audio prototyping.

For the sighted, we first did a test to find room 340 in the Art and Design Building. We identified a complex route to find a room in the building, which by its nature is a complicated architecture. We asked users to take a video camera and find the room with no other instructions. We observed the user. This technique was easily applied to blind users with the exception that we had to have the observer walk around with the video camera. However, I modified the testing for blind people since the pool of users is a lot smaller, and being a blind person myself, I know more blind people would remember the route they took to find a room (the blind generally have better memories), and that would create issues for the second stage of the prototyping.

I told blind users, and some sighted expert users, to find room 210 instead of room 340 in the same building coming from the wheel chair accessible entrance of the building, an entrance which offered similar complexity for both users, such as half level floors.

The second phase of the RouteMe prototyping was creating a step-by-step direction to room 340 with a paper prototype.



(RouteMe sighted prototype)

Screenshots of instructions were generated in balsamiq.com and then printed on a set of stapled papers. This is where we found the biggest challenge.

I had created tools for myself so that I could work with sighted people, but I had no way to test blind users, too. It would be hypocritical of me to be a blind designer and not be able to apply all I learned to improve the lives of others like myself. Thus, I needed an audio prototyping.

I walked behind a blind user and announced out loud the next step direction. This is acting prototyping. However, during my first testing acting as a human GPS I learned that although very useful, it would not give me the same information that I was getting with a paper prototype in the sighted RouteMe testing. If I wanted to test only the directions, the human GPS would suffice. However, how about the device, the screen size, the distribution of the directions, and other ideas?

I looked everywhere for other prototyping tools, including places like LinkedIn. I was looking for software that could help create a haptic or audio tool that I could test. I used some building tools such as mobile site templates, but I ran into the issue of them not being fully low fidelity. They had a lot of sub text already built in on the style sheets, forcing me use their format instead of being able to have only a direction on the page. I asked for help from the computer science department, but I wanted to have some existing good information already prepared.

Then, when a programmer built a prototype, it would be already a more high fidelity prototype with the correct concept that I had discovered in the low fidelity prototype phase. In addition, a low fidelity prototype should be easy, inexpensive, and fast to implement. None of the present options were affording me any of these three requirements. In a real world situation, special programming would be costly and take time, and a ready program, most of the time, is not accessible to screen readers for the blind. Therefore, I had to find an alternative way.

In my organizational behavior business class, we use the Essentials of Organizational Behavior, Eighth Edition, by Stephen P. Robbins. Robbins claimed that only experts in a particular field are able to be creative in that field. I interpreted that to mean that experts were people with extensive knowledge in a particular field. Therefore, a plumber could not innovate in the investment field, but he could be creative about pipe networks. Of course, it does not mean that an innovation in pipe network cannot be the source of inspiration for creativity and innovation in an investment company, but the experts in each field are the ones most likely to recognize that transferability. After all, the advances that NASA made to take man to the moon were designed solely for that purpose and not to serve the kitchenware industry. Nevertheless, other industries have transferred the inventions of NASA for the everyday life, profiting from it as well as adding value and quality to life. Therefore, I stopped thinking that others could do anything for me and realized that ultimately, I held the answers I

needed. I was the blind person and the designer. I was the expert in living as an active blind person, a student navigator. I decided to look into my own life and try to find tools I could reuse or transfer to prototyping. If it was something I already owned, it would be low cost, usable, and rapid to implement.

I had recently purchased a device called “PenFriend.” This is an assistive technology made by the Royal National Institute of Blind People (RNIB) in the UK. It is in the shape of a big, fat pen. I can touch the tip of it to a recordable label and get audio feedback of what was previously recorded on that label.



(PenFriend)

This “pen” is designed for use in households, to identify kitchen food such as cans and boxes, medications and even DVDs.

I used this gadget mainly for my medications and for food preparation directions and to label other non-perishable products. The cost of the “PenFriend” in 2011 was \$170 and a packet of labels about \$40. The labels are reusable for an average of 100 times and so are quite useful.

