DESIGN EDUCATION: TEACHING DESIGN SCIENCE BY INCORPORATING EYE-TRACKING DATA INTO UNDERGRADUATE VISUAL COMMUNICATION DESIGN STUDIOS

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ABSTRACT:

This paper presents an applied Design Education Methodology. This method is currently incorporated into the undergraduate Visual Communication Design education curriculum at a large R1 University. The author incorporates both the SMI Red, and SMI ETGs (Eye-Tracking Glasses) into a range of studio based problems including web design, symbology, and editorial design.

The presented educational methodology includes 5 phases: problem definition, research, ideation, scientific analysis, and refinement. The case study presented applies this methodology to a hidden-symbol branding / symbology project. In addition to moving through the 5 phases, students are asked to incorporate aspects of the Scientific Method, including the preparation of various hypotheses regarding their designs, in an effort to blend additional theories with design education. Once students execute their initial solution, they proceed to the fourth phase of the educational methodology: scientific analysis and collect eye-tracking data from a medium sized usability sample (n <= 10). Students are then lead through a series of analytical exercises to extract actionable data, which in turn drive the final phase: refinement.

This studio methodology moves students out of the studio and into a research lab exposing them to new research tools by applying Science and the Scientific Method. This educational methodology augments the traditional critique model of evaluation. More importantly, by exposing students to normally disparate disciplines and theories, they are allowed to develop a synergistic link between design, research, and science.

Keywords: Design Education, Design Science, Eye-Tracking, Design, Symbology

1. BACKGROUND

Art & Design Education (A/DE), broadly defined, is the instruction of theory and application in the creation of products, services, and communications. Integral to design education is

the process of studio critiques that incorporate educator comments and reactions to student work in an attempt to educate future designers on making powerful design decisions. Studio critiques date back to the Master / Apprentice model and remain remnants of the Bauhaus style in today's design education. While valuable, critiques often lack tangible substance that students can capture, process, and apply to future design problems. A/DE is subjective in nature; however, as educators we can look to the concept of Design "as" Science (aka, design science) for direction in validating design decisions via the analysis of quantitative data. In validating design decisions and allowing scientific data to influence the iterative design process, students gain a better understanding of design and ultimately execute more human-centered results. This methodology and methods like it help validate the A/DE discipline through publishing and recreating solutions in classrooms across the country.

Formal Art & Design Education (A/DE) can be traced back to the United Kingdom where it bears the distinction as being "the oldest form of publicly funded education," (Bird, n.d.) A/DE was begun to meet the needs of trained 'artisans.' These 'artisans' are the nineteenth century equivalent of today's designers. From the start, A/DE maintained a strong emphasis on practice and was defined as "…the link between the historical training of the artisan and the current education of the artist, designer and craftsperson." (Bird, n.d.) With this emphasis, many Schools of Art & Design operated independently and did not see a need to parallel themselves with their academic counterparts. Because of this, A/DE curriculums initially failed to attain academic degree status for their offerings. This trend continued in the UK until the late 1960's, when formal degree status was granted to A/DE disciplines, and has similarly influenced design education in the US.

As a relatively fledgling discipline – and one with few PhD graduate programs – many A/DE programs across the UK and US have tended to focus on undergraduate provisions and preparing professional designers. With the (somewhat) recent introduction of PhD's in design research (only four currently exist in the US), only now do we see A/DE programs beginning to incorporate more research, theory, and methods into the undergraduate education in hopes to prepare students for graduate education in a design related discipline. Design research is becoming more prevalent in undergraduate curriculums. These design approaches are gaining additional importance as the resulting methodologies help validate the design discipline. Bruce Archer states, "Design research is systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems." (Archer, 1981) Through this systematic process, we can expand the possible solutions to the given design problem, all while assisting to continually validate the discipline. This validation will allow for further interdisciplinary recognition and integration across domains.

This paper presents an undergraduate visual communication design studio methodology incorporating usability testing as theory and techniques to test design decisions to further validate the final design solution. The Scientific Method is used to frame the studio problem and present a linear framework by which to solve the problem. A morphological sketching method is introduced to increase the students' output and explore additional possibilities. By

fusing more scientific research with design solutions the author hopes to further substantiate A/DE and the discipline as a whole.

1. 1. RESEARCH QUESTIONS

Undergraduate visual communication design students often struggle with branding and logo design, especially when initially exposed to this area of our discipline.

