Creativity Through the Use of Color as an External Stimulus

by

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A thesis submitted to the graduate faculty of
Auburn University
In partial fulfillment
For the Degree of
Master of Industrial Design

Auburn, Alabama
May 14, 2010

Keywords: Creativity, Color, Psychology, Design, Emotion, Workspace

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Abstract

All people have within them the gift of creativity and the capacity to become more creative. Measuring creativity, however, has always been a challenge since studies on the subject began in the mid 20th century. The one characteristic of creativity that most psychologists and researchers agree upon is that it is domain specific. This research paper sets out to prove that color, as an external stimulus, can have an effect on individuals' creative output and illustrates how through a new product concept. Using previously proven research, methodology, and primary research studies as building blocks design themes can be outlined that define an alternative to the professional workspace which can be developed to not only produce a more creative work setting, but to control the level of creativity generated within that environment.

Acknowledgements

To my father and mother, the strongest and most sincere love and thanks for being so supportive and understanding. To my brother and sister for being two of my closest friends, I dislike you less and miss you more every day. To my grandmother and the rest of my extended family and all my oldest friends who have helped to define me and have placed the seed in my heart for the pursuit of adventure (one being, of course, surviving higher education) I have nothing, but gratitude. I have never stopped learning and I owe more than I can ever reciprocate to my professors and the unique people I have met during my time at Auburn University. We never truly know how we will react in situations until they present themselves, but I am confident that on my trek through the future challenges of my life using the skills developed and honed by the interactions I have had with everyone whom I have been in contact with throughout my years I will continue to evolve into a better person and strive to make positive contributions to the world. My life will always be defined by the challenges I endure and the lessons I learn every day before this one.

Table of Contents

List of Tables

List of Figures

Chapter 1: To Be Creative

1.1. Problem Statement

Creativity is hard to define and is an almost immeasurable factor of design, although, over the past 50 years many psychologists have made attempts to determine the level of creativity active in specific areas of study. Researchers have hounded the unattainable question of how creativity truly can be measured using subjects of all ages from elementary schools to universities. The consensus of these numerous research studies is that creativity is discipline specific; "Domain-specific knowledge is essential- one cannot use a requisite element in a creative solution if one is not aware of the existence of that element" (Baer, pg 20). In order to increase creativity in any one profession an individual must first become familiar with that discipline's core principles.

After undergoing an education strongly rooted in the practical methodologies of product development the author of this paper was interested in determining how creativity might be enhanced in the design process through external physical factors to compliment the practical methods imparted throughout years of study. Initially, this study was directed on lighting as a means of enhancing the creative process, but

this proved to be an uncontrollable variable. Since design is a visual discipline the use of color as an external stimulus became the main focus of study.

Color variations in and around the design workspace can affect creativity in a positive manner by giving designers an environment that changes with them and their process. In a time of great economic uncertainty, creativity is being tapped now more than ever to improve the business bottom line and the needs of people. Intelligence and a strong work ethic can no longer be the only means of businesses to grow and have successful outputs. Margins of error in the workplace have also shrunk as companies have consolidated. Now is the time to explore additional options for positive growth and ideation within organizations. "Every single person in business needs to acquire the ability to change, the self-confidence to learn new things and the capacity for helicopter vision. The idea that we can win with brilliant scientists and technologists alone is absolute nonsense" (Sir John Harvey-Jones, 2001).

1.2. Need for Study

Designers use creativity in their everyday lives to invent, improve and develop the products of their trade. "Design covers an increasingly large spectrum. Nearly everything you use and see, from advertising to automobiles, has been the product of a designer" (Designschools.com, 2010). Enhancing creativity in a designer's work process can further benefit the larger populace as a whole that come into contact with these works. Furthermore, increasing productivity in a workspace

by increasing creativity can be a step towards higher efficiency in attaining a company's goals. Using industrial design as an example for increasing creative output a model will be developed which can be employed to many work environments.

1.3. Objective of Study

The objective of this research paper is to define color as a stimulus for creativity. Specifically, first, in the industrial design profession and then, second, to use this example as a tool to develop concepts for a new workspace that can increase creativity for workers in other professions. The following is a summarized order of what this research study will entail:

· Define the methodology of design by following the example of a leading company in the field of industrial design

· Use existing research for the study of colors' effects on creativity to develop testing procedures specific to industrial design

· Test individuals still at a level of elementary understanding of the discipline of industrial design to determine colors' raw effect on creativity during the design process

· Develop design themes based on the tests' outcomes to develop concepts that can be used in a professional setting

1.4. Definition of Key Terms

Anagrams- 1 a word or phrase that contains all the letters of another word or phrase in a different order. **2** a game whose object is to make words by arranging letters from a common pool or by forming anagrams from other words

Brainstorm- a group creativity technique designed to generate a large number of ideas for the solution of a problem

Color- the sensation resulting from stimulation of the retina of the eye by light waves of certain lengths

Creativity- creative ability; artistic or intellectual inventiveness

Design- to make original plans, sketches, patterns, etc.; work as a designer

Discipline- a branch of knowledge or learning

Divergent Thinking- is a thought process or method used to generate creative ideas by exploring many possible solutions

Ergonomics- the study of the problems of people in adjusting to their environment; especially the science that seeks to adapt work or working conditions to suit the worker

Hue- one of the main properties of a color, defined technically as "the degree to which a stimulus can be described as similar to or different from stimuli that are described as red, green, blue, and yellow

Ideation- the formation or conception of ideas by the mind

Industrial Design- a combination of applied art and applied science, whereby the aesthetics and usability of mass-produced products may be improved for marketability and production

I/O Psychology- (industrial and organizational psychology) applies psychology to organizations and the workplace

Methodology- the branch of logic concerned with the application of the principles of reasoning to scientific and philosophical science

Observation- the act or practice of noting and recording facts and events, as for some scientific study

Prototype- an original type, form, or instance of something serving as a typical example, basis, or standard for other things of the same category

Saturation- the saturation of a color is determined by a combination of light intensity and how much it is distributed across the spectrum of different wavelengths. The purest color is achieved by using just one wavelength at a high intensity

Stimulus- any action or agent that that causes or changes an activity in an organism

Valence- as used in psychology, especially in discussing emotions, means the intrinsic attractiveness (positive valence) or aversiveness (negative valence) of an event, object, or situation

Value- a property of a color, or a dimension of a color space, that is defined in a way to reflect the subjective brightness perception of a color for humans along a lightness–darkness axis

Workstation (workspace)- a person's work area, including furniture, appliances, etc.

1.5 Literature Review

1.5.1. Creativity

Psychologists have tried to not only define creativity, but typically develop theories that "explain creative thought processes, predict creative behavior, and demonstrate an underlying unity among diverse creative activities and productions" (Baer, 1993). Some psychologists have entertained the notion that creativity and intelligence are inter-related. Leon Smith is one such psychologist. He tested Benjamin S. Blooms view that intelligence is a subset of creativity as was supported in Bloom's Taxonomy of Educational Objectives. "The basic assumption of the taxonomy is that cognitive processes can be placed along a cumulative and hierarchical continuum, beginning with the major class of knowledge and proceeding through the classes of comprehension, application, analysis, synthesis, and evaluation. Intellectual ability is required in the first four processes and creative ability is required for the last two: synthesis and evaluation." (Sternberg, 1999)

Traditional intelligence tests usually measure convergent thinking, the type of thought used when a person must "converge" on a specific answer to a problem. Divergent thinking is the sort of thought that produces multiple responses to a question. "Because some of the resulting ideas are original, divergent thinking represents the potential for creative thinking and problem solving." (Runco, 1999)

In his book Creativity and Divergent Thinking, John Baer takes a task-specific approach to support the divergent thinking model of creativity as the superior method for describing individuals' responses in situations that creativity is recognized as being used. Baer developed 5 studies that tested (a) writing poetry, (b) writing short stories, (c) writing mathematical word problems, (d) writing mathematical equations, and (e) responding to a one-time verbal-fluency question that attempted to find a cross-disciplinary model to support the movement for teaching divergent thinking as a means of producing creative thought.

"The influence of any skill on actual performance involves at least two conceptually distinct factors: availability and production. One must have the skills available, of course, or it cannot be produced" (Baer, 1993). This supports the idea that creativity is discipline specific. "Some forms of creativity require skills that are specific to particular domains: to music, to mathematics, to poetry, to dance, to design, to engineering and so on… Their creativity derives from their feel for the materials they use and for particular forms of activity" (Robinson, 2001).

Paul Torrance, the originator of the best known standardized creativity tests suggested that "creativity defies precise definition" (Parkhurst, 1999). In 1966 he developed a benchmark method for quantifying creativity. The battery of tests he developed is coined TTCT (Torrance Tests of Creative Thinking). The battery consists of nonverbal and verbal forms, Thinking Creatively with Pictures and Thinking Creatively with Words, which are suitable for grades kindergarten through

graduate school to assess four creative abilities: fluency, flexibility, originality, and elaboration. "The Torrance tests are the most widely used tests to measure creativity" (Khatena, 1989).

Torrance's work is built upon the earlier studies of J.P. Guilford, an American psychologist. Guilford's lasting achievement is the Structure of Intellect theory which hypothesizes that an individual's performance on intelligence tests can be traced back to the underlying mental abilities or factors of intelligence. He proposed that there are up to 180 intellectual abilities, creativity or divergent production, being just one of the 180 (Guilford, 1962). Guilford's work lacks the validity of Torrance's research though and traditional intelligence tests do not require much creative or divergent-production thinking which lends support to the hypothesis that creativity and intelligence are separate constructs.

Even in Torrance's tests questions can be raised. If an individual scores very well on the Torrance test it means he or she thinks creatively, but not necessarily that he had or will produce creative works. The only guarantee, in this instance, is that the individual has the building blocks for creativity (Kerr and Gagliardi, 1999). "When people engage in creative activity their thoughts and actions are guided by the personal definitions of creativity and beliefs about how to foster and evaluate creativity that may be very different from the theories developed by creativity experts" (Plucker and Runco, 1998). Perhaps the best definition of creativity is stated in the Handbook of Creativity edited by John Glover, Royce Ronning and Cecil Reynolds;

"Creativity means a person's capacity to produce new or original ideas, insights, restructuring, inventions, or artistic objects, which are accepted by experts as being of scientific, aesthetic, social, or technological value" (Glover, Ronning, Reynolds, 1989).

1.5.2. Emotional Facts

The previous section implies that creativity is domain specific. This would seem to indicate that individuals working in a range of professions have the ability to apply creative thinking in a unique way to his or her job. If a worker's creativity improves job performance a parallel could be drawn from that performance to the company's success. Therefore, it would be advantageous for business owners and managers to maintain a positive work atmosphere that would benefit the workers' morals.

Robert G. Lord, Richard J. Klimoski and Ruth Kanfer edited a book titled Emotions in the Workplace. In this book several models for emotion are described. The primary emotions view is "useful as a theoretical foundation when the psychologist has a specific behavior or category of acts that he or she is interested in understanding". There is a second view however that suggests "all emotional experiences are blends of a few dimensional ingredients" (Lord, Klimoski & Kanfer, 2002). The dimensional view, as it's called, employs valence and arousal as its longitudinal and latitudinal dimensions.

For example, anger is considered a high arousal, negatively valenced emotion along with others like anxiety, fear, disgust or distress. Most people who experience one high arousal negative emotion are often susceptible to experiencing others as well. The Dimensional view follows the line of thought that most processes that influence or are influenced by emotions are "sensitive to broad classes of emotion, such as the high-arousal negative emotions, and are not diagnostic of specific emotions" (Lord, Klimoski & Kanfer, 2002). Within the dimensional view a circumplex model has been created to illustrate its characteristics.

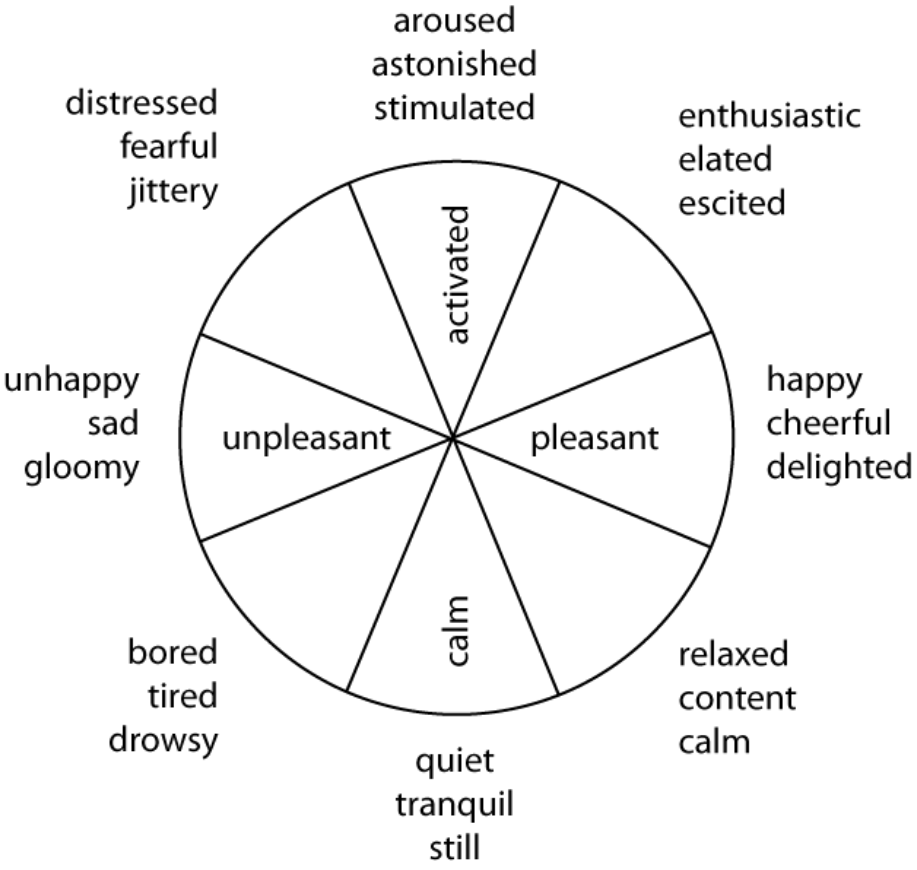

Figure 1. The Affect Circumplex Model (Lord, Klimoski & Kanfer, 2002)

"Emotion is directly relevant to understanding specific topics essential to I/O psychology, such as job satisfaction, worker motivation, and understanding how job characteristics (such as personal control) contribute to important outcomes, such as productivity" (Warr, 1999). There is a thought that specific job characteristics might contribute to job satisfaction through the promotion of frequent positive emotions at work. It has also been proven that people who have a healthy positive work life have an over-all better lifestyle. S.A. Lobel devised four "methods human resource managers can use to demonstrate the value added by work-life support" (Lobel, 1996). The most popular, "human-cost", highlights reduced labor cost. "Human-investment" is the long term organizational benefits to meeting the work-life needs of employees. "Stakeholder" demonstrates the impact of various programs and policies on different groups of shareholders. And "strategy" demonstrates how work-life supports are linked to higher organizational goals (Avery, 2001). It is beneficial for companies to explore options for increasing the comfort and satisfaction of their employees while at work.

1.5.3. Blue vs. Red

Perhaps a business' attempts at increasing the comfort and satisfaction of their employees at work would not be enough. If companies simply improve work-life benefits and then sit back to wait for their employees to generate with creative solutions to the tasks set before them they may not see immediate outcomes.

As Kerr and Gagliardi explained; if an individual scores very well on the Torrance test it means he or she thinks creatively, but not necessarily that he had or will produce creative works. The only guarantee, in this instance, is that the individual has the building blocks for creativity (Kerr and Gagliardi, 1999). External stimuli could be implemented that might expedite an individuals ability to be more creative.

In February of 2009 a research pair, Ravi Mehta and Juliet Zhu, at the University of British Columbia explored the effect of color on cognitive task performances. All six of their studies were done at the University of British Columbia. The purest red and blue colors were chosen by manipulating only hue, leaving saturation and value unmolested. Some studies were performed with a neutral white as well in order to have a basis of comparison. The reports on their six studies support the hypotheses that the color blue activates an approach motivation and enhances performance on creative tasks. In contrast, the color red activates an avoidance motivation, "which has been shown to make people more vigilant and risk-averse" and enhances performance on detail oriented tasks (Mehta & Zhu, 2009).

As stated in the abstract to this study, the colors red and blue were chosen because of the age old question as to which color is more creative. Although they avoided bringing other colors into the study the human psyche is affected by all colors in the visual spectrum which is discussed by psychologists working in the field of color psychology.

1.5.4. Color Psychology

Different cultures all across the world have a profound impact on how color is perceived in daily life. For instance Americans associate red with love, danger, and anger. In China, red symbolizes celebration and luck, and in India it is the color of purity. White is seen as pure and peaceful, but in Japan white carnations signify death. The three primary colors red, blue and yellow cannot be created by mixing any other colors. They can however be used to create every other color in the visible spectrum with the correct application of hue, saturation (chroma) and value.

Each color has its own emotional affect on individuals. Some colors are thought to cause physical affects as well. For instance red has been shown to raise blood pressure, speed respiration and increase heart rate. "Color is physiologically and psychologically beneficial and may be put to effective human service" (Birren, 1961). Yellow communicates happiness, but people are more likely to lose their temper in a yellow room. Crimson can make some people feel irritable whereas blue brings down blood pressure. Blue is calming, relaxing and serene. Green is the most restful color for the eyes. It's considered a balance color, neither causing anxiety nor overly depressing.

Research has demonstrated in many cases that the mood-altering effects of color may only be temporary. "To state a principle, it seems that the immediate action of any color stimulation is followed in time by a reverse effect" (Birren, 1961).

Generally the colors on the warm half of the spectrum (the yellows, oranges, and reds) have an aggressive feel to them and heighten individuals' moods almost to an erratic, uncomfortable state. The cool colors (blues, indigos, and violets) have a calming effect, almost a depressing feeling.

In his book Color Psychology and Color Therapy Faber Birren outlines modern American color associations. From each color's general appearance and direct associations to the objective impressions a person has when viewing a singular color.