I thought, “Why not use it for my prototype?” My user would only have to learn how to use the pen. The learning curve to read a label is less than 30 seconds. I could easily, and for low cost, test my idea. It did not have to look pretty, only be functional which is true for most low fidelity prototypes. However, I still wanted to ensure that I did not use all my labels and I wanted to be able to reuse my prototype for other mobile design tests to keep it affordable.

Low Fidelity Audio Prototypes for Indoor Navigation

Now I had the tool to create my first low fidelity audio prototype for navigation comparable to the first RouteMe prototype. I made and tested four prototypes for good usability (effectiveness, efficiency, and satisfaction) before I produced the fifth and final one that was actually used in the task of finding room 340 in the Art & Design Building. Following is the breakdown of each audio prototype.



Description:

In this model I tried to be as loyal as possible to the original paper prototype for sighted users with 2 staples at the top and regular paper sheets cut in approximately 2 by 3 inches. I placed a square label of approximately 1 by 1 inches at the center.



Description:

I used rectangular foam that is used inside of phone cases to imitate a phone, with the same 2" by 3" sheets with the audio labels in the center and a pair of pushpins to hold the sheets onto the foam.



Description:

I used colored card stock paper also cut in approximately 2 by 3 inches a sheet with audio labels at the center. Instead of staples as the first version, I used dog tag rings to facilitate easier flipping and to avoid marks left from using it.



Description:

Next, I used an empty IPod plastic case with foam inside to imitate the screen, and a stack of Post-it notes at the center of the foam with circular audio labels. The idea was that users could get a Post-it note out and place it in the back to read the instructions instead of flipping the paper.



Description:

In the final version of my low fidelity audio prototype, I used foam-core to delineate the start and the end of the steps. I also used 2 by 3 inch transparency sheets to protect my prototype from rips as well as to avoid colors and interference in case the user had some residual sight. Individual binder rings and the audio square labels on the sheets and circular small labels right below the sheets glued directly on the foam-core represented the same option bar the sighted users had in one of the regular paper versions.

The reason I designed the last prototype was because it allowed me to reuse materials and therefore make what regular low fidelity prototypes offer. The process of making the audio RouteMe prototypes not only gave me function and information about the user, it opened a whole new path for me to find answers to unsolved quandaries.

Velcro Prototyping

When I was consulting for Bushnell (2009), I could only test sighted people. One of the low fidelity prototypes we used were 3 by 3 inch foam-cores covered with Velcro. There were square papers people could stick on it to design their desired screens. Eureka! With the "PenFriend" I could use this same technique and create a Velcro prototype for the blind. I used the same testing concept, covering 2" by 3" foam-core with the soft part of the Velcro and the other side I cut very small pieces that were glued to the back of the audio labels, both square and circular ones.



(Velcro prototyping)

Accessible Player

Without a coded app specifically created for my testing, I still was able to run tests on button preference, audio topography, usability, and desirability. Users were asked to design their dream or ideal player. They could choose what buttons and functionalities their player would have, where the buttons would be placed and how the app would behave, even what names the buttons and functions would have. Potential users were taught how to use the PenFriend recording function and with their own voice they could design their ideal player.

The most amazing part was the social impact. It was the first time I was able to let a blind user be the designer of his or her own ideas and dreams. Each of them told me they loved the testing and the ability to build whatever they wanted. One user said, "It was wonderful being able to dream and being able to express it." Now blind users could be actual participants in shaping their own products. Another user told me it was hard to even start because she had never been asked to say how she wanted something done. Another user said they would like to have my profession because it was a lot more fun than their profession.

To me, this kind of discovery is the reason why the assistive technology industry is innovating, but at a very different pace than the mainstream technology industry. The problem is the lack of participatory design and understanding of the context. Now I have a tool to open the discussion and actually collect answers -- interaction. With this new tool and method, I can easily get information necessary to understand the principles and develop the guidelines for audio and haptic design, filling the gap that exists in current practice and research. Furthermore, I will be able to uncover critical information required for innovation for the blind in assistive technology or mainstream development.

Exploring Other Methods

With these discoveries and successes, I gained confidence in my prototyping skills. I felt free to start playing more and finding my own way. I used my own

foam board to test the drawing ability of other blind users. I also did testing with blocks and Legos as well as clay models. I was able to rise above the need to do everything the same way as my traditional (sighted) counterparts. I normally think three-dimensionally. Therefore, I struggled sometimes trying to express things two-dimensionally. Then I developed my magnet boards and started to express things that way.