Prior to writing the design studio problem statement, the following overarching research questions were formulated:

1. Can second year design students be taught symbology and branding design utilizing the scientific method?
2. Can a symbol be shrouded within a symbol in an effort to produce a more interesting branding symbol? And can usability testing methodologies mainly eye-tracking, be utilized to analyze a shrouded symbol design to validate the presence of hidden symbology and guide design decisions?
3. Can a morphological method be devised which assists students to increase their exploration at the sketching phase of design?

These questions were central to the presented studio problem, and the study as a whole. They cover a broad basis, from the studio problem definition, to the methodologies utilized to create the artifact, and finally usability testing methods to validate the design decisions made along the way. Important and central to this research was to create a methodology that could be reproduced in other A/DE classrooms and shared with peer educators.

2. IMPLEMENTATION / METHODS

2.1 THE SCIENTIFIC METHOD

Nigel Cross discusses the foundations of incorporating the Scientific Method (SM) into design when he says, "[a] recurring theme in recent design theory has been a desire to relate design method to [the] scientific method: to create the 'science of design' or a 'design science.'" (Cross, Naughton, & Walker, 1981) Educators, and researchers alike, desire to continually validate their discipline through the application of methodologies from other domains. More recently design as science has begun to permeate A/DE classrooms across the United States and Asia. (Bayazit, 2004) For this reason, utilizing the Scientific Method to teach a complex concept of branding and design to undergraduate visual communication design students intrigued the researcher.

A linearized schema of the scientific method is often observed in the following order: (Crawford & Stucki, 1990)

1. Define a question
2. Gather information and resources (observe)
3. Form an explanatory hypothesis
4. Test the hypothesis by performing an experiment and collecting data in a reproducible manner

5. Analyze the data
6. Interpret the data and draw conclusions that serve as a starting point for new hypothesis
7. Publish results
8. Retest (frequently done by other scientists)

This schema provides the framework for which the design problem was presented. It was simplified into the following steps that are more approachable to design students. Along with this simplification come several main questions posed at each stage of the process:

1. Question- What is the design problem at hand? Who is the client? What domain do they work in? What are the constraints of the problem?
2. Research- Who is the audience? What represents the client / business domain?
3. Hypothesis- Gestalt theories can be used to incorporate hidden symbology into unique branding marks. Can this theory be testable and repeatable?
4. Experiment- Can a morphological method be utilized to increase students' output and generate more possible solutions?
5. Collect Data- Can eye-tracking be used to gauge the areas of interest in a symbol?
6. Analyze Data- Does data reflect an increased area of visual concentration with regards to the shrouded symbol?
7. Conclusion- What design decisions could be driven by the analysis of the data? What further refinements could be made to increase the overall brand?

This schema was further simplified and combined for the A/DE studio into five phases (Figure 1):

1. Problem Definition
2. Research
3. Ideation
4. Scientific Analysis
5. Refinement

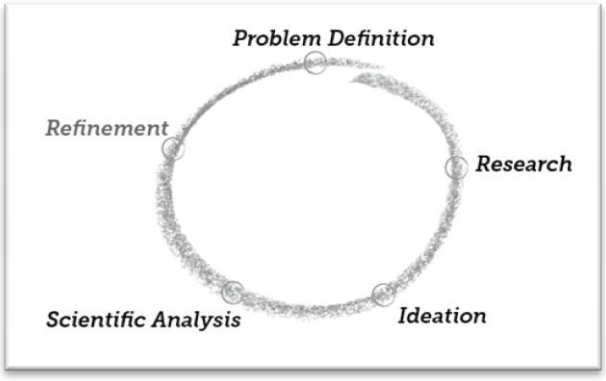


Figure 1: The five phases of the Design Education Method.