Modern American Color Associations

Color	General Appearance	Mental Associations	Direct Associations	Objective Impressions	Subjective Impressions
Red	Brilliant, intense, opaque, dry	Hot, fire, heat, blood	Danger, Christmas, Fourth of July, Valentine's Day, Mother's Day, flag	Passionate, exciting, fervid, active	Intensity, rage,rapacity, fierceness
Orange	Bright, luminous, glowing	Warm, metallic, autumnal	Halloween, Thanksgiving	Jovial, lively, energetic, forceful	Hilarity, exuberance, satiety
Yellow	Sunny, incandescent, radiant	Sunlight	Caution	Cheerful, inspiring, vital, celestial	High spirit, health
Green	Clear, moist	Cool, nature, water	Clear, St. Patrick's Day	Quieting, refreshing, peaceful, nascent	Ghastliness, disease, terror, guilt
Blue	Transparent, wet	Cold, sky, water, ice	Service, flag	Subduing, melancholy, contemplative, sober	Gloom, fearfulness, furtiveness
Purple	Deep, soft, atmospheric	Cool, mist, darkness, shadow	Mourning, Easter	Dignified, pompous, mournful, mystic	Lonliness, desperation
White	Spatial- light	Cool, snow	Cleanliness, Mother's Day, flag	Pure, clean, frank, youthful	Brightness of spirit, normality
Black	Spatial- darkness	Neutral, night, emptiness	Mourning	Funeral, ominous, deadly, depressing	Negation of spirit, death

Table 1. Modern American Color Associations (Birren, 1961)

1.5.5. Preferences for Colors and Color-Emotion Combinations in Early Childhood

Birrens table was created in 1961. Since then numerous studies have been reported on color perceptions and the effect color has on emotion. Not surprisingly, the associations Birren outlines have held true even in some instances involving countries other than America. A study conducted in 2001 by Marcel R. Zentner at the University of Geneva in Switzerland explored the color-emotion preferences of 127 children, with a mean age of 45 months (3-4 years old). The question Zentner addressed was whether young children could detect a relationship between a color and an emotional expression. This capacity to go beyond the mere appearance of the objects, relating them to some deeper grounds, might be a conceptual prerequisite to appreciating more abstract relationships, such as relating 'bright' to 'happy' (Zentner, 2001). In the color-emotion matching task the children were instructed to match six colored cardboard rectangles to three cartoon-like drawings of faces designed to express emotions of happiness, sadness and anger.

Patterns of colour-emotion mappings in children

	Red	Yellow	Blue	Brown	Green	Black
Happiness						
Males	21	11	8	3	6	4
Females	9	13	8	6	6	8
Total	30	24	16	9	12	12
Sadness						
Males	9	3	16	12	8	5
Females	10	6	14	5	4	11
Total	19	9	30	17	12	16
Anger						
Males	8	12	10	9	8	6
Females	11	7	13	5	5	9
Total	19	19	23	14	13	15

Table 2. Patterns of color-emotion mapping in children (Zentner, 2001)

The children were tested individually in a quiet room in their daycare center under daylight conditions. Less than 5 percent of the children needed help identifying the expressions. The girls were found to be slightly more sensitive to bright versus dark color preference. Overall 68.1% of the children manifested a bright preference. The number of children choosing either red or yellow for the happy expression and either blue or brown for the sad expression was three times the number of children choosing the opposite pattern (Zentner, 2001).

A comparison test of adults was also administered. 65 undergraduates with a mean age of 23 years were tested in a group session.

Patterns of colour-emotion mappings in adults

	Red	Yellow	Blue	Brown	Green	Black
Happiness						
Males	1	16	10	0	1	0
Females	4	20	7	0	1	0
Total	5	36	17	0	2	0
Sadness						
Males	0	0	1	6	1	20
Females	0	0	5	5	2	20
Total	0	0	6	11	3	40
Anger						
Males	22	1	0	2	0	3
Females	22	0	0	2	0	8
Total	44	1	0	4	0	11

Table 3. Patterns of color-emotion mapping in adults (Zentner, 2001)

Adults' color-emotion matches were different from 3-4 year olds' associations. For, example, red was rarely matched with happiness and became the color of anger and sadness was primarily associated with black. Similar in both samples was the choice of yellow for happiness and the non-emotionality of the color green (Zentner, 2001). This study seems to indicate that the human psyche associates color with emotion even at a very young age.

1.5.6. Relationship between Color and Emotion: A Study of College Students

In 2004 Naz Kaya and Helen H. Epps conducted a study to examine college students' color-emotion associations at the University of Georgia. They sampled 98 college students with a mean age of 21 years using ten fully saturated chromatic colors and without any pre-determined emotions. The participants were presented a color sample on a computer screen, one at a time, and asked, "What emotional response do you associate with this color? How does this color make you feel? Why do you feel this way?" (Kaya & Epps, 2004) The research pair felt that asking participants to match colors to only a few specific colors, as in previous studies (Zentner, 2001), produced limited results for the assessment of reactions to colors.

Non-designated emotions for responses to the colors presented provided a higher number of emotions, but gave a low frequency of results for some of the emotions provided by students. This prompted Kaya and Epps to code the emotions as "positive", "negative" or "no emotion".

About 80% of the responses to the principle hues, including red, yellow, green, blue, and purple were positive (Kaya & Epps, 2004).

	Red	Yellow	Green	Blue	Purple	Yellow-Red	Green-Yellow	Blue-Green	Purple-Blue	Red-Purple	White	Gray	Black
Angry	28	0	0	0	0	0	0	0	0	0	0	3	7
Annoyed	0	0	0	0	0	5	8	7	0	2	0	0	0
Bored	0	0	0	0	5	4	2	0	0	2	5	14	0
Calm	4	0	29	60	28	0	0	16	38	13	8	5	0
Comfortable	0	0	15	4	3	3	7	7	0	0	0	0	5
Confused	0	0	0	0	0	0	2	6	0	0	0	6	0
Depressed	0	0	0	6	0	0	0	0	12	8	0	23	22
Disgusted	0	0	0	0	0	9	26	2	0	3	0	0	0
Empty/Void	0	0	0	0	0	0	0	0	0	0	25	0	0
Energetic	5	10	0	0	0	14	0	10	0	0	0	0	0
Excited	18	8	2	0	4	25	6	11	0	12	0	0	0
Fearful	0	0	0	0	5	0	0	0	0	0	0	3	17
Happy	21	74	28	10	21	31	11	36	13	26	0	0	0
Hopeful	0	0	0	0	0	0	0	0	5	0	6	0	0
Innocent	0	0	0	0	0	0	0	0	0	0	33	0	0
Lonely	0	0	0	3	0	0	0	0	3	0	6	4	0
Loved	15	0	0	0	0	0	0	0	0	17	0	0	0
Peaceful	0	0	12	4	0	0	0	0	8	0	13	0	0
Powerful	0	0	0	0	7	0	0	0	0	7	0	2	14
Sad	0	0	0	8	13	0	0	0	10	0	0	30	24
Sick	0	0	0	0	0	0	32	0	0	0	0	0	0
Tired	0	6	0	0	9	0	0	0	5	0	0	5	7
No Emotion	3	0	4	3	3	7	4	3	4	8	8	3	2

Table 4. Color-emotion associations of college students (Kaya & Epps, 2004)

The result of Kaya and Epps' research shows that the affect of color on the human psyche is predominately positive. This is good groundwork for employing color as an external stimulus to increase creativity by controlling emotion in the workplace. However to be more certain a study similar to that performed by Mehta and Zhu (Blue vs. Red) could be developed that would allow for the observation of colors' effect on creativity. The research of this thesis was originally geared towards design and since creativity has been cited as being domain-specific the field of industrial design, a discipline familiar to the author of this research, will be used as the tool for creating such a study.

1.5.7. Specific Domain: The Design Process

In order to familiarize readers with the discipline of industrial design to the degree necessary to understand the methodology of the study to be created it is important to describe the process through which successful designers develop products or solutions. There are only a few books that outline the process of design. Businesses have taken design and molded it to their business models in an attempt to be more successful. The reality is that each problem may require its own steps to be solved that are unique. Often, the best way to describe the design process is through the evidence of successful outcomes. IDEO is one of the leading companies in the design profession. They have worked with thousands of clients including "some of the best-known and best-managed companies in the world" (Kelley, 2001).

They are leaders in the design profession both from a successful practice and through proven research methods. They employ a simple yet involved process that they outline in three steps: observation, brainstorming, and prototyping. These three steps can be used in any order necessary when working on a project.

Observation is a key step in acknowledging problems present with an existing design. The design problem could involve anything from brushing teeth to servicing the engine of an automobile. Multiple methods of observation have been employed during this problem identification phase and IDEO has defined an extensive list themselves, but other companies use observation to research problems in specific areas of focus. Steelcase, a global leader in the office furniture industry with over 13,000 employees worldwide and the parent company of IDEO has a research division within their organization. They "ask questions, observe work processes, and guide users through experiences that reveal hidden needs" (steelcase.com, 2008). Some examples of the methods of observation are contextual interviews, fly on the wall, shadowing, photography/videography, and field notes. For good note taking and to insure every detail is captured during observations Steelcase employees are taught the A.E.I.O.U. method: Activity- what are the users doing? Environment- where is the activity taking place? Interaction- what are the users interacting with and how? Object- what are they using? User- who are they? Having thorough notes accessible during the ideation phase of the design process can be the difference in successfully solving problems.

"What do stand-up toothpaste tubes, all-in-one fishing kits, high-tech blood analyzers, flexible office shelves, and self-sealing sports bottles have in common?" (Kelley, 2001). They are all IDEO products developed from information gleaned from watching people use the pre-existing products. Team members working on these products observed problems or areas of opportunity and brainstormed possible changes that would be advantageous to users. Brainstorming can be explosive and fast paced, but it must be focused. Alex Osborn was the first to bring this to the attention of the main stream in 1953. In his book Applied Imagination he proposed that groups could double their creative output with brainstorming. While in recent years, group collaboration has been known to have some weaknesses, well run brainstorming groups can create hundreds of ideas (a fraction of which may be useful). The key word here is "guide". Brainstorming sessions don't have many rules. While this can be a positive, IDEO has come up with a few "don'ts" that should be avoided for a brainstormer to survive and be successful: Never let the boss speak first and set the agenda; democratically allowing everyone a chance to speak isn't productive; having experts on the subject matter at hand isn't necessary; working off site to try to increase free thought can be counterproductive; don't write everything down and don't worry that an idea is too silly. Sometimes the crazy ideas are the ones that evoke creative thought from other team members and lead to successful solutions.

A brainstorm session is the place for fun, quirky, crazy ideas and tangents, but thoughts of this nature should be seen as what they are; stepping stones to innovative, workable solutions to the problems found during the observation phase of the design process (Kelley, 2001).

1.5.8. Experience Design

Experience design is a new focus and a growing discipline in the design field. It is developing into the next step in understanding the relationship between the user and design. By creating frameworks for experiences, designers are taking it upon themselves to manipulate their audiences in order to evoke a desired response. In the case of a professional workspace, a new experience can be created to elicit immediate effects such as creative thought and abstract problem solving capabilities.

In an article featured in a recent issue of INNOVATION magazine Ben Jacobsen imparts: “the internal culture and social dynamics of groups often become impediments to doing new things” (Jacobsen, 2006). Sometimes the sequence of everyday activity becomes so ingrained in a person’s normal routine that any tangent from this norm would be rejected and would therefore fail to elicit the desired response. Even if the current situation is ineffective and has obvious room for improvement workers may be repulsed from a new experience that threatens to alter their daily ‘normal’ routine. In this case, any change must be first understood in the terms of how it will affect the audience it is being geared toward.

In understanding that people are more than likely going to be unhappy about a change in their routine the possibility of this response can be diminished by first, knowing that it is a possibility and, second, designing to elicit a response from the other end of the spectrum of human emotion. In order to do this there must be some understanding of how an individual will react to a new experience. Rob Culver, quoted in the article Uses of Fear, stated "I think that the most successful designs are the ones that elicit an emotional response. A potential user has an experience with the product- fear, intimidation, comfort, etc. - that leads to interest then purchase, and then use that will enhance the person's life in some way" (Hadar, 2003). If professionals are weary at first of stepping into a new atmosphere their curiosity may overcome their fear (which may have been the eliciting factor for curiosity in the first place). CEO and chief creative director of Philips Design, Stefano Marzano, expands on Rob Culver's words: "what really delights people is when you give them something nice they didn't expect. And this may be something that they didn't expect because they had never thought of it; or if they had thought of it, they never believed it was possible" (Marzano, 2006).

"When you start with the idea of making a thing, you're artificially limiting what you can deliver. The reason that many of these exemplars forward thinking product design succeed is explicitly because they don't design products. Products are realized only as necessary artifacts to address customer needs" (Merholz, 2007). By this line of thought it could be stated that the experience is the product.

Peter Merholz, a founding partner and president of the design consulting/user experience based company Adaptive Path in San Francisco posted an article on the core77 website explaining why, when a designer creates a thing, sometimes it's not successful. The reason for this is that, in some cases, a product isn't the answer; it is an experience that users crave, even if they are not aware because people find delight in new things which can have an effect on their mood and creative output. Products, though inanimate, cannot affect people as completely as a carefully planned experience. "In the first and final analysis, design is about effecting change in people's choices and behavior." (Schrage, 2004) Only some products, designed for any specific situation can affect a person's choice and behavior. In this article, Michael Shrage is explaining the need for inclusion of persuasion in all design and how to induce a person's will for self-persuasion. In Experience Design 1 Nathan Shedroff adds to this line of thought by stating: "There's no reason why an experience can't be designed to change based on how people react to it, whether the experience is digital, theatrical or occurs in real space. Even small changes to only a few characteristics can make an experience feel more interactive" (Shedroff, 2001).

Designers cannot look at the people they are designing for as simply consumers; a wallet or pocket book at the end of the design process. "Experience designers must regard their audiences as active participants- not passive viewers. Many real-space experiences (such as parties and other events versus art displays or theater) require participation in order to be successful. These are often the most satisfying experiences for us" (Shedroff, 2001).

Likewise the designer finds satisfaction in eliciting this positive response from the user, but just as products lose their "freshness", experiences can play themselves out to become obsolete. Joseph Pine and James Gilmore explain this in their book The Experience Economy: "The second time you experience something, it will be marginally less enjoyable then the first time, the third time less enjoyable than that and so on until you finally notice the experience doesn't engage you" (Pine and Gilmore, 1999). This must be avoided at all costs and it can be with the right mix of design, intrigue and participation by those engaged in the experience. "Entertainment experiences can alter our view of the world, while educational experiences can make us rethink how we fit into the world. Escapist experiences can boost our personal capabilities and characteristics to new levels, while esthetic experiences can imbue a sense of wonder, beauty and appreciation. But again, the most engaging life-transforming experiences will center around the sweet spot, composed of multiple elements from all four realms" (Pine and Gilmore, 1999). Here, Pine and Gilmore have given a minimal method for surviving past the moment when an experience may become dull and unconnected with the participant. When it seems the ride is coming to an end and the punch line is about to be an obvious cliché, Pine and Gilmore suggest a curveball in the experience that twists the users conscience from increasing aversion back to interest.

In The Design Experience Mike Press and Rachel Cooper reveal a quote from Darrel Rhea explaining another way designers can be sure to create an experience that resists fading with use.

He says, “the real challenges come when we step back and reassess all the ways a design might influence and benefit customers- physically, emotionally, intellectually, and culturally; it is, in fact, customers’ every experience with a product that reveals opportunities to use design in innovative ways” (Press and Cooper, 2003). He puts voice to the idea that a designers job does not end after the product or the experience has been developed and released to the public. The designer needs to revisit the design, be immersed in the workspace to assess the level of participation or interaction and if necessary, retool the experience to have a greater effect on those engaged.

“As with feedback, comparing the amount of control in real-world experiences gives a good starting point for designing other kinds of experiences. People expect to have some kind of control over their experiences. This control usually makes them feel more comfortable and respected. It might be controlling the rate of interaction, the sequence of steps, the type of action or features or even how much feedback they desire. The only way to know how much control is important is to question participants about their needs and desires, and then test the experiences to see how well they work” (Shedroff, 2001).

To develop an experience that can evoke this amount of response would take layers of manipulation to keep the workers engaged in participation at a level that allows the flow of creativity at an almost subliminal level. Of course, there will always be a level of rejection to any type of experience, but this may be minimized through extensive research and user-studies.

1.6 Assumptions

The primary research conducted in this paper is original. This paper assumes that all information gathered from books, journals, and creditable internet sites is accurate and honest. The idea of color affecting creativity was first explored by the research pair Ravi Mehta and Juliet Rui Zhu in 2009. This paper assumes that their research is factual and truthful. It is assumed that their study ruled out the inclusion of colors other than red and blue from secondary research on color theory from reputable sources and that if there had been any discrepancy as to red and blue not being the most creative colors in the human visual spectrum red and blue would not have been the only colors in the study. The concepts in this paper presume to believe that technology is growing at a rapid pace and what is now the frontier of visual electronics will one day become common place and more prevalent in human lifestyles.

1.7 Scope and Limits

The scope of this research is aimed at studying creativity in the professional workspace or the educational studio. It does not limit itself to a specific demographic group as it should be understood that all people are capable of creativity in their respective field of focus. The primary research is limited to the industrial design students at Auburn University in Auburn, Alabama.

The concepts developed from this paper, however are not limited to the industrial design discipline as the research is merely an example of how creativity can be increased and understood to be a small sample of a much larger global work force. The scope of individuals targeted by the concepts developed includes all workers and professionals in vocations that could be positively affected by an increase in creative work output.