What matters are the effectiveness, efficiency, and satisfaction in this design process. My little wooden man – typically used by design and art students - even served as entertainment for the industrial design students at the design shop as they made him jump my various design pieces. Again, they saw it as a toy. I saw it as a tool. All interactions are social, and there is no end to the interpretations of the use for various, especially new, objects.

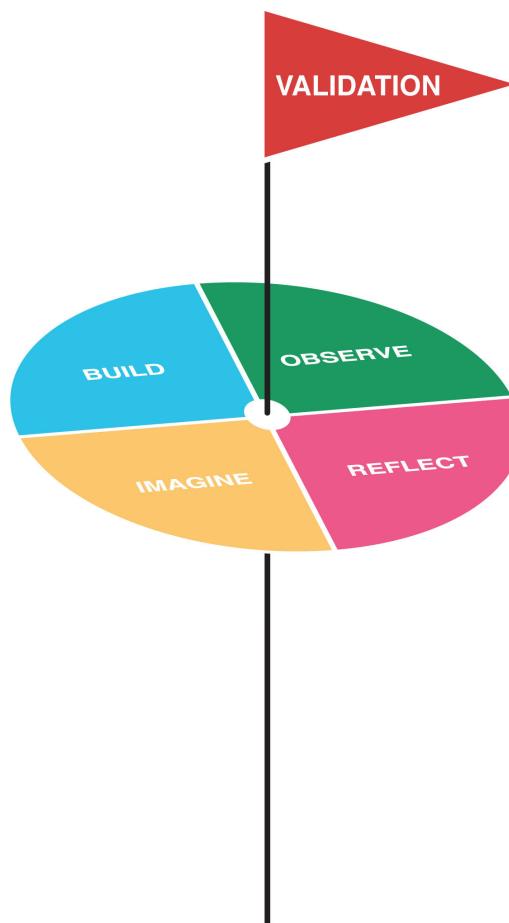
Therefore, I found that I needed to be able to effectively share my ideas with others to corroborate understanding. I needed to be able to ensure that my pictures and models would be clear and reliable. This prototype, below, allowed me to take pictures of 8 ½" by 11" sheets with perfect focus.



(Acrylic and wood iPhone picture stand)

My Validation Process

The journey to my final process output was one that demonstrated that with every method, testing and learning, I needed to observe, reflect, imagine, and build. The observation and the reflection allows for analysis of what is (the situation or event). The imagining and building is the flow of synthesizing “what if” (prototypes and possibilities, representation) to become a reality.



Axis of Validation – Design Process (Magario 2012)

This process is iterative and must be applied over and over again at the task, goal, and even motive levels. This ORIB process validates my actions and results and allows my inquisitive mind to communicate in a tangible way.

Conclusion

My long journey through grad school has taught me that innovation is a process of understanding complex adaptive systems. Second Order thinking is the philosophy that guides the frameworks and methods to understand the links (interactions/activities) of the system to design for the right context. I learned that failure of products and services is rooted in the lack of access to information/processes and lack of effectiveness, efficiency, or satisfaction. My process of observing, reflecting, imagining, and building validates hypotheses that can be approached through second order thinking, frameworks, and methods into the design process.

Innovation has not been approached through a non-visual point of view until now, and my audio and Velcro low fidelity prototypes have opened the door to a new way of collecting information that has the potential to fill in the gaps of research and practices for audio and haptic design.

In addition, we must look at all the senses because humans are not just composed of eyes and ears, but rather are a complex adaptive system that receives information in various ways. I believe we can only achieve new radical

innovations when we start to include the whole human, with all the senses that can be used to decode information, and not just focus on the visual. Until then, we are just on the tip of the iceberg of great innovations. The greatest part is still to come. I will continue the fight because I have to find ways for myself to become a better designer and a contributing member of society. For most of you, this new step is just a choice. For me, it is an entirely new world and age of discovery. I hope you will join me in this new empowerment of design.

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