2.2 MORPHOLOGICAL METHOD: SKETCHING FAMILIES

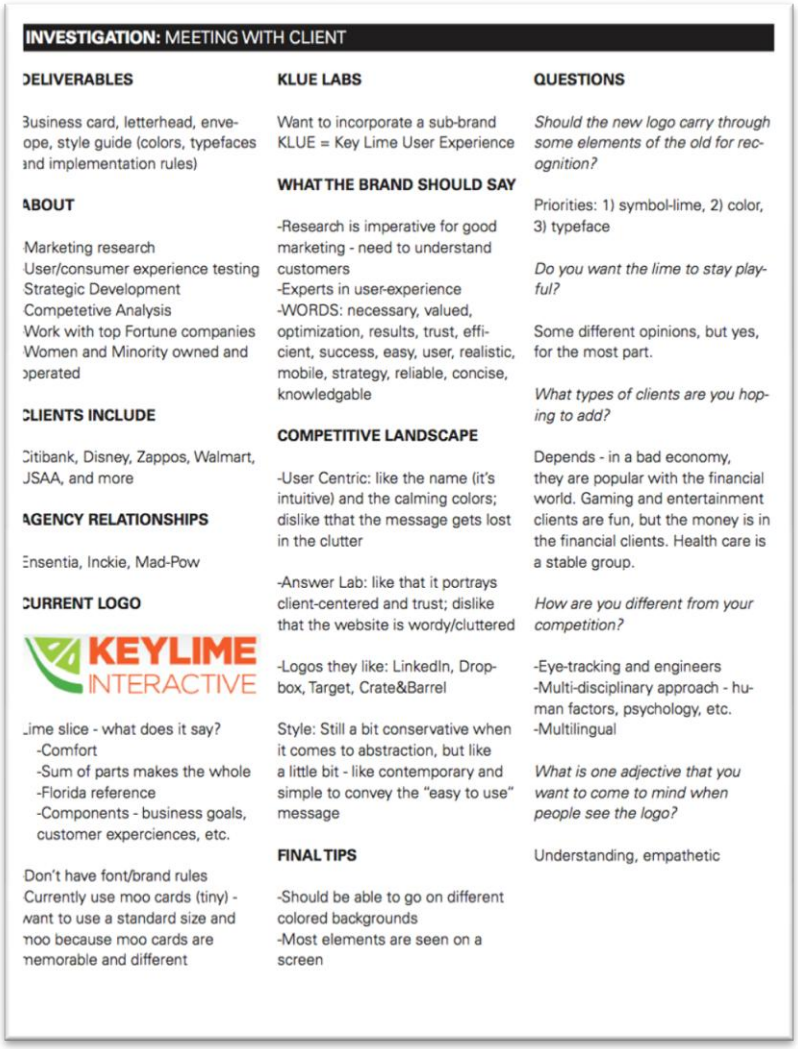
Morphology is by definition the study of form. Robert Carter introduced a creative matrix in his book, which incorporates a creative exercise with sketching to produce unique results.

(CARTER, Day, & Meggs, 2012) This methodology was modified to fit this project based upon work done by Lisa Fontaine at Iowa State University. Placing design principles along the X-axis, and adjectives describing the business unit along the Y-axis, a 7 x 7 matrix is created. At the intersection of each axis students quickly produce a thumbnail. These thumbnails are then reviewed and taken into the next step of ideation.

Once 10 thumbnails are selected, students move to what is referred to as Family Sketching. This method was designed to quickly create several alternatives to the initial 10. A "family" mentality is introduced to assist students in understanding that at this stage, sketches can be related in form and style. Only small changes need to be executed in order to produce a new alternative to the initial candidate sketch. After families of sketches are produced, final candidates can be digitized and taken through ideation.

3. STUDENT OUTPUT

Step 1: Problem Definition. Starting with the Problem Definition step of the scientific method, students were asked to interview their real-world client, Key Lime Interactive (KLI). KLI is a usability and interactive design firm specializing in several disciplines including health care, financial, and the travel business sectors. Students asked questions such as, "Who is the company's audience? What are the goals for rebranding the company? Who are the stakeholders? What are the constraints of the project?" Once their initial questions were answered they moved into the Research phase. (Figure 2)



INVESTIGATION: MEETING WITH CLIENT

DELIVERABLES

Business card, letterhead, envelope, style guide (colors, typefaces and implementation rules)

ABOUT

Marketing research
User/consumer experience testing
Strategic Development
Competetive Analysis
Work with top Fortune companies
Women and Minority owned and operated

CLIENTS INCLUDE

Citibank, Disney, Zappos, Walmart, USAA, and more

AGENCY RELATIONSHIPS

Ensentia, Inckie, Mad-Pow

CURRENT LOGO

KEYLIME INTERACTIVE

Lime slice - what does it say?
-Comfort
-Sum of parts makes the whole
-Florida reference
-Components - business goals, customer experciences, etc.