1.8 Procedures and Methods

The following procedures and methods were used to conduct the study:

· Research the effects of color on creativity

- Study psychology of creativity
- Study tests done by psychologists to measure creativity
- Find existing, recent research for the effects of color on creativity
- Contact researchers for more detailed information

·Research the effects of color on the design process

- Define the design process
- Create a series of tests to determine color's effect on design

·Concept Development

1.9 Anticipated Outcome

The question of how color affects creativity was chosen because there has been relatively little research done on the subject. It is hoped that this research project will continue to solidify evidence for the existence of a relationship between color and creativity in the design field as well as in other disciplines. It is understood by the author that while limited, this research paper may bring to light statistical information that color can affect creativity. It is this first hand research that will drive a concept for the workspace geared, first and foremost, toward the designer in the professional setting, but with the hopes that those working in fields that are not traditionally considered “creative” would be interested in increasing their creative output as well.

Chapter 2: How Does Color Affect Creativity?

The following study was developed as a means to test the affect of color on creativity. Industrial design was chosen as the platform for discovering this effect. As has already been cited, creativity is discipline specific and, after completing nearly three years of study, the discipline most familiar to the author of this research is design. The Blue vs. Red research study conducted by Mehta and Zhu was used as a springboard, but where their tests spanned a range of activities, the following study focuses on design and, more exactly, the design process.

2.1. Pilot Study

The IDSA Atlanta Chapter 24 hour design charette is a bi-annual event that challenges the industrial design students of Auburn University, Georgia Tech and Savannah College of Art and Design to come up with a solution to a specific design problem within one day. The first design charette was in the spring of 2009 and the second was in October of 2009. This second design charette was used as an initial test for the experiment to come and to determine the validity of the research this study is suggesting to exemplify.

At midnight of the proposed day a design brief is posted online at the IDSA Atlanta chapter website. From this point on students have 24 hours to solve or improve upon the problem explained on the website. The title for the 2009 fall semester challenge was "Wii + the elderly". Students were charged with the task of creating some way to increase the interests of the United States elderly demographic in Nintendo's Wii.

The guidelines for the challenge were vague. Students were essentially on their own as to how to interpret the problem and what would be developed for a final product. This student's group at Auburn University was comprised of one graduate student and six third year students who have had classes and experience in design methodology as well as been involved in studio work that involves interpreting design problems into easily understood appropriate solutions. It was through this project that an initial study would be conducted on how color within a designer's environment might affect their creative process.

Figure 2. Brainstorming session during pilot study

For the initial group brainstorming a medium blue paper was placed on the work table where everyone was gathered. During this phase the problem was defined and any and all ideas were brought forward and considered.

Blue paper was used under the auspices that the color lends to freer more radical thoughts which are important in the beginnings of any ideation (Mehta and Zhu, 2009). For the second phase; refining the ideas and developing a communicable end product, a medium red paper was laid over the work table.

Figure 3. Concept refinement phase during pilot study

Throughout the brainstorming (blue paper) session there was an explosion of thoughts and ideas as everyone involved played off one another to push the ideas further than any individual could have alone. Essentially a very vague problem statement and dozens of ideas were developed as to how to interpret it in an hour brainstorm session.

During the one hour idea refinement stage with the red paper there was an almost immediate focus for all the students as soon as one specific interpretation of the relationship between the Wii and the elderly was addressed.

For the entire hour there was only one line of thought; many additions as the idea evolved, but the original concept remained unaltered.

The group's final product that was submitted to the judges of the design charette was a new game that took elderly individuals to different parts of the world where they could sample the local cuisine, get recipes, explore landmarks and play sports indigenous to the area. All of it was controlled with the movement of the joystick and the use of only the A button. The concept received an honorable mention by the judges behind one other honorable mention and the first place team.

2.2. Covered Work Surface Study

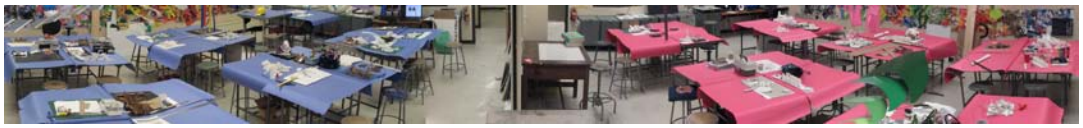

Figure 4. Covered work surface study panorama of studio

Though patterns had been observed, there remained an impression that more could be discovered. The main goal of this test was to observe creativity in the design process with forty six industrial design students in their second year of the ID program at Auburn University. The tests would be conducted through a more structured task in the studio classroom, yet should not be viewed as a highly scientific, quantitative study.

Rather, these tests should be appreciated as qualitative pattern identifiers. These students were tested to determine if their creative output could be enhanced with the application of color as an external stimulus. The classroom these students were tested in is naturally split; two adjoining rooms with an adjustable screen between that is permanently drawn back. There are twenty three students on either side of the room making it an ideal location for a comparison study.

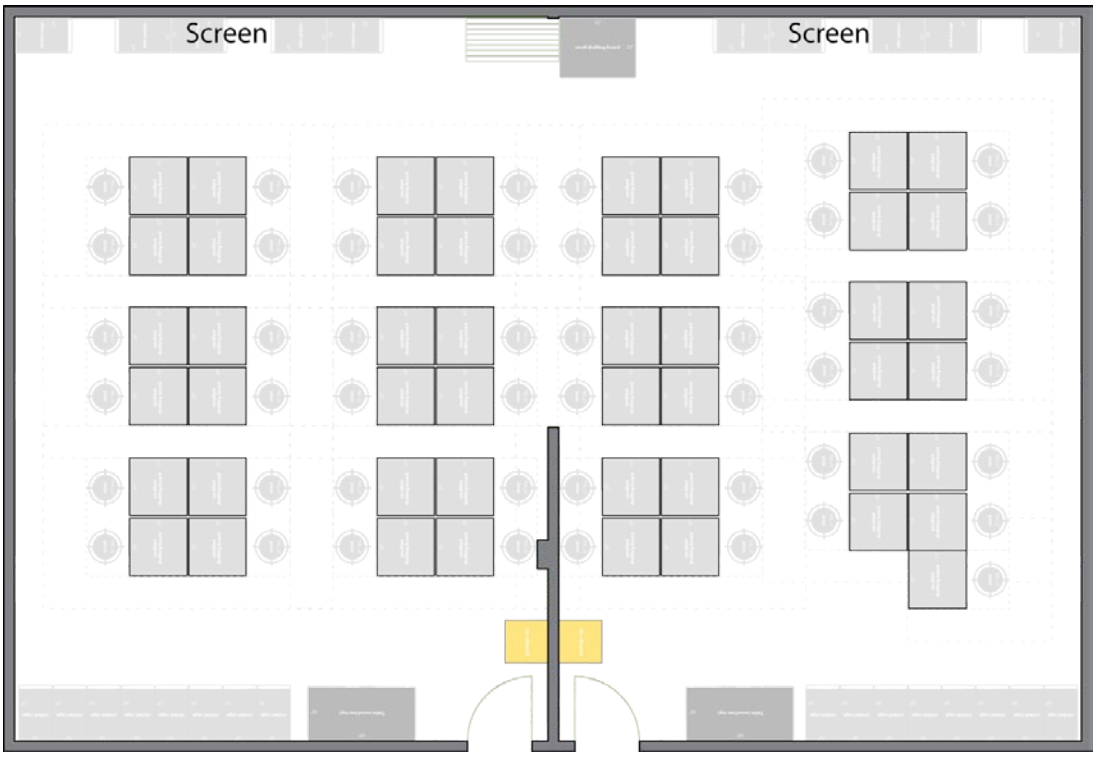

Figure 5. Floor diagram of studio used for covered work surface study

2.2.1. Description of Tests

Four tests were conducted over a cumulative four day period of time: two observation studies and two idea generation exercises. Tests one and three were used as catalysts for tests two and four, respectively. In each of the observation studies (tests one and three) every student in the classroom was asked to view a video of a process being completed and record what they saw. During the idea generation exercises (tests two and four) the students used their observations to come up with products/ solutions to problems they witnessed in each process video.

The videos were produced especially for this experiment. The first video captured the struggles of a 21 year old college student attempting to take apart a dated Schwinn bicycle in the hopes that he could later reconstruct the bike with improvements and modern equipment. He had never taken apart this bike let alone any other so his efforts and difficulties were genuine. The video produced for test three was twice as long (even after editing which was performed on both videos). The volunteer in this process was asked to construct a four man Ozark Trail camping tent. He was knowledgeable of pitching tents, but not this particular model. Needless to say, even with his confidence prior to shooting, he struggled more with a product he was familiar with than the individual in the first video with a bike of which he had no knowledge.

During tests one and two, the twenty three desks on the right half of the studio (to the right of the opened dividing wall, facing the screen) were covered with blue

paper. For common purpose, consider this side “B”. The desks to the left of the dividing wall, side “A” were all covered with red paper. The paper used was butcher paper on a three by 1000 foot roll and had been ordered online through a retail office supply store. During tests three and four the colored paper was switched so that the blue paper then covered the desks to the left and the red paper the desks to the right side of the dividing wall.

2.2.2. Observation Test One

Figure 6. Still frame image from first observation video

The observation video created for test one was titled “Deconstruction of a classic Schwinn road bike” and consisted of a college student attempting to take apart an old Schwinn bicycle on the balcony of a second story apartment. Students viewed the video on two large overhead projector screens located at the front of the classroom. They were asked to record everything they saw as if they were in the field taking notes and had to report back to a team or individual that had not been there, but would be instrumental in any work developed at a later date using the observations as reference.

While watching the video the students recorded their observations on an 8.5 by 11 inch letter size piece of white paper provided for them so they would not bring in their own outward stimulus however unintentional. The observation page consisted of fifty numbered lines to record thoughts and supplied directions at the top of the page that read:

·Record the problems and inconsistencies you witness in the video

·Start each thought on a new line

Before the video started two power point slides were shown on the screen to describe a few methods in observation studies and to suggest how to take successful observations using the A.E.I.O.U. method used by the research divisions of organizations such as Microsoft and Steelcase. A.E.I.O.U. is the short hand to help remember points of importance during observational fieldwork.

It stands for:

Activity- what are the users doing?

Environment- where is the activity taking place?

Interaction- who are the users interfacing with and how?

Object- what are they using?

User- who are they?

Students viewed the video twice and were given the option of recording observations both times or just the second time after they had been acclimated with what was occurring on the screen.

2.2.3. Ideation Session One

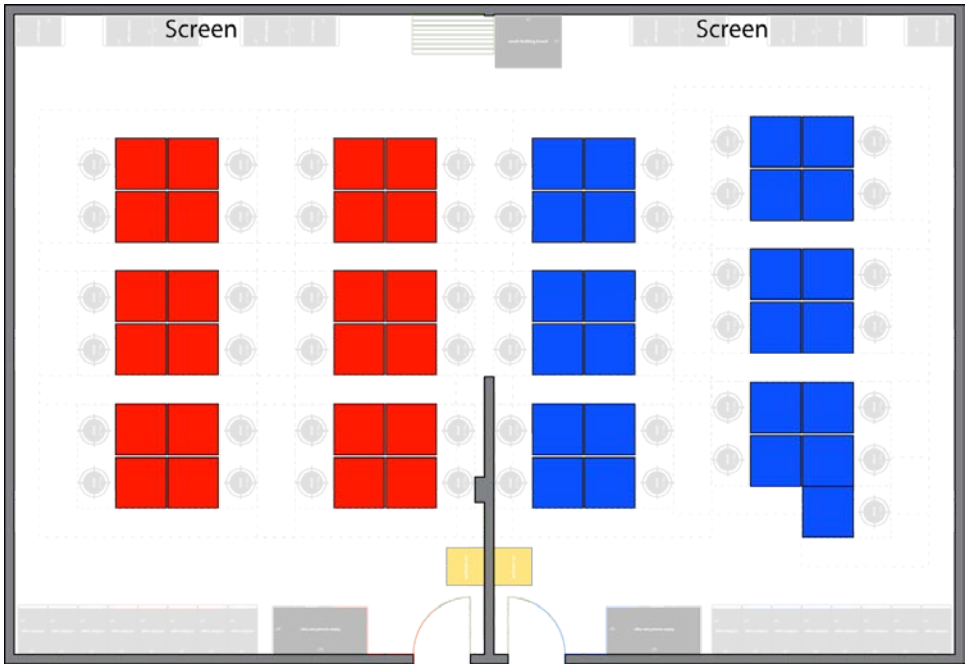

Figure 7. Diagram of color paper positioning during tests one and two

The second test was conducted during the next class meeting two days after the first test. The students were asked to use the observations they had recorded during test one to create products/ solutions to the problems they witnessed in the "Deconstruction of a classic Schwinn road bike" video. The information was still fresh in their minds and they had the sheet of observations they had taken in front of them. Each student was provided with an 11 by 17 inch piece of tabloid size paper to record their ideations. The sheet had four large rectangles, 4 x 7 5/8 that filled up the page. Each rectangle was intended to be the canvas for one idea.

If the students ran out of room, or came up with more than the four ideas than they were told to flip the page over and use the back or begin on a second sheet of paper.

Three categories were listed at the top of the ideation sheet from which the students could choose to focus their improvements. During test two the three categories provided were brakes, tools and workspace. Each category had an assigned symbol that the students were asked to place in the upper left corner of whichever rectangular idea area they were working in to signify the category of focus. They were not, however, limited to working within only these categories. In fact, working outside of the suggested categories was, if not encouraged, than absolutely praised.

2.2.4. Observation Test Two

Figure 8. Still frame image from second observation video

The third test followed the same guidelines as test number one, but the content was new. Again, as in test one, students were shown a video created to illustrate the struggles an individual would have while working through a process involving a specific product. In the video in test three an individual was conscripted to put together a tent. The tent was a general 3-4 man tent purchased at a discount retail store.

The students were shown the video twice on the overhead projector screen. As in the first test, they were allowed to watch the video the first time before beginning to take observations during the second viewing. For the screening of this video the desks were covered with colored paper. The color was the same as that of tests one and two, but the placement of the colored paper was reciprocated.

In this test, if you were facing the front wall with the viewing screens, the blue colored paper was on the left side of the classroom and the red paper covered the table desks on the right side of the room. Students viewed the video and wrote down all of their observations.

2.2.5. Ideation Session Two

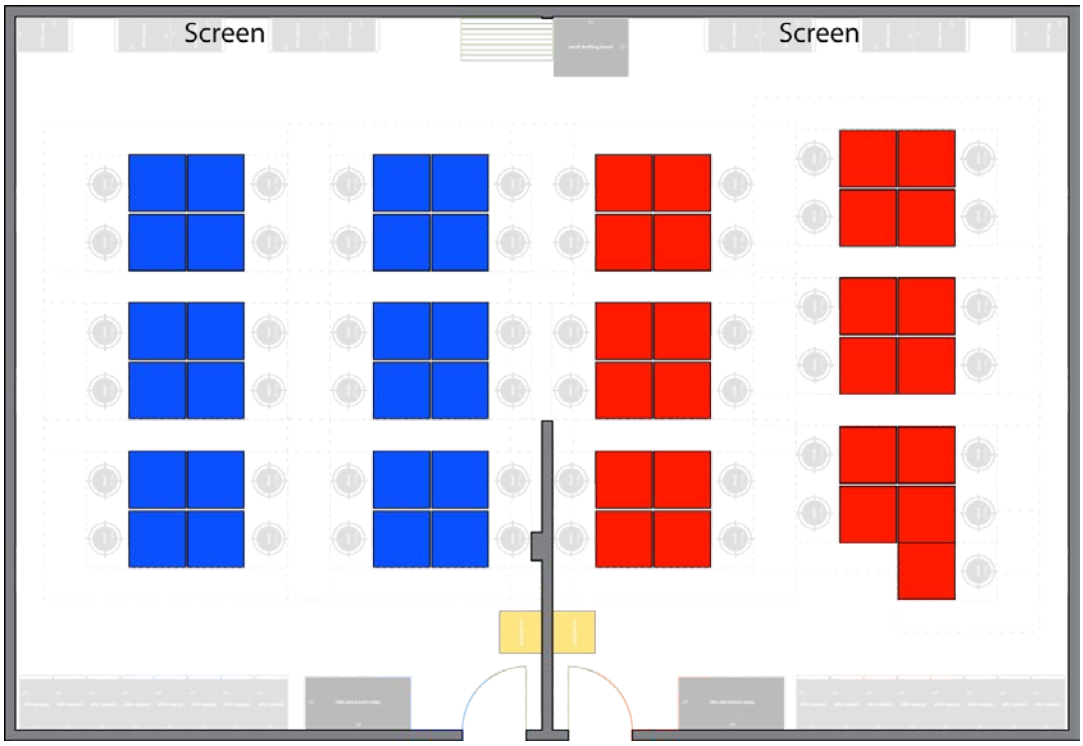

Figure 9. Diagram of color paper positioning during tests one and two

Test four used the findings from test three to continue the experience process. This test took place two days after the observations were recorded. During test four students' creativity was tested by means of ideation; same as test two. The students all had their observations ready from test three and were handed another 11x17 piece of paper with the same format as the sheets passed out during test two. For this circumstance the categories provided for the students were specific to the process they witnessed. The three categories were tent fly, tent poles, and stakes.
The students were instructed to create as many products/solutions for their observations as they could in fifteen minutes. They were alerted at ten minutes, five minutes and two minutes as to how much time remained.

If the students used up all four spaces provided then they could flip the paper over to continue or ask for another sheet of 11x17. Sketches were preferred, but if the students were not capable of converting their thoughts to images than they could write out a description instead. As in test two the students were not limited to creating solutions for things only in the three categories provided. And all for the better if their ideations created an "outside of the box idea".

2.3. Findings

The following is all the data collected from this primary research. Because the outcomes are more easily understood the data for both the observation tests (tests one and three) are grouped together as is the data from the ideation sessions

(tests two and four). The concluding evidence is more definitive when portrayed in this manner as opposed to explaining the results to the tests in the chronological order the tests were administered.

2.3.1. Observations Data

There was a healthy amount of data collected from the four tests with the students from the second year studio. Tests one and three were structured identically and responses from students were measured quantitatively. The total number of observations from both tests combined for all students involved was 1445. Test three had more than twice the amount of observations than that of test one, but the video length in test three was also more than twice as long as that of test one. In the end the students with red paper covering their desks had a higher average of 17.1 observations per student compared to the 16.1 observations for students working with blue paper covering their desks.