Don't have font/brand rules
Currently use moo cards (tiny) - want to use a standard size and moo because moo cards are memorable and different

KLUE LABS

Want to incorporate a sub-brand
KLUE = Key Lime User Experience

WHAT THE BRAND SHOULD SAY

-Research is imperative for good marketing - need to understand customers
-Experts in user-experience
-WORDS: necessary, valued, optimization, results, trust, efficient, success, easy, user, realistic, mobile, strategy, reliable, concise, knowledgable

COMPETITIVE LANDSCAPE

-User Centric: like the name (it's intuitive) and the calming colors; dislike tthat the message gets lost in the clutter

-Answer Lab: like that it portrays client-centered and trust; dislike that the website is wordy/cluttered

-Logos they like: LinkedIn, Dropbox, Target, Crate&Barrel

Style: Still a bit conservative when it comes to abstraction, but like a little bit - like contemporary and simple to convey the "easy to use" message

FINAL TIPS

-Should be able to go on different colored backgrounds
-Most elements are seen on a screen

QUESTIONS

Should the new logo carry through some elements of the old for recognition?

Priorities: 1) symbol-lime, 2) color, 3) typeface

Do you want the lime to stay playful?

Some different opinions, but yes, for the most part.

What types of clients are you hoping to add?

Depends - in a bad economy, they are popular with the financial world. Gaming and entertainment clients are fun, but the money is in the financial clients. Health care is a stable group.

How are you different from your competition?

-Eye-tracking and engineers
-Multi-disciplinary approach - human factors, psychology, etc.
-Multilingual

What is one adjective that you want to come to mind when people see the logo?

Understanding, empathetic

Figure 2: Student research and problem definition.

Step 2: Research. In the Research phase of the methodology students were asked to conduct through in-depth research into current brands in the sector, different design principles common in branding in this sector, list colors and design principles which could possibly represent KLI, and generate a word cache of adjectives to describe the company and their holdings and services. Once this stage was complete, students started the Hypothesis stage.

All students shared the same Hypothesis, generated by the researcher, and provided to them in the design problem. The main statement was "Gestalt theories can be used to incorporate hidden symbology into unique branding marks. Can this theory be testable and repeatable?"

Step 3: Ideation. At the Experimentation / Ideation stage, students were introduced to the Morphological method referred to as Sketching Families (described in the methods section of this paper). Students explored the intersections of design principles and adjectives used to describe the company while maintaining concentration in shrouding a hidden symbol inside their sketches while completing the exploratory matrix. This matrix had adjectives along the

X-axis and design principles along the Y-axis. This 6 x 7 matrix allowed for exploration at the intersection of each x and y axis. (This matrix is based on one introduced to the research at Iowa State University by Assistant Professor Lisa Fontaine). At this stage of the sketching process, students completed at least 42 sketches (6 x 7 matrix). (Figure 3)

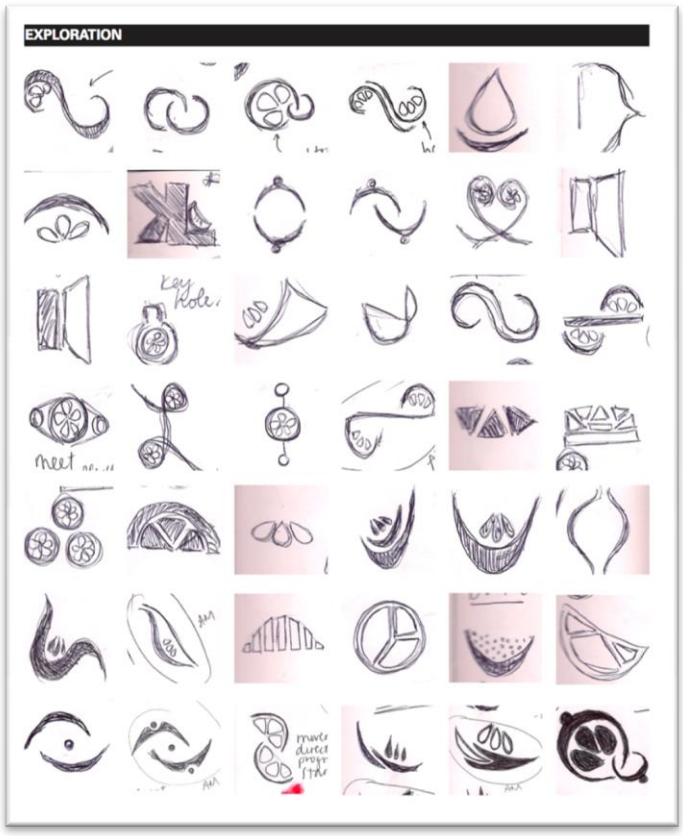


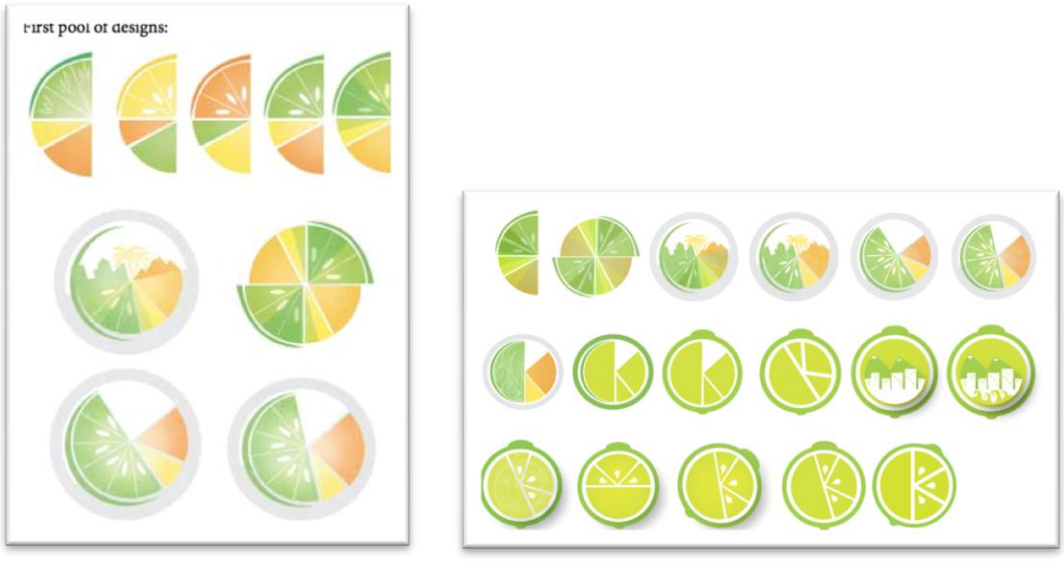
Figure 3: The morphological matrix.

Once the 6 x 7 matrix was completed, the thumbnail sketches were reviewed by the instructor (researcher) and the top 7 solutions were taken into the next stage of sketching: Families. Families of sketches are groups of quickly generated drafts that share similar qualities. These drafts are described to the students as brother and sister sketches of the main idea, derivatives of the main idea with small incremental changes made along the way. They are related to the main idea and could all be part of the same family. Essentially each page in a sketchbook is a system of rough sketches all related to one another. Students were instructed to do at least 15 brother and sister sketches for each main idea. At this stage of ideation students created at least 105 rough sketches (7 main ideas x 15 sketches each).

Figures 4-5. Sample 'Family' page sketches

Students, with the help of the instructor, then choose the top 3 ideas from the 105 rough sketches. (Figure 4-5) These top 3 sketches were then again ideated at least 7 times into another Family of sketches. This stage produced at least 21 sketches (7 x 3). By this stage, students have produced at least 150 sketches of possible solutions to the design problem!

The top solution was then digitized in the computer and colorized. Once the students completed the digital rendering of their brand, they undertook a systematic form revision, slightly changing proportions, rotations, relationships, and color through an iterative process. This systematic revision process brought more structure and science to an otherwise organic design process. The parameters each student choose to manipulate was their choice as these were not explicitly spelled out for them. (Figures 6-7)



Figures 6-7: Systematic form revision.