2.3.1.1. Observation Test One Data

The classroom was broken into two sides one with red paper covering the desks and the other with blue paper covering the desks. Both sides of the room together recorded 391 observations. The video length during test one came to a total of 217 seconds. The red side came up with a total of 162 observations with an

average of 8.1 observations per student. The blue side totaled 229 with an average of 10.4 observations per student. The captured process was three minutes and thirty seven seconds in length. The video was shown twice which came out to a total of 434 seconds. Factoring in this time, each observation on the red side of the room took an average of 2.67 seconds and on the blue side, an average of 1.89 seconds. The blue side of the room side, for this test outperformed the students working on the red covered desks, both in the amount of observations and the speed at which they were recorded.

2.3.1.2. Observation Test Two Data

Test three had slightly different returns. Overall there were 1054 observations taken from the two sides of the room. The watch time for the tent construction process finished at ten minutes, fifty one seconds. The students viewed the process video twice during their note taking in test three. Out of the 1302 total seconds of video just short of half were recorded by students on the blue side of the room. Each student averaged 21.8 observations. All 481 were recorded at a rate of 2.71 seconds per observation. The side of the classroom covered in red for test three wrote down 573 total observations. Each student averaged 24.9. The progress was faster here as each observation only took 2.27 seconds to record; nearly a half second quicker than the students hunched over the color blue.

2.3.1.3. Observations Totality

The previous data would suggest that the outcome for the observations tests is inconclusive. Together, from round one and round two the students watched 14 minutes and 28 seconds of video footage. The summation of recorded observations for notes taken while red paper was covering the desk of the student writing was 735. This number is 25 observations greater than the amount of notes taken while a student was seated at a desk covered with blue paper. There were 1736 seconds of video to watch factoring in the double viewings for each process video. Each blue observation took 2.45 seconds to record while every red observation was written in only 2.36 seconds. In both quantity and rate of notation the red paper proved to be a more productive stimulus than the blue in terms of observational note taking.

	Video Length x 2		Red Observations			Blue Observations		
	Minutes	Seconds	Total	Average per Person	Seconds per Observation	Total	Average per Person	Seconds per Observation
Round 1	7:14	162	162	8.1	2.67	229	10.4	1.89
Round 2	21:42	1302	573	24.9	2.27	481	21.8	2.71
Total	28:56	1736	735	17.1	2.36	710	16.1	2.45

Table 5. Observations findings

2.3.2. Ideations Data

The findings for the ideation tests cannot be summarized as easily as the tests for the observations. This study chose the subject group for a specific purpose. The 2nd year students in the Industrial Design major are still at an elementary level understanding of the processes performed at a professional level. This is not a negative and is, indeed, necessary for the purposes of the tests in this study. More information can be read in the literature review from chapter one describing the design process. What this basic understanding of how each student expresses the ideas he or she develops from the observations recorded accomplishes is the creation of raw, uncorrupted evidence for the effect of color on creativity.

The ideation data from tests two and four could not be scored by simply averaging the quantity of ideas developed for the red and blue stimuli as in tests one and three. For the purpose of judging tests three and four the pilot edition (which was still under development) of the experiment "What could it be?" prepared by Torrance and Phillips from the Department of Educational Psychology at the University of Georgia in 1970 was referenced. Their own scoring guide was adapted from Elizabeth Starkweather's Originality Test dated 1965.

Starkweather's scoring was again altered to incorporate the changes necessary to properly score the responses to the tests given to the Industrial Design students in tests three and four of this study. Each participant's ideas were judged on the following scale:

A. One point awarded for every idea not duplicated in different words
B. One point awarded for sketching an idea
C. One point awarded for an idea not defined by the pre-determined categories listed on the answer sheet
D. One point awarded for an original idea no one else in the study had developed.

For example, in category A if a student came up with an idea during test four showing or explaining the steps to set up a tent attached to the side of the tent, but also an answer that explained the need for an instruction booklet to be packed with the tent separately than that student received only one point as the ideas are essentially the same solution to the problem of no instructions. Some students did not sketch all of their ideas, an essential part of an Industrial designer defending his solution to a defined problem. The students who failed to sketch did not receive credit when scored in category B. Three pre-determined categories were presented to the students listed on the pages handed out before each ideation session. If a student's answer was outside of one of these three groups than they were awarded one point during the scoring in category C. Finally, if an individual reached further from the realm of recognizable answers for solutions to the problems found by the class and their idea was ultimately original (un-explored by anyone else in the test sample) than they were given a point during the scoring in category D. It should be made aware that points were seldom handed out in category D.

2.3.2.1. Ideation Session One Findings

The ideas recorded by each participant in test two were contingent on the observations taken during test one. During test one the students were asked to take notes to the degree of detail that would allow them to explain to someone who had not witnessed the video exactly what occurred. Each participant used their notes to recall problems the subject in the video had while working through the process of deconstructing a bicycle. Solutions were then developed to deal with the witnessed inconsistencies. Two sets of data were listed for interpreting the ideas created into the level of creativity engaged. The students working on red paper covered desks in test two developed 76 ideas altogether at a rate of 3.62 ideas per student. With the above scoring method each participant earned 5.33 points giving the color red a total score of 112 points. For the students working at desks covered in blue paper there were a total of 90 ideas, 4.09 per student. The blue stimulus earned 33 points more than the red coming in at 145 total. Each student scored an average of 6.59 points, that's more than one point higher per student than those working with the color red as a stimulus.

2.3.2.2. Ideation Session Two Findings

In test four students were asked to come up with solutions to the problems they witnessed in the video during test three. Their notes were the only thing they

were permitted to reference while trying to recall troubling incidents the subject had while constructing a tent. It should be recalled that the video length from test three was greater than that of test one and therefore the response level in test four should be higher (quantitatively) than in test two. In the allotted 15 minutes for ideation the students working with the color red as an external stimulus developed 151 solutions. Each student averaged 6.56 ideas. With Torrance's adapted scoring procedure the red stimulus earned 310 points total. Students creating solutions with blue as a stimulus generated 153 ideas. Just two ideas more may appear too small a margin to be used as an appropriate statistic for determining the color blue as more creative external stimulus, but it must be taken into account that for test four, on the blue half of the studio, there were three less students present when the test was administered. Each of these twenty students averaged 7.65 ideas; greater than one solution more than the students on the other half of the room. The total score for students on the blue side of the room was 284 points. Slightly less than the red, but the blue stimulus averaged 14.2 points per students; nearly an entire point more per student than that of the color red.

2.3.2.3. Ideations Finality

Forty six students were asked to take part in the ideation tests. Not every student was present during both test dates which makes it more impressive that the end results show the color blue as an external stimulus to be more conducive of

creativity. During tests two and four there were a total of 44 students in the studio working with red as a stimulus. Each of these students averaged 5.16 ideas and generated 227 altogether. The red stimulus scored 422 points total at an average of 9.59 points per student. The blue stimulus had a slightly smaller number of test subjects at 42, but still managed to create more ideas and earn a higher score. There were 243 ideas developed at 5.76 concepts per student. The blue stimulus earned 429 points total at 10.21 points per student. Even with fewer participants the color blue created more ideas and gained a higher score.

	Red					Blue				
	Number of Students	Ideas Developed	Points Earned	Points per Student	Ideas per Student	Number of Students	Ideas Developed	Points Earned	Points per Student	Ideas per Student
Round 1	21	76	112	5.33	3.62	22	90	145	6.59	4.09
Round 2	23	151	310	13.48	6.56	20	153	284	14.2	7.65
Total	44	227	422	9.59	5.16	42	243	429	10.21	5.79

Table 6. Ideations findings

2.4. Primary Research Survey

A survey was conducted at the end of the four tests to determine the participants' feelings on their experience during the study. The results were not as conclusive as the quantitative data gathered throughout the experiment.

Over all, the students in the study who had the color blue as a stimulus for the first two tests and the color red as a stimulus for the second set of tests believed that red had increased their creativity greater than blue. Reciprocally, those students whom were tested throughout the first half of the study with red as a stimulus and with blue for tests three and four were more biased to say blue was the more creatively generative color.

2.5. Primary Research Conclusion

The survey could be understood to state that the color the students had just been exposed to stood out more prominently in their minds to helping develop more creative solutions to the observed problems from the videos they witnessed. Though the survey presented data of a less scientific nature, humanities feelings and emotions must be emphatically considered. What the survey states that the empirical data can be understood to support is that individuals, and most specifically (in terms of this study) in the design field, have a disposition to generate more create thoughts when the color in their immediate surrounding changes. It can be stated that color, as an external stimulus, could increase creativity. Understanding how to apply this stimulus change to a greater variety of disciplines, even those that are not generally involved with creative activities, required further research into the emotionality and psychology of the workplace, as is described in chapter one.

When considered cumulatively the results of this study and the research gathered in chapter one can be considered linearly to point to several solutions as to the implementation of a change stimulus affecting creativity.

Chapter 3: Design Themes

The study conducted in chapter two highlighted the possibility that color change could be implemented as an external stimulus to positively affect creative thought. Chapter three focuses on the aspect of control that could be important for an individual in the workplace to manage a more creative immediate environment. In the book Out of Our Minds Ken Robinson describes the three features he feels are crucial to the process of creativity. "The importance of finding the right medium for your own creative strengths, the necessity of being able to control the medium, and the need for freedom to experiment and take risks" (Robinson, 2001).

3.1. Color and Emotion

While the basic purpose of human color vision is to discriminate objects, at a more elaborate level this sensory capacity is used to attribute salience and meaning to chromatic stimuli. A prime example is that individuals not only show specific color preferences but also attribute emotional characteristics to colors in consistent ways from school age on (Zentner, 2001).

Although the study Preferences for colors and color-emotion combinations in early childhood was performed in a culture different from that of America, (the cultural preferences of individuals' color perceptions this research paper accepts as a benchmark), it highlights the fact that humans indeed have color-emotion associations throughout life, even at a very young age. More importantly, they continue to do so. The only differences between the results of the study conducted with the children and the study on participants of adult age was the choice of red for anger (in adults) that was not existent in children and black (rather than blue in children) is associated with sadness (Zentner, 2001).Children only saw red as a bright color that affected them positively. This implies that, throughout life, the cultural prejudices of color become more ingrained in the human psyche.Black is accepted as the color of mourning in some countries, however it symbolizes wedding in some others (Linton, 1991). This research paper focuses on color associations as they are perceived by Americans in Western culture.

Kaya and Epps findings support the "Modern American Color Associations" put-forth by Birren more than 40 years before their study was performed. Also, the necessity to categorize colors in terms of having a positive or negative effect on the participants' emotions, and the fact that the results show most of the principle hues influencing emotions positively gives favorable support for the use of color as an external stimulus.

3.1.1. Matching Color and Emotion

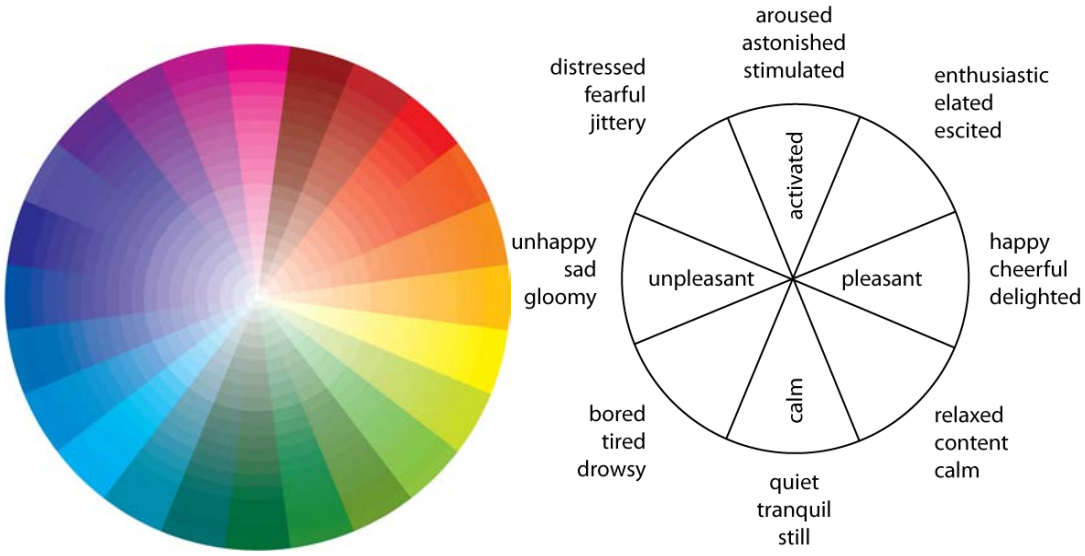

Figure 10. Color wheel

Figure 1. The Affect Circumplex Model (Lord, Klimoski & Kanfer, 2002)

By means of the work done on color-emotion association as support a connection may be drawn between psychologists' views of the affect circumplex model (Lord, 2002) illustrated in the Emotional Facts section of the literature review of this research paper and the Modern American Color Associations (Birren, 1961) table developed by Faber Birren.

Modern American Color Associations

Color	General Appearance	Mental Associations	Direct Associations	Objective Impressions	Subjective Impressions
Red	Brilliant, intense, opaque, dry	Hot, fire, heat, blood	Danger, Christmas, Fourth of July, Valentine's Day, Mother's Day, flag	Passionate, exciting, fervid, active	Intensity, rage,rapacity, fierceness
Orange	Bright, luminous, glowing	Warm, metallic, autumnal	Halloween, Thanksgiving	Jovial, lively, energetic, forceful	Hilarity, exuberance, satiety
Yellow	Sunny, incandescent, radiant	Sunlight	Caution	Cheerful, inspiring, vital, celestial	High spirit, health
Green	Clear, moist	Cool, nature, water	Clear, St. Patrick's Day	Quieting, refreshing, peaceful, nascent	Ghastliness, disease, terror, guilt
Blue	Transparent, wet	Cold, sky, water, ice	Service, flag	Subduing, melancholy, contemplative, sober	Gloom, fearfulness, furtiveness
Purple	Deep, soft, atmospheric	Cool, mist, darkness, shadow	Mourning, Easter	Dignified, pompous, mournful, mystic	Lonliness, desperation
White	Spatial- light	Cool, snow	Cleanliness, Mother's Day, flag	Pure, clean, frank, youthful	Brightness of spirit, normality
Black	Spatial- darkness	Neutral, night, emptiness	Mourning	Funeral, ominous, deadly, depressing	Negation of spirit, death

Table 1. Modern American Color Associations (Birren, 1961)

The Munsell color wheel, created by Professor Albert Munsell in the first decade of the 20th century, lines up almost intentionally with the affect circumplex model to display complementary colors at opposite poles of the valences on the circle. Red is a high activation color whereas green and blue are calming, quiet, inactivated. Yellow is associated with cheerfulness while its compliment, purple, is gloomy and mournful.

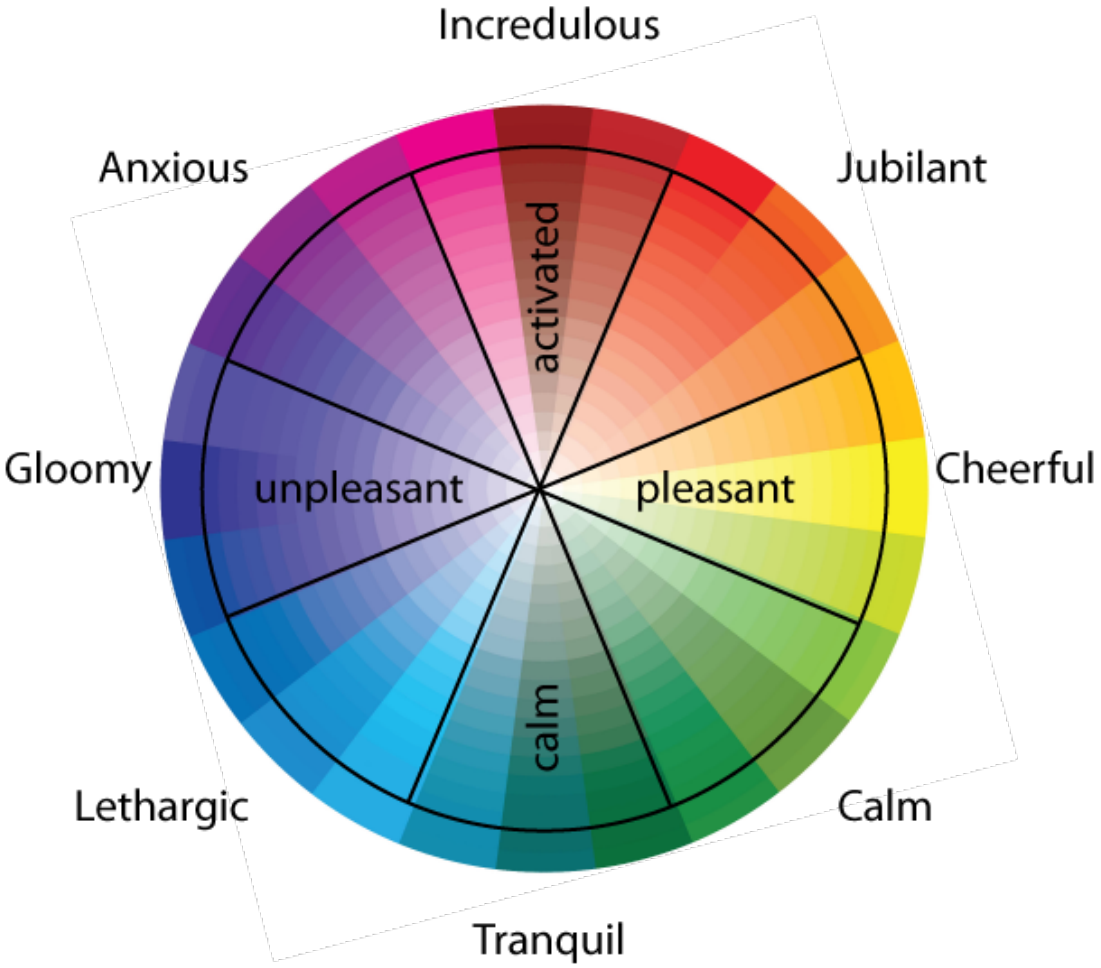

Figure 11. Color stimulus changing workstation affect circumplex color wheel

3.1.2. Equilibrium

According to Babbitt, “Substances combine in a harmonizing union with those substances whose colors form a chemical affinity with their own and thus keep up that law of equilibrium which is the safety of all things. If the red arterial blood should become overactive and inflammatory, blue light or some other blue substance

must be the harmonizing principle, while again, if the yellow and to some extent the red and orange principle of the nerves should become unduly excited, the violet and also the blue and indigo would be the soothing principles to have applied" (Birren, 1961).