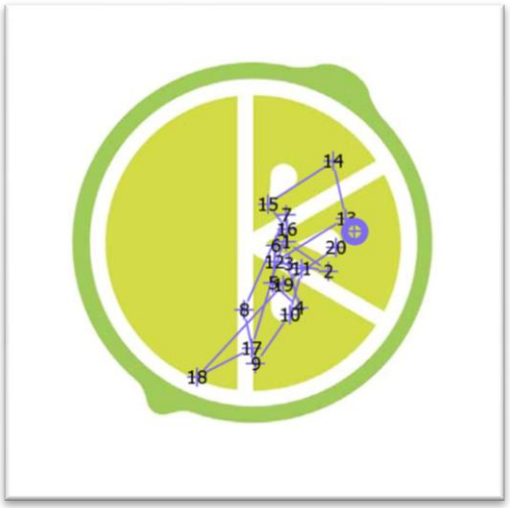
Step 4: Scientific Analysis. The symbol was then complimented with a typographic signature and the brand was generated. This initial brand generation was then placed upon a grid structure so students could analyze the internal integrity of the brand mark. Students were asked to explore ratios and mathematic relationships (including the rule of thirds, the golden ratio, etc.) to establish internal structure and achieve brand economy and simplicity. (Figure 8) Once complete, this final solution was brought into the eye-tracking lab to be tested.

Figure 8: Ratio and scientific analysis

The eye-tracking system is created by Sensomotoric Instruments (SMI) and includes a hardware and software solution. On the hardware side, the system includes an infrared camera to track eye movements, a stimulus monitor, a Windows based PC, and an operators monitor. The software includes the SMI BeGaze suite (Instruments, 2012) which includes the experiment creation and data analysis software.

Once students executed their initial solution, and rendered the mark in the computer, they proceeded to the fourth phase of the educational methodology: scientific analysis. They collected eye-tracking data from a medium sized usability sample (n <=10). Once data was collected, students were led through a series of analytical exercised to extract actionable data, which in turn drove their final design phase: refinement.

Eye-tracking data indicates participants were able to identify the hidden 'K' and abstracted 'L' glyphs inside the symbol and therefore indicate a successful design. (Figures 9-11)



Figures 9-11:

Step 5: Refinement. This particular student had findings, which indicated her success at shrouding the 'K' and 'L' glyphs into her symbol; therefore, no further refinement of her mark was necessary. However, several students utilized the data discovered to further drive several iterative design cycles.

4. CONCLUSION

Applying the Scientific Method to the studio problem did not increase the output of the students, however, it did help them organize their process. Organization is something most designers lack, so in this regard, the Scientific Method was helpful. Overall, incorporation of the Scientific Method was not necessary so long as a design methodology is introduced and followed.

In following the Morphological Methodology, several students commented on the copious amount of sketches they produced and could not believe they generated so many. They were pleased with their output and the many options they had created. When faced with the challenge of sketching in later courses, many were thankful for the Family Sketching

methodology and continue to apply it to other studio problems throughout their undergraduate education.

Utilizing eye-tracking surely assisted students by uncovering viewers' cognition of their symbol design. Students were able to understand if viewers recognized their shrouded symbol. Scan path data was used to drive future design decisions.

5. FUTURE RESEARCH

To further validate these findings, the researcher must share this methodology and ask those educators who test it to share their findings with the greater discipline. The Scientific Method may also be applied to other design studio problem in an effort to provide a solid framework for which to devise studio problems. The Family Sketching methodology proved very successful in this symbology / branding design problem, and the researcher wonders if it can be adapted to other studio design problems.

REFERENCES:

Archer, L. B. (1981). A View of the Nature of the Design Research. In R. Jacques & J. A. Powell, *Design Science Method* (pp. 30–47).

Bayazit, N. (2004). Investigating design: A review of forty years of design research. *Design Issues*, *20*(1), 16–29. doi:10.1162/074793604772933739

Bird, E. (n.d.). Research in Art and Design: the first decade. *Https://Www.Herts.Ac.Uk/__Data/Assets/Pdf_File/0015/12282/WPIAAD_Vol1_Bird.Pdf*. Retrieved September 11, 2014, from https://www.herts.ac.uk/__data/assets/pdf_file/0015/12282/WPIAAD_vol1_bird.pdf

CARTER, R., Day, B., & Meggs, P. B. (2012). *Typographic design: Form and communication*.

Crawford, S., & Stucki, L. (1990). Peer review and the changing research record. *Journal of the American Society for Information Science*, *41*(3), 223–228. doi:10.1002/(SICI)1097-4571(199004)41:3<223::AID-ASI14>3.0.CO;2-3

Cross, N., Naughton, J., & Walker, D. (1981). Design method and scientific method. *Design Studies*, *2*(4), 195–201. doi:10.1016/0142-694X(81)90050-8

Instruments, S. (2012). Begaze Version 3.2 Manual. *SensoMotoric Instruments*.