3.1.2.1. Affect Circumplex Model

Emotion concepts are proposed to be organized according to a circular structure, a "circumplex", in a two-dimensional space of pleasure-displeasure and degree of arousal. Affect terms are arranged along the circumference of a circle with similarity of meaning between two terms represented by how far apart the terms are along the circle's edge. The location of any term can be determined using two dimensions at right angles to each other, and the meaning of those dimensions will be generated by the particular affect terms that fall at the dimension's poles (Lord & Klimoski & Kanfer, 2002).

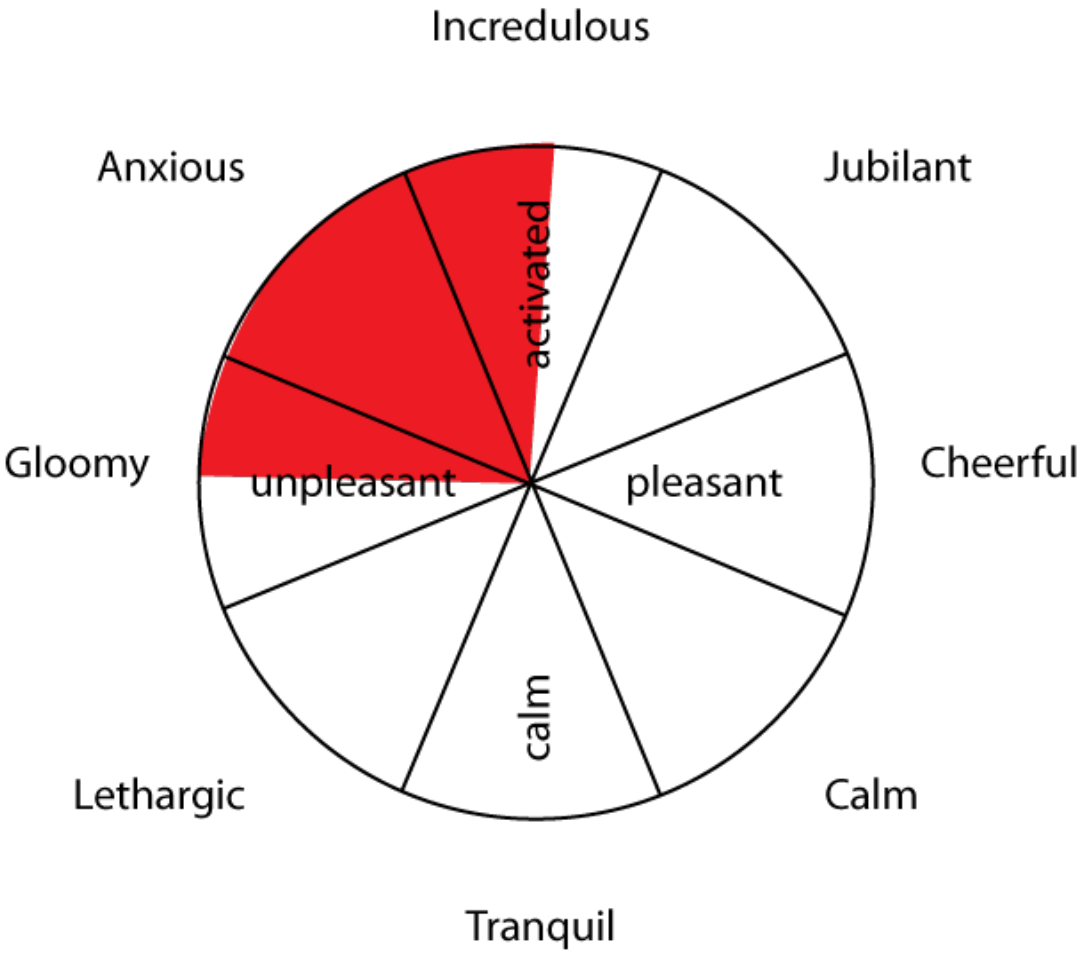

Figure 12. Affect circumplex model description of use part one

An activated, unpleasant external event would leave a subject anxious. The degree of activation or pleasantness determines the emotional response to a stimulus.

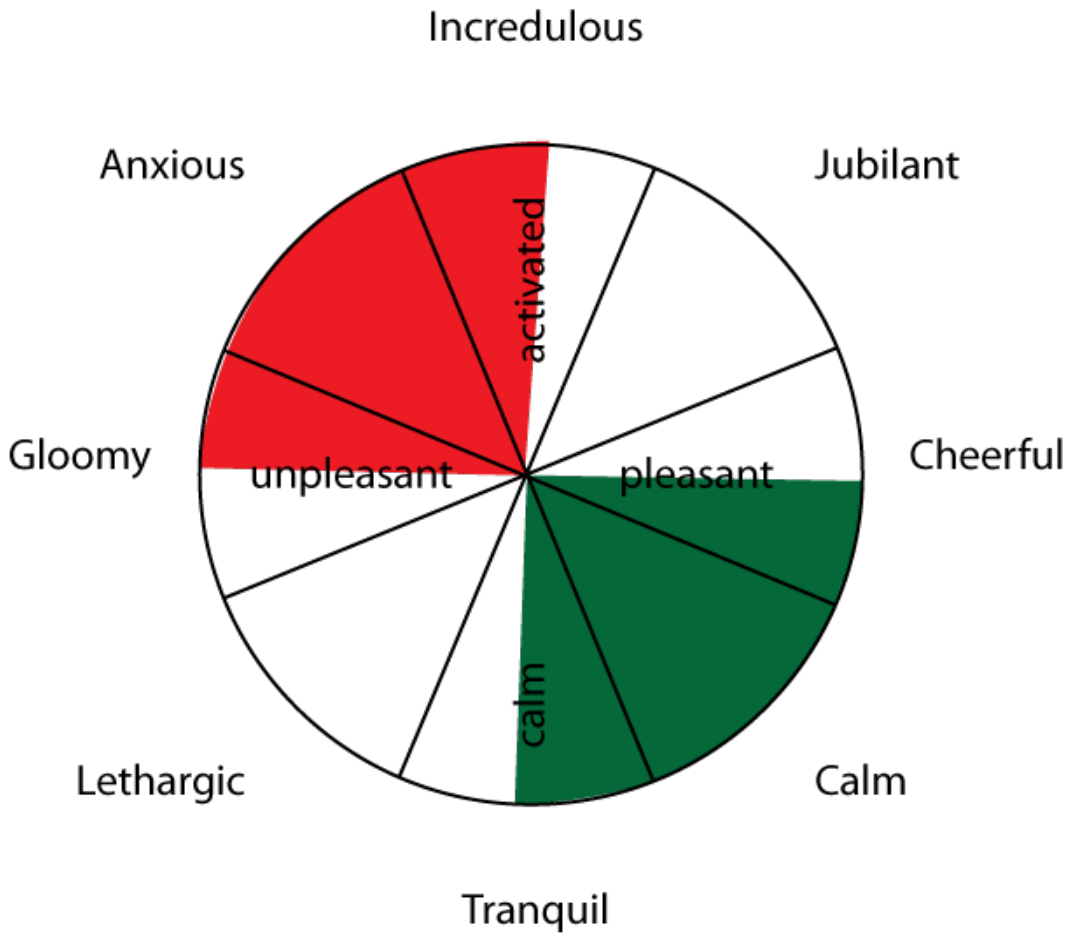

Figure 13. Affect circumplex model description of use part two

The reciprocal emotion that would be needed to balance whatever mood had been created by the external stimulus is located at the polar opposite of the circumplex circle. Although the duel dimensionality pairing of pleasant and calm may seem to be the desired pinnacle of emotion in any situation it is possible for an individual to become too calm or tranquil, especially at moments when a higher level of energy would be prudent.

3.1.2.2. Controlling emotion with color

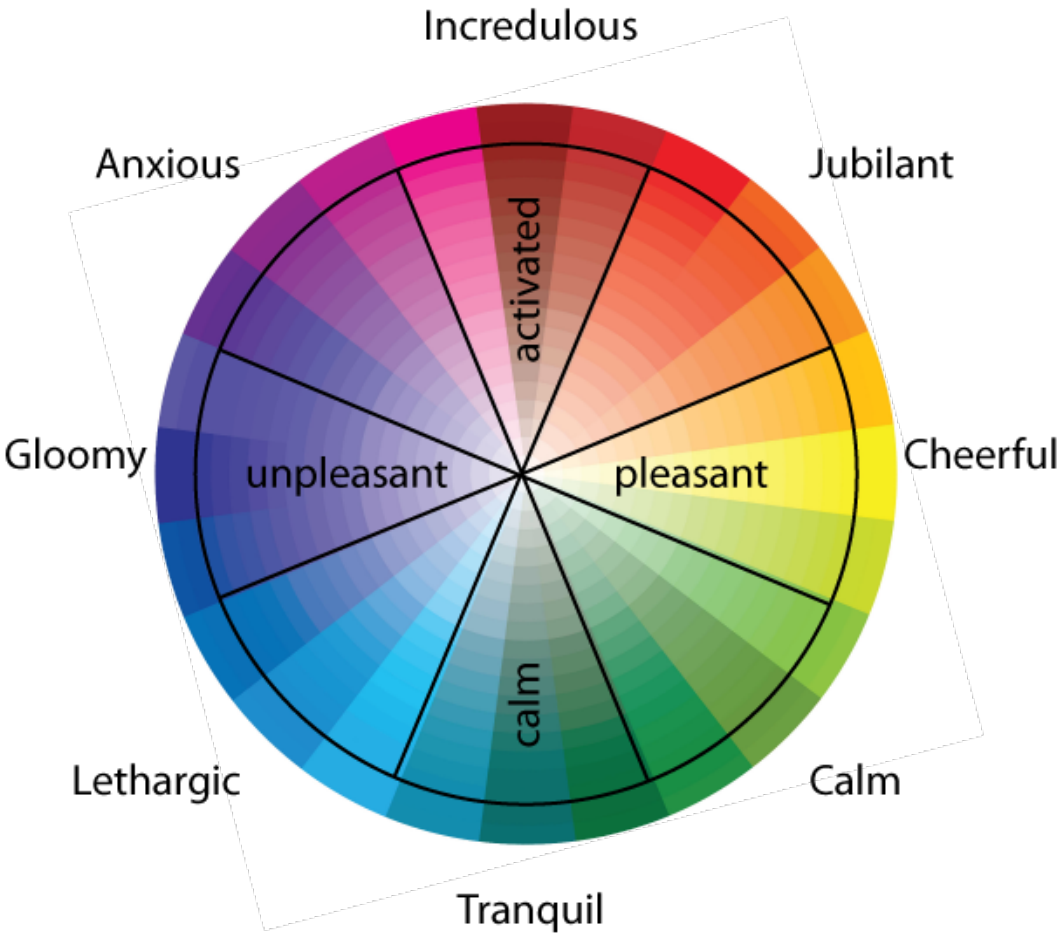

Figure 11. Color stimulus changing workstation affect circumplex color wheel

Colors complement one another and emotions have reciprocal moods. In terms of the workplace, productivity may be impeded if an individual is "feeling" a certain way. By combining the color associations defined by Birren with the affect circumplex model it may be possible to neutralize an emotion detrimental to an individual's ability to get work done by displaying the complementary color associated with the polar opposite emotion on the affect circumplex circle. The

following sub-chapter illustrates a full work day of two designers as their emotions are radically altered due to the events throughout the day.

3.2. A Day in the Life of a Designer

Two individuals currently working in the field of design volunteered to keep a journal for a day. They were asked to record every action that occurred that day, both before during and after work; the time it occurred, the emotion felt during the action and the reason it occurred. The following graphs illustrate the wide spectrum of emotions someone is capable of feeling throughout the work day as they are confronted with deadlines, a boss, or work load.

The first designer works for the international design consultancy company Design Continuum at the Boston, Massachusetts headquarter office.
He works collaboratively with other designers to develop products and ideas. He opted to remain anonymous.

Day in the life
Anonymous
5/12/2010

Time	Action	Reason	Emotion
8:15 am	Wake up	Snoozed for about two hours	Anxious
9:12 am	Get to work	Meeting at 10	Anxious
9:15 am	Prototype quick models for meeting		Cheerful
9:20 am	Found a nice note from boss	Shitty day yesterday	Jubilant
10:00 am	Draw/Doodle	Need to come up with the future	Cheerful
10:10 am	Head to meeting	Walking into project room	Anxious
11:00 am	All left meeting, Still here	Everyone is coming back soon	Gloomy
11:15 am	Start talking again	Everyone got back	Calm
12:15 pm	Printing my portfolio	Have interview at 1pm	Anxious
12:30 pm	Grab lunch	Hungry	Gloomy
12:40 pm	Stuffing pizza in my face	Hungry and don't have a lot of time	Anxious
12:55 pm	Get to coffee shop	That's where the interview is	Calm
1:08 pm	Drinking coffee	Supposed to talk at 1	Gloomy
1:10 pm	Call secretary that set it up	Wondering if there was a time mix up	Incredulous
1:15 pm	She shows. We talk	Trying to get a job	Tranquil
2:08 pm	Head back to work	Have to finish out the day	Gloomy
2:30 pm	Start drawing for the rest of the afternoon	Money, and i like my job	Anxious
5:00 pm	People start leaving for the bar, I stay until 6:30	5pm Friday	Lethargic
6:30 pm	Wait around for project manager	She said we should chat before we leave	Lethargic
7:00 pm	Leave for the bar		Calm
7:30 pm	Leave bar	Dinner with a friend	Cheerful
9:00 pm	Leave dinner with friend	He has a long run in the morning	Calm
9:30 pm	Meet back up with people from work	They are right near my house	Cheerful
1:30 am	Leave bar		Jubilant

Table 7. Day in the life activity sheet, participant one

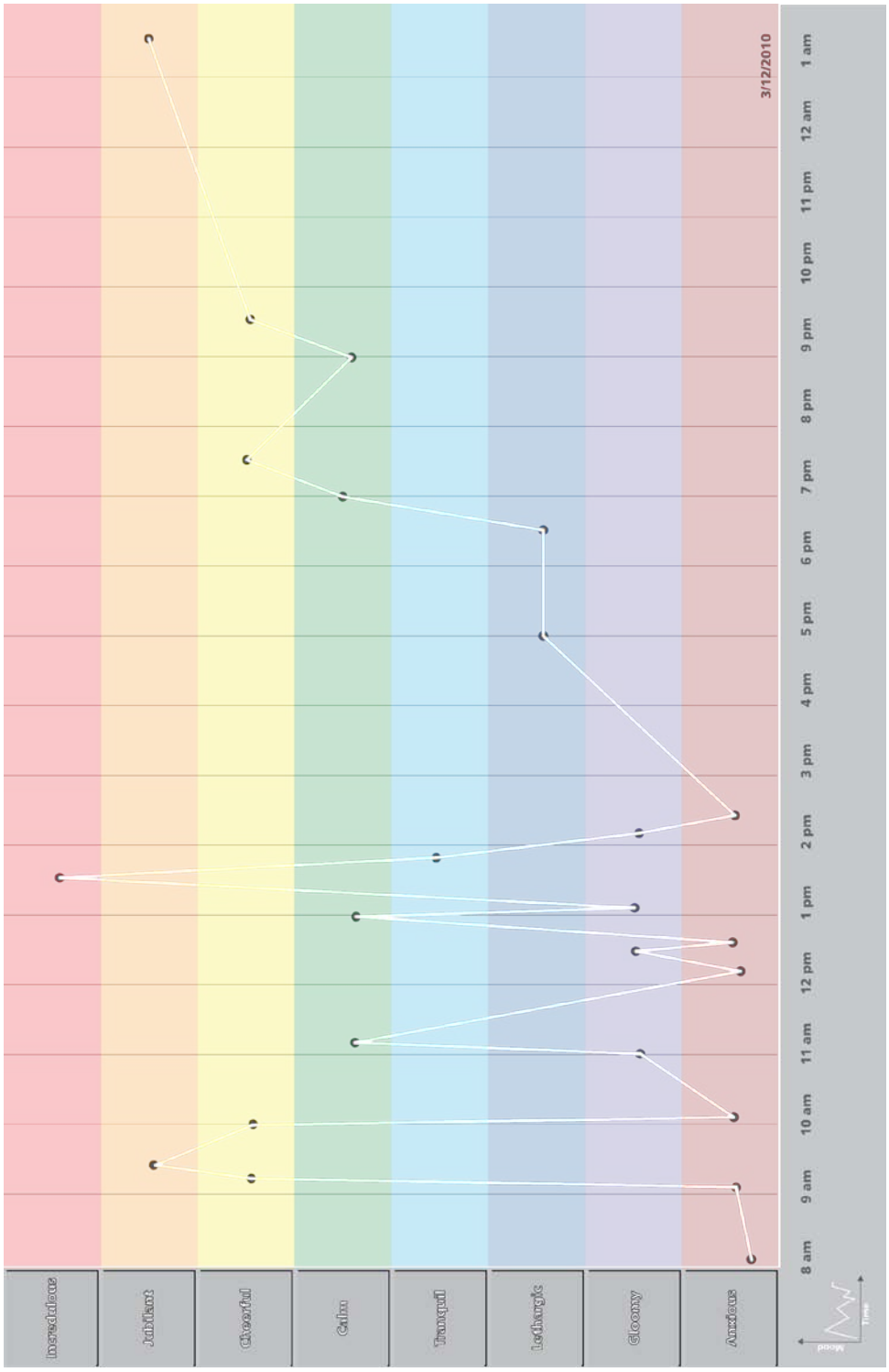

Figure 14. Day in the life emotion graph, participant one

The second volunteer works for Body Glove International, LLC. She is a technical designer in charge of overseeing and maintaining wetsuit repairs, shipments and future apparel catalogs. At any given time during the day her entire office could be covered with material from wetsuits, shirts or hats, etc. Body Glove's warehouse is onsite which is convenient in case she has to compare a sample or run an errand for her boss.

Day in the life
Tara Hammond
3/10/2010

Time	Action	Reason	Emotion
6:05 am	Wake up	Make a smoothie and pack lunch	Calm
6:20 am	Change for work	Jeans and a T-shirt	Calm
6:45 am	Breakfast with my husband	He makes breakfast every morning	Cheerful
7:05 am	Commute 21 miles to work	Equivalent of 70 miles in any other city	Gloomy
7:42 am	Get to work	Change last name on voice mail	Calm
7:48 am	Clock in	to comply with customs in order to get shipments direct to warehouse	Incredulous
7:50 am	Turn on Computer and radio	Set up for the day	Calm
8:00 am	Check emails, forums, blogs, chat with co-workers		Tranquil
8:50 am	Work on Spring 2011 material spec sheet,. Update the line by style, prototype order sheet, note changes for Spring 2011 season	Material specs require a lot of cross referencing. and every individual style I work on needs to be updated	Anxious
9:30 am	Give 9 complete tech packs to my boss	He has 25 yrs XP. He checks it all.	Anxious
10:00 am	Run out to office to reference material specs	Make sure that my specifications are right	Cheerful
10:30 am	9 more tech packs to the boss	1 pack left, but its a brand new style	Anxious
11:00 am	Go over e-mails, call boss, run to art department	Need to answer questions from the warehouse and get samples from the art department	Gloomy
11:45 am	Grab sandwich and drive to The Cotton Shop	Early lunch and need material for project I'm working on	Cheerful

Time	Action	Reason	Emotion
12:45 pm	Get back from lunch	Continue working on final mat'l specs	Calm
1:00 pm	Review Spring 2011 prototype order	There is a color/material conflict	Anxious
1:30 pm	Double check purchase orderfrom Production Deparment	Find mistakes that could really throw off our sample order	Incredulous
1:45 pm	Drink coffee, chat with boss	Need an afternoon spike.	Cheerful
1:50 pm	Run to check the repair rack in the warehouse	Do a final inspection with 4 wetsuits that came back from JMJ	Anxious
2:00 pm	Call JMJ, the repair shop	All repairs are outsourced to a local shop	Calm
2:05 pm	Social network a little	getting texts from friends is like a treat	Cheerful
2:15 pm	Make a mock up pattern piece	need to send it to the factory	Calm
2:30 pm	Work on material specs	They are right near my house	Gloomy
2:40 pm	Go down to warehouse	Boss needs a sheet of neoprene	Calm
3:00 pm	Finish research on one particular style	Boss tells me to wait and email factory	Incredulous
3:30 pm	Compare lab dips inside and outside	Received lab dips	Cheerful
3:45 pm	Water break. More e-mails		Calm
4:00 pm	Focus is diminishing	One hour to go	Lethargic
4:15 pm	Will work on spec sheets in the AM	Art department gave me a stack	Lethargic
4:30 pm	Research competition online	companies have similar dive suits	Calm
4:40 pm	Organize for tomorrow	Day is winding down	Calm
5:00 pm	Commute home	Finally out of there	Cheerful
6:00 pm	Home at last		Jubilant
6:30 pm	Write a post on my sewing blog, snack	Hanging out with Alex	Cheerful
7:45 pm	Leave for Pilates class	Pilates at 8:00	Calm
8:00 pm	Pilates		Cheerful
9:00 pm	Go home and relax	Its time for bed	Tranquil

Table 8. Day in the life activity sheet, participant two

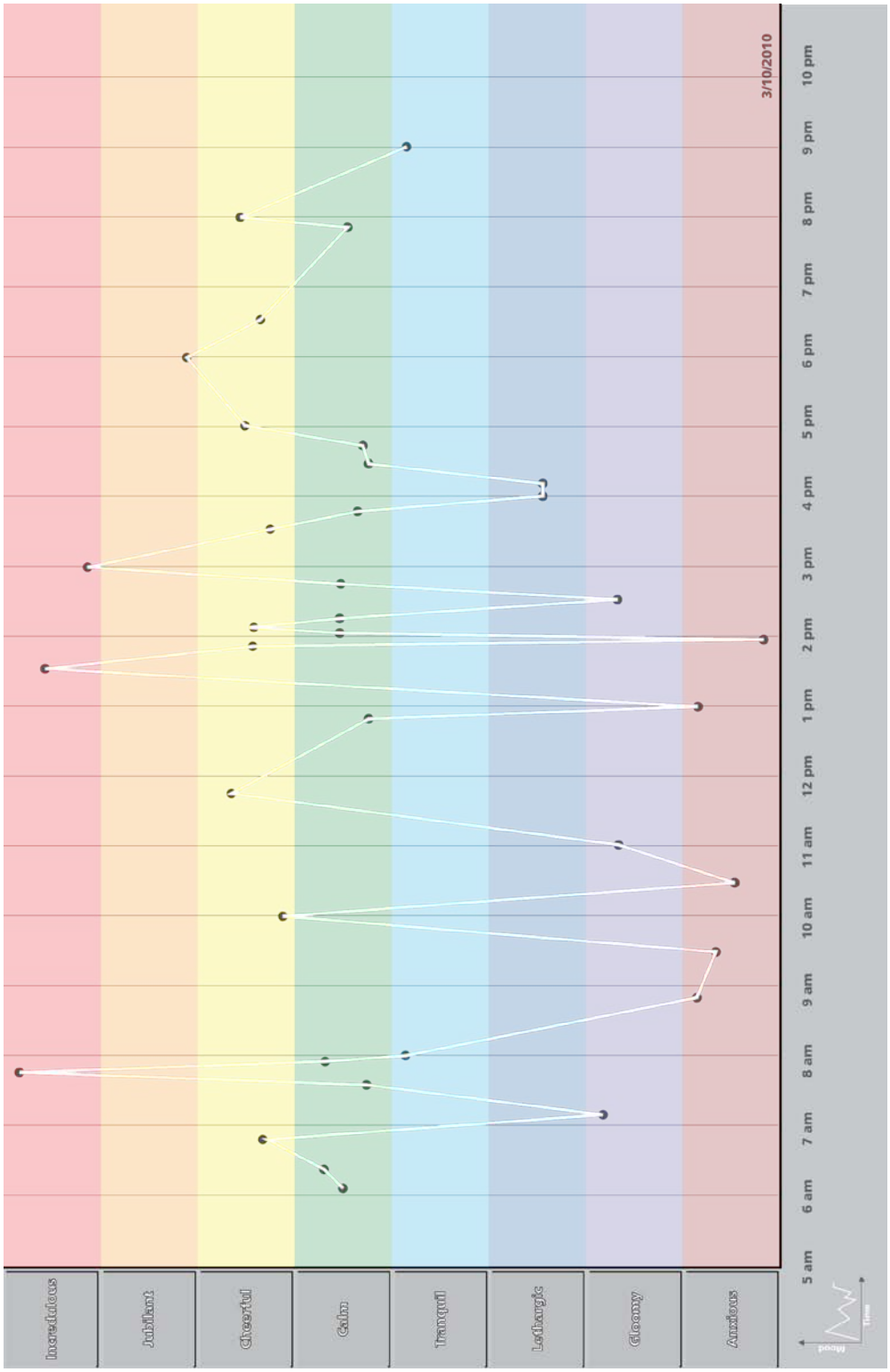

Figure 15. Day in the life emotion graph, participant two

3.3. Conclusion

The colors on the graphs represent the emotions each designer suddenly had to cope with in response to the events throughout the day. While it would seem that the pinnacle of activated arousal should be a positive, happy mood levels of extreme heightened arousal are more expressive of anger or incredulity. Reciprocally, one would assume that the lowest emotion a worker would be capable of reaching should be one of sadness or depression, but this is incorrect also as stress can be as detrimental if not more so than gloom (Birren, 1961). Achieving an extended, equalized, emotional level of calm appears to be difficult for the two designers portrayed here. Yet, wouldn't this be the optimal situation for a worker especially in terms of productivity and the allowance of creativity? It is a matter of concentration, a rare ability in Western culture and, according to Harold Anderson, one of the conditions of creativity. Americans engage in a task, but still manage to only think of the next thing; the moment when the current task can be finished to start the next. Another condition Anderson outlines is the ability to accept conflict and tension resulting from polarity. To be aware of these conflicts, to experience them deeply, to accept them not just intellectually but in feeling, is one of the conditions of creativity (Anderson, 1957). A calm state of mind and the feeling of conflict can both be realized through control of emotion; something, thus far, that seems elusive to the designers mentioned in chapter three.

Chapter 4: Existing Elements

Chapter three discussed aspects of control in the workplace and illustrated the lack of with two designers' days. Controlling emotions in the workplace and understanding how to counter specific moods is tackled in chapter five, the design portion of this research. Certain elements, which are discussed here in chapter four, already exist and are important to the work done in chapter five.

4.1. Workstation

While the focus of this research project is not directly focused on ergonomics, discussion of recreating the professional or educational workspace is not complete unless these issues are addressed. Ergonomics has become a word synonymous with the office and furniture manufacturers. Studying Ergonomics has become a concentration and big name companies like Steelcase spend big bucks determining how to fit the workspace to the worker instead of obliging the reverse.

4.1.1. Workspace Ergonomics

Anthropometric and ergonomic studies have been exhaustive in their attempts to understand and improve the individual worker's personal workspace. Ergonomics reduces the risk of injury by adapting the work to fit the person instead of forcing the person to adapt to the work. It is a tool which business owners and managers can use to help prevent injuries in the office and enhance work performance. The application of ergonomics in the workplace is a creative process and to be successful it may require all of the available expertise within a company.

WMSD's or work-related musculoskeletal disorders account for over 40% of workers compensation claims. These injuries result in medical and time loss costs of over 12 million dollars and are responsible for over 70,000 lost work days. (WSHA services division, 2002) WMSDs develop over time and the goals of a proactive program should be to prevent as many workers' compensation claims as possible.

The focus of ergonomics is always on designing for the individual employee, who brings unique characteristics with her or him to the job.

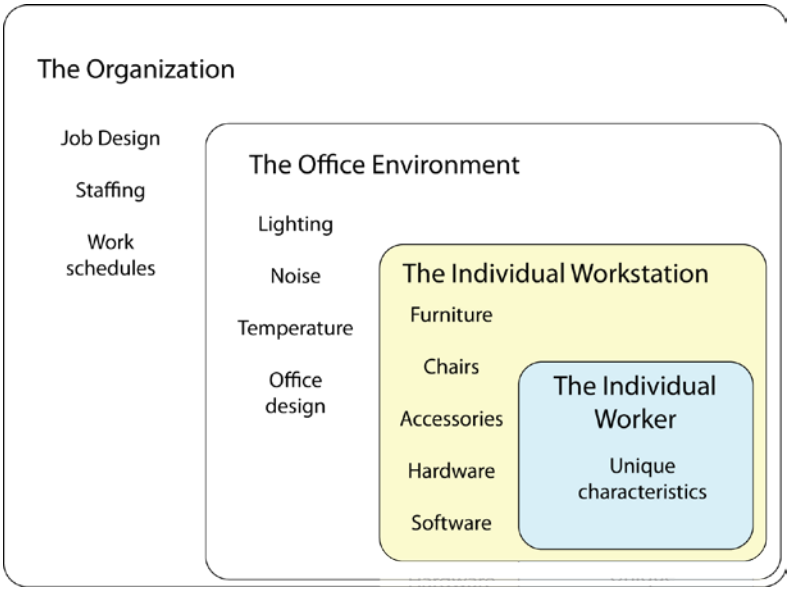

Figure 16. Workplace hierarchy diagram (WSHA services division, 2002)

4.1.2. Typical Furniture Measurements

Workstation analysis looks at the physical components of the workstation, such as monitor and keyboard location, work surfaces, and chair adjustments. Each of these components is measured relative to the individual worker. Making adjustments to the workspace is meant to create a neutral posture. Having an adjustable chair and appropriate sized work surfaces are examples of ways to prevent work-related injuries.

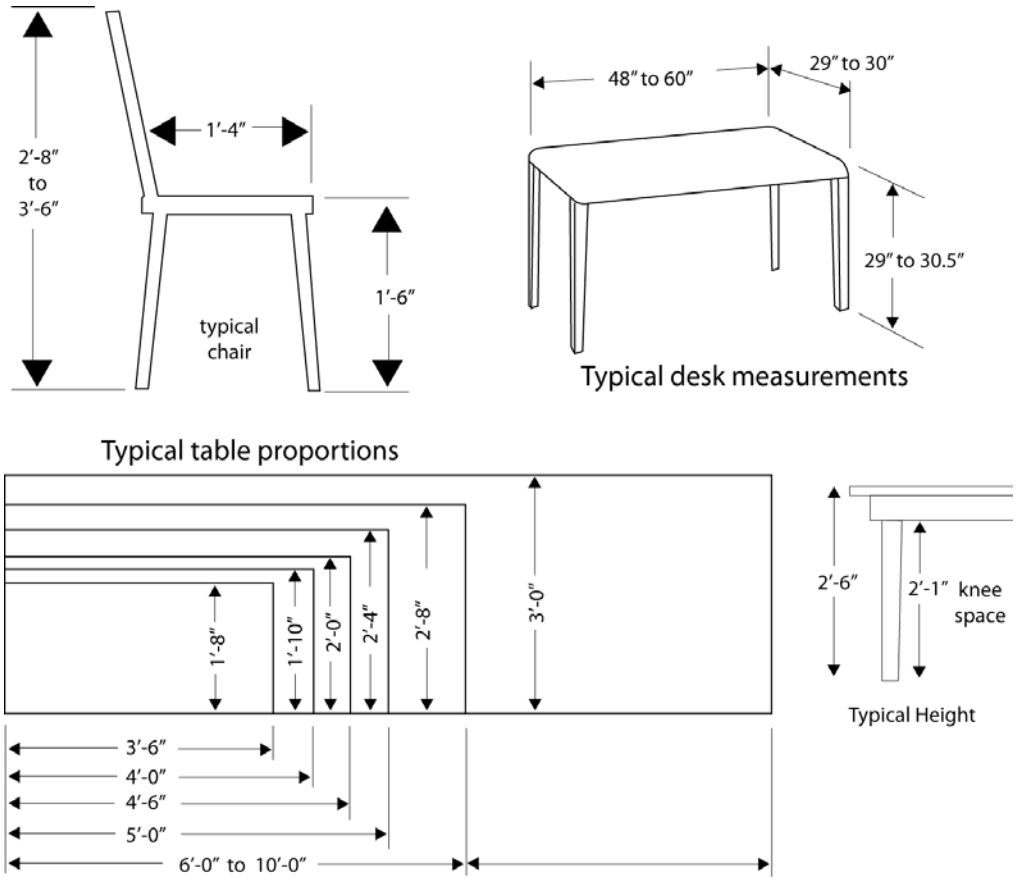

Figure 17. Typical table and desk measurements (Griggs, 2001)

4.2. Display System

In this modern day, technology continues to advance at a tremendous pace. Companies working to develop pioneering products hold tightly to their secrets. Competing companies understand the necessity of any small edge that keeps their stock growing and their profit margins high in the face of opposition. Apple recently launched the iPad tablet with a touch screen that utilizes OLED technology, the next step up from LCD displays. Samsung has begun utilizing the OLED display as

opposed to LCD screens in their television sets. Plasma screen Televisions were once the ultimate accessory to the living room. These were conquered by LCD technology which gave the ability for even thinner television sets and a sharper, crisper image that filled the whole screen all the way to the corners. Hard on LCD's heels and even more impressive is the OLED technology that requires no backlight and has a much clearer display than LCD.

Figure 18. Mitsubishi 155 inch OLED display screen (ubergizmo.com, 2009)

OLED were at one time limited in size and were mainly found on cellular phone displays and other small electronic devices. Recently, in 2009, Mitsubishi, found a way to create a massive display screen of 155 inches using OLED technology. There are two types of OLEDs, active and passive matrix.

4.2.1. PMOLED

A passive-matrix poly-LED display consists of an array of transparent conductive ITO (indium–tin oxide, on a sheet glass) columns onto which a thin layer of light-emitting polymer is spin-coated. The display is completed with a structured metal cathode, which forms the rows. The crossovers of rows and columns form the pixels of the display. In a passive-matrix poly-LED display each line of the picture is addressed sequentially and flashes brightly for a very short time. At the same time, all non-addressed pixels are kept at zero or reverse bias. By scanning the lines sufficiently fast (generating about 60 pictures per second), the eye integrates all the light flashes into a picture, and no flicker is observed as in a traditional CRT-based TV (Sempel & Buchel, 2002).

4.2.2. AMOLED

An active-matrix OLED (AMOLED) display consists of OLED pixels that have been deposited or integrated onto a thin film transistor (TFT) array to form a matrix of pixels that generate light upon electrical activation, which functions as a series of switches to control the current flowing to each of the pixels. Active-matrix

OLED displays provide higher refresh rate than their passive-matrix OLED counterparts, and they consume significantly less power. The amount of power the display consumes varies significantly depending on the color and brightness shown. (Wikipedia.org)

4.3. Conclusion

Using pre-existing research for the dimensions of workstations and the suggestions for workspace furniture proportions the creation of a new workspace can be developed in consistency with accepted professional benchmarks in these areas. Furthermore, the application of new technology could be a risk unless sufficient research describing the possibilities of this technology are cited and recognized. Chapter four describes the possibilities of existing OLED technology and illustrates the probability that technology of this caliber could improve in the future.

Chapter 5: Design Development-Novo Emotive Workstation

The embodiment of this research is not so much a product as it is an experience. Rob Culver states "that the most successful designs are the ones that elicit an emotional response. A potential user has an experience with the product… that will enhance the person's life in some way" (Hadar, 2003). Of course experiences can't truly be designed, but designers can give others the tools to create their own experiences. The elements from chapter four, workspace ergonomics and OLED display screens, become a conduit through which individuals would be able to utilize the information and discoveries discussed in the first three chapters of this research to create a work experience more conducive to creativity.

5.1 Sketches

In order to include all the elements necessary to give a worker the ingredients for creating his or her own, personalized experience at work that could generate creativity a desk or workstation would be developed. This prompted the question of how to imply creativity in a desk form.

5.1.1. Exploratory Sketches

For the first round of exploratory sketches a google image search was done for the words “abstract creativity”. The resulting images were then used as visual inspiration for quick thumbnail sketches of a desk with creative form. The following thumbnail sketches are representative of the multitude of quick studies drawn in an attempt to capture the essence of creativity in a physical form.

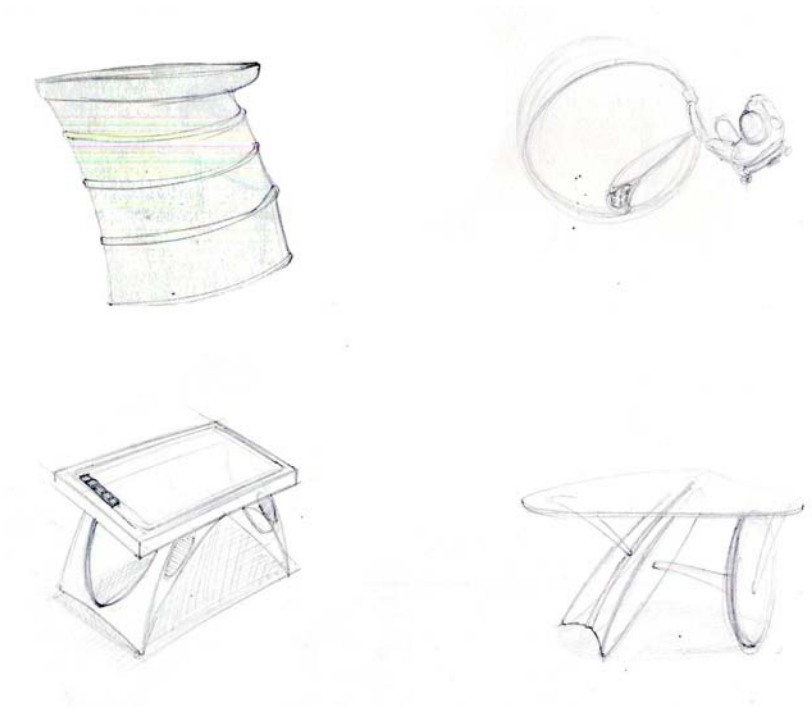

Figure 19. Thumbnail sketches 1

Figure 20. Thumbnail sketches 2

Figure 21. Thumbnail sketches 3

5.1.2. Table Edge Exploration

It became apparent after the initial exploratory thumbnail sketches that a desk with an entirely new form that could be associated with creativity was not the answer to expressing the target experience. The workers interaction with the desk is about more than the visual appeal of the form, it is about the interaction between the workstation and the user. With this new insight focus was directed towards the details of the desk. A quick study of the table top edges and corners was sketched.

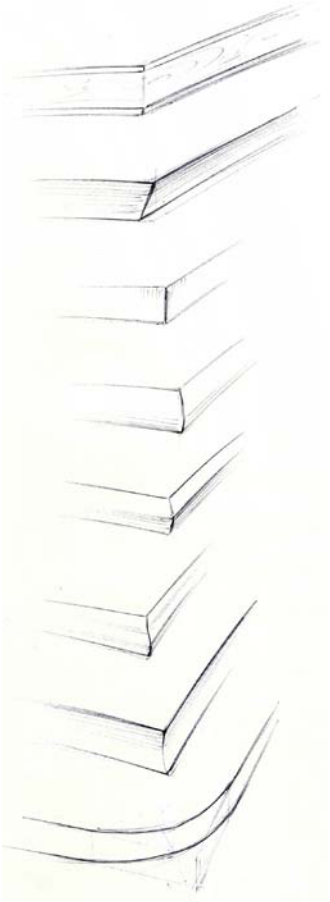

Figure 22. Table top corner/ edge study

5.1.3 Exploded View

An exploded view was drawn in an attempt to understand how the table would be constructed if it were to be height adjustable to allow for seated and standing tasks.

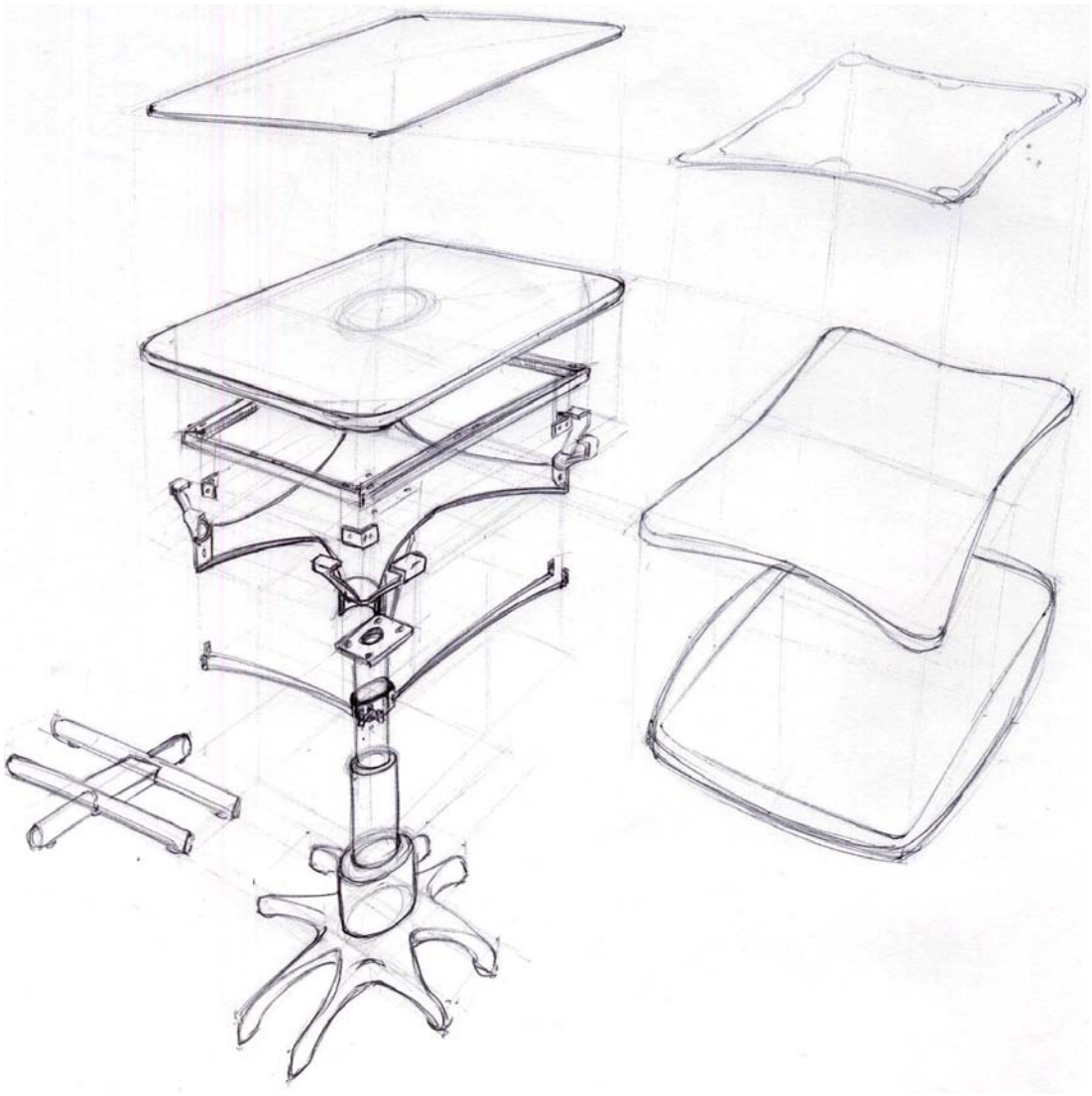

Figure 23. Exploded view

5.1.4. Interface Sketch Study

The next round of sketches explored the visual appearance of the interface that users would interact with to control their creativity level.

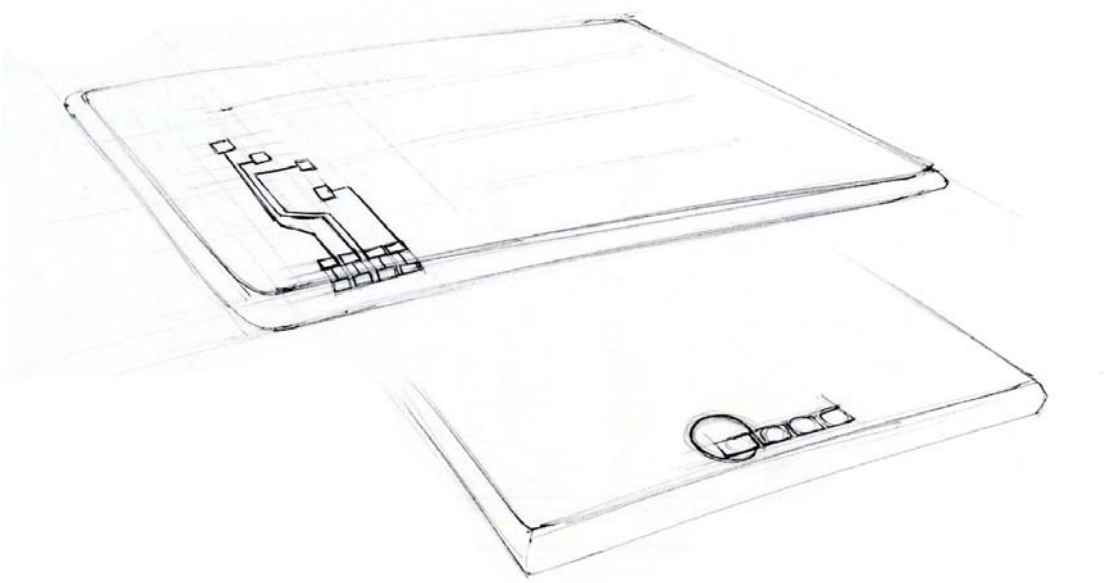

Figure 24. Interface sketches 1

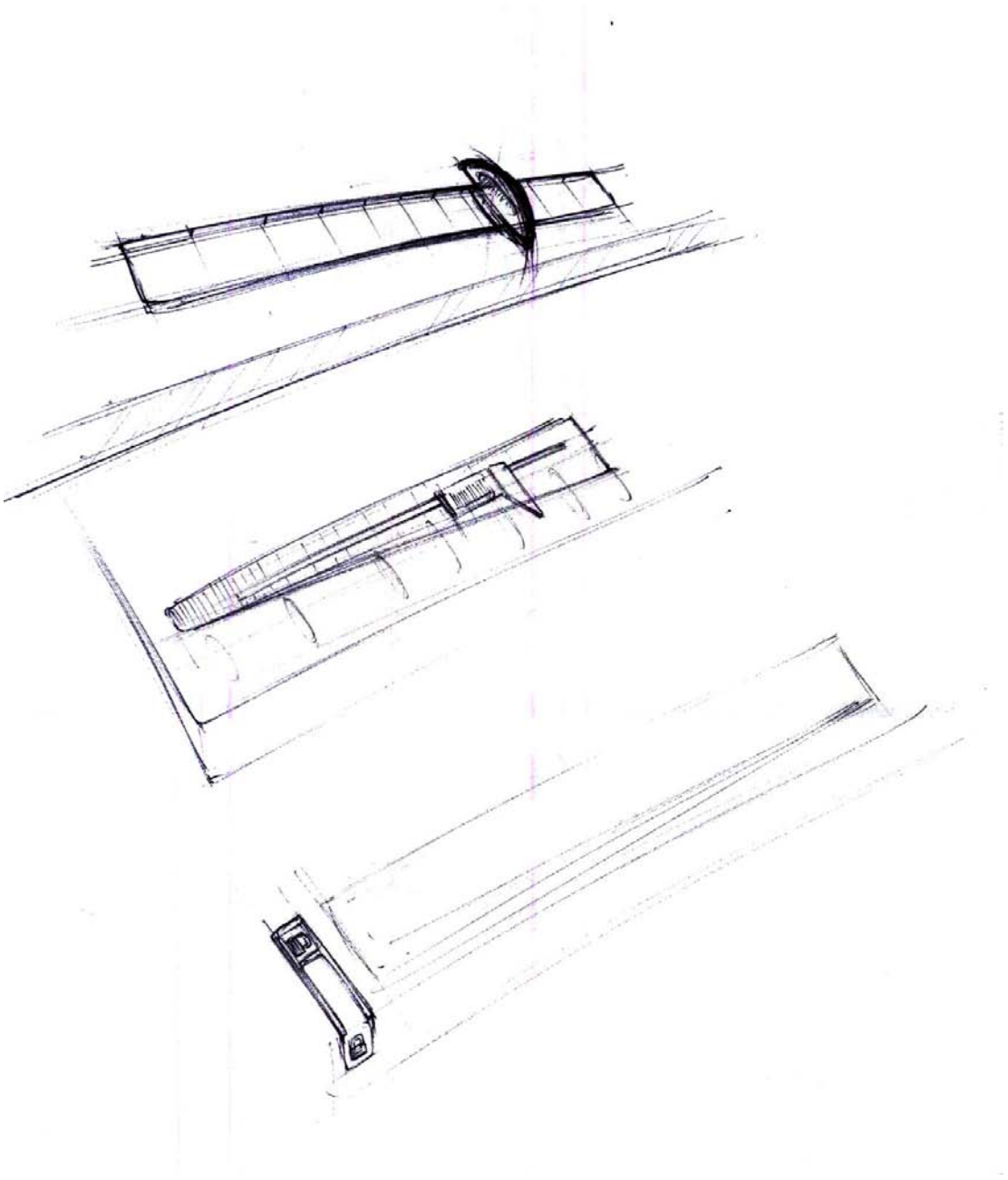

Figure 25. Interface sketches 2

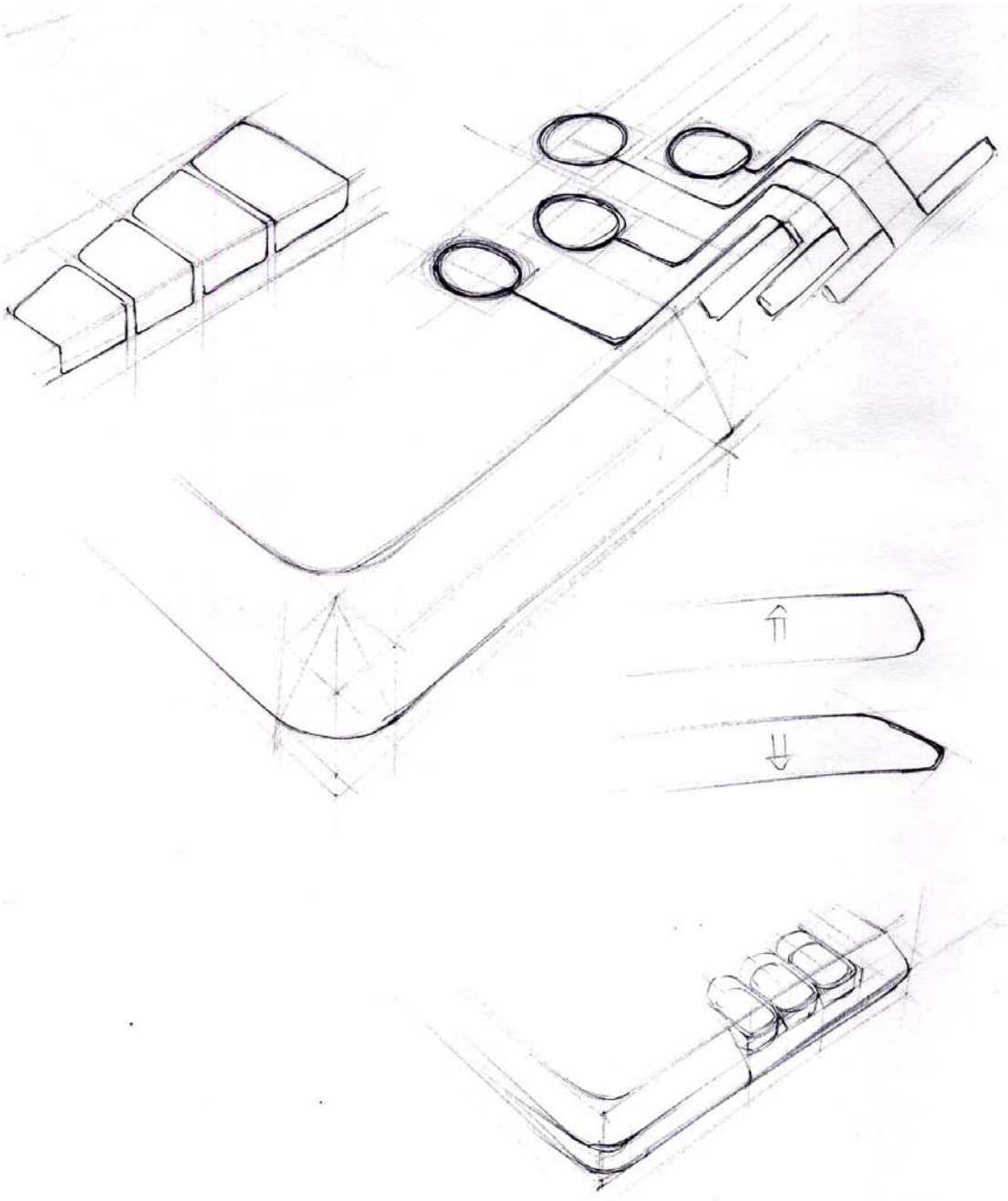

Figure 26. Interface sketches 3

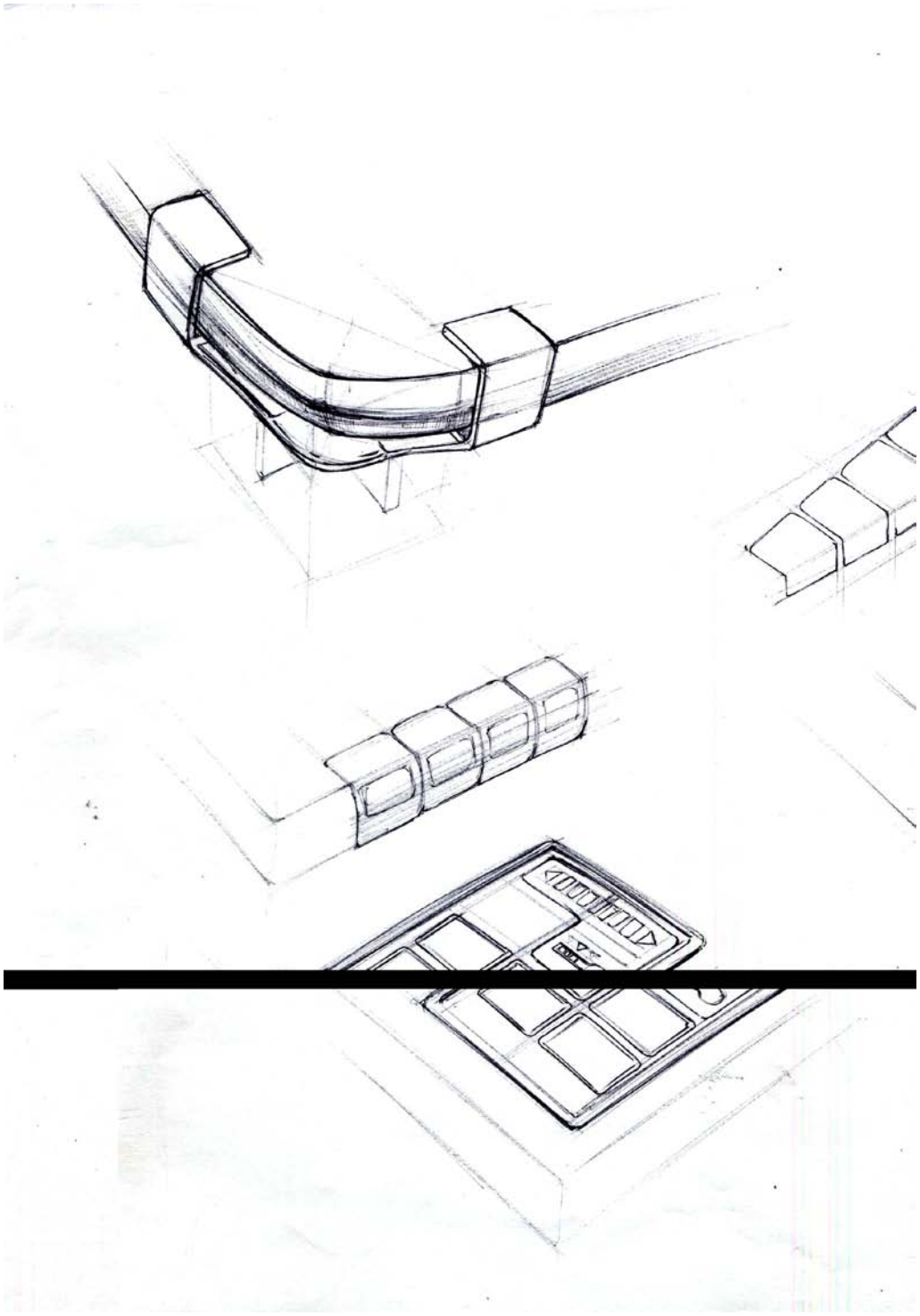

Figure 27. Interface sketches 4

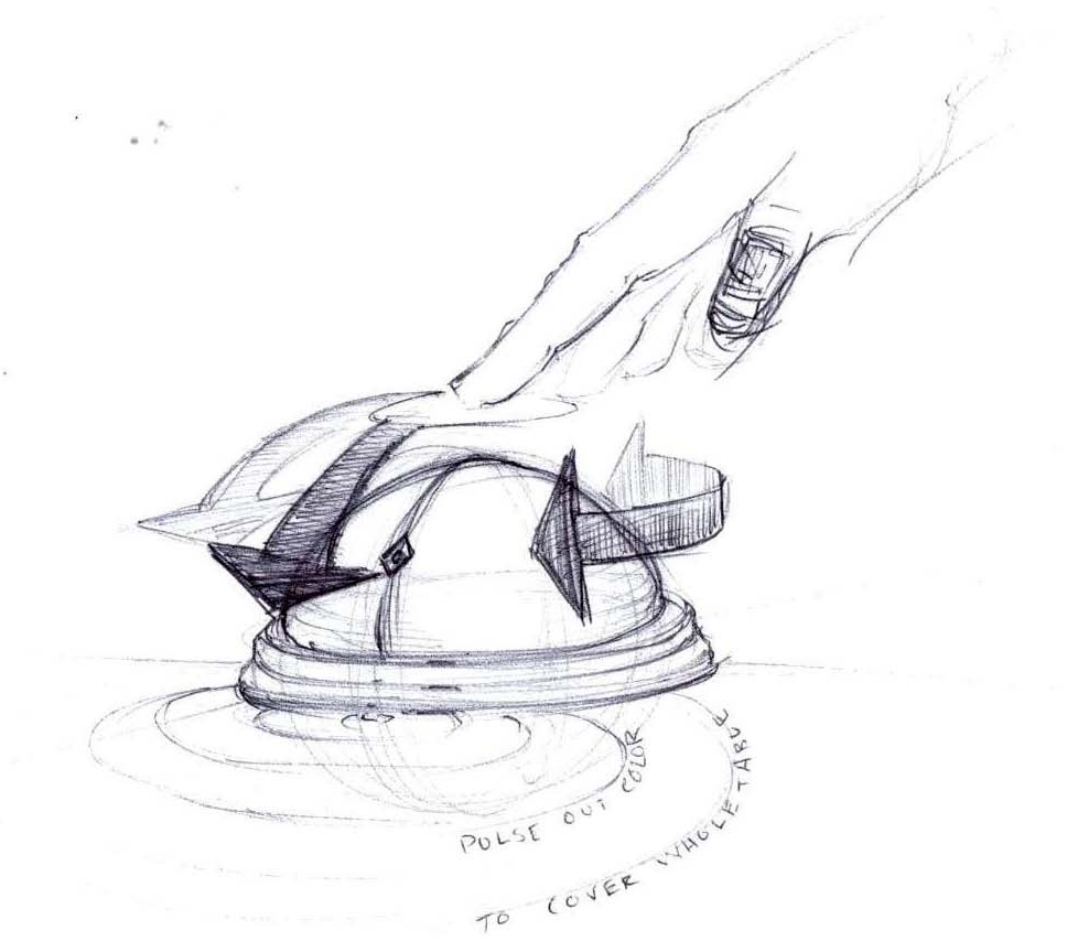

Figure 28. Interface sketches 5

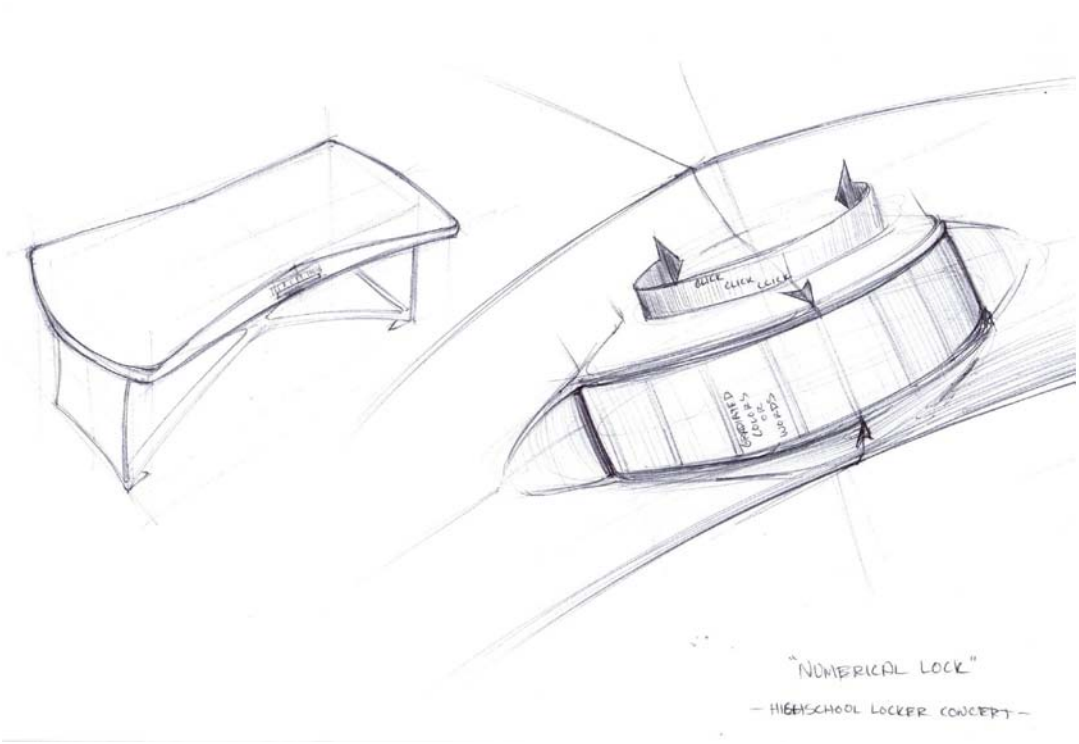

Figure 29. Interface sketches 6

5.2. Concepts

A series of concepts was built in the 3D Cad program Rhinoceros to give a more complete view of what an individual could be interacting with on a daily basis. The concepts continue to explore the questions of how to show creativity in desk form and where the interface would be positioned on the work surface.

5.2.1. Concept One

Figure30. Concept One

5.2.2. Concept Two

Concept two was a design of the collaborative workspace. Shown below, the table is meant to appear light as if it could float away and is only anchored by the table legs that wrap about and clamp to the corners.

Figure 31. Concept Two

5.2.3. Concept Three

The third concept model was the closest to a final solution. The workstation implements a color wheel touch pad that the user could use to direct the color change of the table top. Also, preset buttons were added that display the name of an emotion found on the Affect Circumplex diagram described by Lord from chapter one. These buttons could be pressed to display the color associated with the polar opposite emotion the individual could be experiencing in order to equate the user's mood.

Figure 32. Concept Three

5.3. Physical Model

A crude model was built to discern the proportional volume that the workstation would be constructed to and to determine whether it would even be plausible to use an OLED display as a work surface. A concern for the use of OLED technology is the intensity of light emitted from the desk-top. The objective of the workstation is to increase an individual's comfort level to smooth the way for greater productivity and heightened creativity not the adverse.

Figure 33. Prototype

To simulate the organic light emitting diodes the Philips Livingcolors light was placed in a box constructed of foam core and lined with tinfoil that was capped with a frosted piece of Spectar plastic. The working model mimicked the actions of the designed workstation.

Figure 34. Philips Livingcolors light

Figure 35. Prototype: red color stimulus

Figure 36. Prototype: blue color stimulus

A volunteer sat at the desk to read as a test of whether the light emitted would be too strong and become an impediment to the desired result rather than a positively stimulating element. It was agreed that the light emission was not of too great a strength and the individual's creative ability would not be compromised.

Figure 37. Prototype: user review

5.4. Final Solution

Figure 38. Individual color changing stimulus desk

The final concept for the color changing work surface workstation is a family of desks that includes an executive station, a collaborative workspace, and an individual workstation. The executive desk comes with overhead cabinet space for storage and an aluminum back wall abutting the desk to amplify its visual effects. The collaborative workspace has two control points at either end of the table whereas the executive and individual desks have only one located within easy reach, but out of the way of any work being done on the desk's surface. The desk top which displays desired colors is an OLED display.

The OLED is thin and is not backlit which allows it to emit light at a far less harsh volume than an LCD display. This allows the user to spend more time in close proximity without becoming over stimulated by the emission of color as well as creating a better environment for the desk to influence creativity. In overall form the desk is visually unassuming with plenty of negative space that draws the eye to the table top. This is important to allow the presence of the desk to dominate its immediate surroundings only through its ability to change stimuli.

Figure 39. Color stimulus themed family of workstations

5.4.1. User Interface

The control unit located directly on the surface of the desk and level with its surface is a 4 inch diameter circle with an internal 3 inch touch pad that displays the Munsell color wheel. Surrounding the color wheel are the names of the emotions associated with the colors directly adjacent. With the personal knowledge of the emotion being felt, the individual working at the desk has the power to equalize their mood, if so desired, by tapping once on the color associated with the emotion at the polar opposite of the color wheel. The color displayed can be de-saturated as well by tapping closer to the center of the color wheel. A preset for "focus" and "create" has also been incorporated that will change the surface color to red and blue respectively.

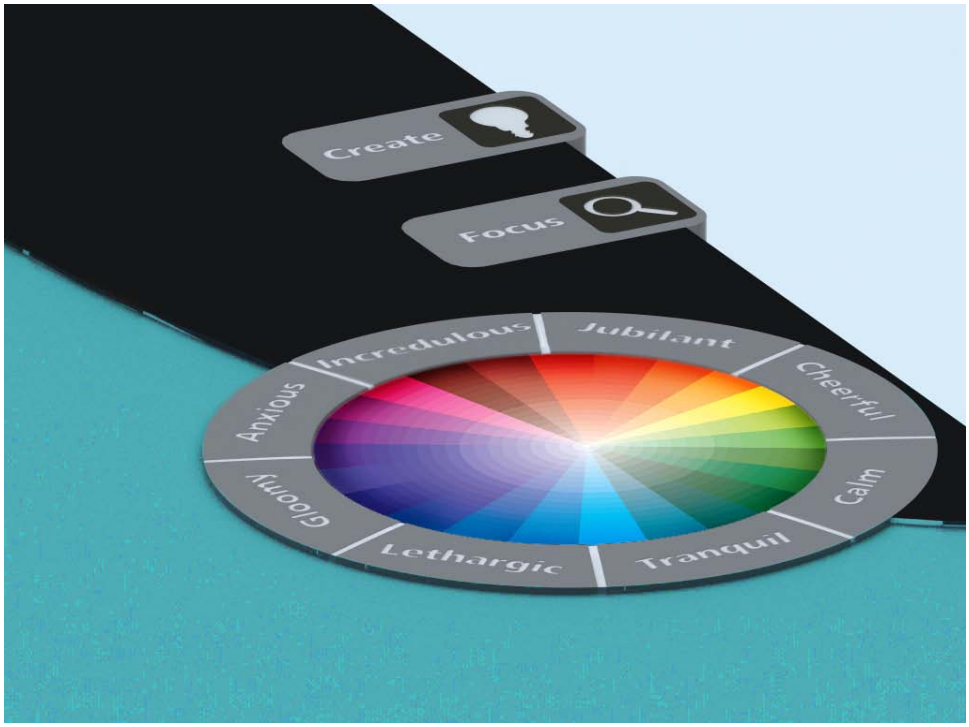

Figure 40. Control unit

5.4.2. Hands-Free Creativity

Direct application of a desired color is possible by selecting the exact hue with the sought saturation on the color wheel. This method of changing the color of the work surface gives the user total control of affecting his or her emotional status. There is a feature that takes away that control if, perhaps, the individual is interested in a randomized display of color stimulus. Setting the workstation to this function is easy. The worker simply double taps the center of the color wheel and the table will begin to change colors at its own pace defined by an algorithm that runs through a series of similarly hued colors and then, at an unspecified time, change dramatically to the complement of whatever color is displayed.

Figure 41. Hands-free creativity control

Figure 42. Hands-free creativity control sequence of change

5.5. Scenario of Use

The following scenario depicts an individual utilizing the color stimulus changing workstation during a given work day as he struggles with the concentration necessary to complete the tasks set before him. The story begins with the worker losing concentration as the green color, which had original served to calm, has replaced his focus with a feeling close to boredom. He realizes the necessity to become more focused and hits the "Focus" preset. The color red stimulates the individual and he regains the concentration to return to work. Over time the red color begins to over-stimulate the user though and he loses his temper. Needing to relax he switches the stimulus of the color stimulus changing workspace to a cooler color located at the polar opposite end of the affect circumplex. The blue color relaxes him and again he can work, but, over time, blue will depress an individual and the worker here grows tired. He realizes the need to be stimulated by a more active color and utilizes the interface to shift the desk top to a cheerful yellow which revives him and raises his energy level to allow work to proceed.

Figure 43-69. Scenario of use 1-27

Chapter 6: Conclusions

6.1. Summary of Research

The origins of this study began years before the research started; before the problem addressed had been noticed. This thesis set out to improve the creative, educational environment of a University facility, but it quickly grew to the large scope of the improvement of all work spaces. Creativity could play a vital role in the professional workspace and this research has taken steps to increasing the existence of creative stimuli within those environments by addressing the individual workspace.

6.2. Results of Study

The first grouping of studies done for this thesis, spring boarding off of recently reported findings from legitimate research, using red and blue colors as external stimuli led to the exploration of controlling emotion in the workplace with color. The covered work surface study described in chapter two concluded with the finding that color as a changing stimulus has a positive effect on creativity. The research gathered on emotion in the workplace found a correlation between color and emotion supported by studies from other researchers. The combination of color and emotion led to the discovery that it may be possible to equate an individual's

immediate emotion through the use of color by implementing the color associative to the polar opposite emotion. These findings helped guide the creation of a tool that individuals in an educational or professional environment could use to create an experience conducive to emotive control and creative output.

6.3. Future Studies

The conclusions of this research give good foundation for the further study of the affect of color on emotions and how the control of emotion could lead to higher levels of creative output. Future studies could use the knowledge addressed in this thesis to do in depth user research on site at a professional workplace. Although research has been done on the topic and it may be proven that color is subjective to individuals, more research is necessary as to the exact affect of color on emotion and whether a specific emotion can quantitavly be matched to a specific emotion.

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