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Evaluating the effects of hand drawing on the conceptual process and the implications for final design solutions

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Evaluating the effects of hand drawing on the conceptual process and the implications for final design solutions

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Abstract

As students become dependent on computer aided design programs to execute projects, they abandon the use of hand drawing in every aspect of the design process. Despite the prevalence of technology in the field, professionals continue to value hand drawing as a part of the ideation process and its role in the development of design abilities. The purpose of this study is to examine drawing as a communicative tool for use in the conceptual design process and its implications related to the success of final design solutions.

Design programs perpetuate the notion that proficiency in hand drawing and the use of digital design software are mutually exclusive. This sentiment is echoed in studies where benefits of hand drawing are analyzed through the production of a refined artifact as opposed to content, attempting to distinguish one method as superior. Findings provide little direction as to the ways in which faculty emphasize drawing as a tool for communication and its implications for the success of project outcomes.

Junior-level interior design students (n=8) participated in a mixed-method study, where the effects of hand drawing as a part of the conceptual design process were examined against the success of the final design solutions. Data from semi-structured interviews and final design presentations were analyzed within the context of instructor feedback and individual student grades to explore a positive correlation between engagement in the design process and higher project scores. Four participants indicated situations in which hand drawing as a part of the conceptual design process facilitated visible improvement related to memory, reflection, and problem solving abilities in the course of achieving project goals. Although modest, results compel educators to re-examine the role of drawing within design curricula and the ways in which it can be reincorporated to best serve student interests at the pre-professional level.

Introduction

"I have seen the future and it doesn't work!" (Cross, 2001, p. 47). A seminal study by Nigel Cross, regarding the prevalence of computer aided design programs and their place in the profession has proven a prophetic one in terms of the way in which computer aided design software has permeated the industry (2001). These programs are a tremendous addition to the professional world of design. AutoCAD, Revit, and 3D StudioMax have revolutionized visualization capabilities and streamlined the production process in ways once unimaginable by pioneers in the field. However, as design moves into an era referred to as the conceptual age (Beacham & Shambaugh, 2011), has this mechanization come at a price? Research indicates professional designers are concerned about the lack of drawing skills possessed by emerging professionals (Schenk, 2014). However, this is not necessarily because students are not *learning how to draw*. Rather, the deficiency stems from a schism among faculty regarding the importance of drawing at the foundational and professional levels. This divide appears to perpetuate hand drawing and proficiency in computer design software as mutually exclusive skill sets (Dulaney & Lyn, 2010; Lyn & Dulaney, 2009).

As a result, drawing is narrowly viewed as an inherent talent, shrouded in mystery and steeped in technical precision, rather than as a tool through which to communicate ideas (Meneely & Danko, 2007). Yet, what exactly are students losing by executing design processes using computer software? While specific cognitive benefits are difficult to measure in an empirical sense, research indicates drawing plays an important role in the process of "design thinking" in terms of visualization and articulation of tacit knowledge impossible to replicate through the use of computer software (Cross, 2001; Kantrowitz; 2012; Schenk, 2014). In light of the divergent perceptions of the importance of hand generated content in the practice of design,

educators could synthesize the use of hand drawing with the advent of computer software to better prepare students to engage in a design process more indicative of professional practice, where innovative and creative problem solving abilities are valued beyond the quality of hand generated visual output.

The advent of computer aided design software has saturated the process of ideation, a practice once completely dominated by hand drawing (Edwards, 2005; Lyn & Dulaney, 2009, 2010; Pable, 2006; Schenk, 2014). Yet, professionals continue to employ hand drawing in the form of sketching as a part of the conceptual process, despite a heavy dependence on digital design software to visualize final outcomes (Edwards, 2005; Schenk, 2014). Despite the tendency towards a hybrid process in professional practice, research indicates design educators are plagued by a rift related to the perceived importance of hand-drawing in collegiate and professional settings (Dulaney & Lyn, 2010; Lyn & Dulaney, 2009).

Some professors argue that the computer is the new pencil, while in the same breath, hand drawing continues to be touted as a foundational skill necessary to the development of competent design professionals (Lyn & Dulaney, 2009; Dulaney & Lyn, 2010). Educators have the difficult task of cultivating thoughtful students capable of solving complex problems, while also ensuring they possess a broad working knowledge of computer aided design programs used in the professional environment. However, this rift in philosophy, related to the importance of hand drawing and digital techniques potentially leaves students at a disadvantage in terms of their ability to solve challenging problems (Schenk, 2014). The current arrangement within design curricula implies hand drawing and the mastery of digital design software are mutually exclusive (Lyn & Dulaney, 2009). As a result, students and faculty view drawing as an object unto itself, rather than as a tool used to solve complex problems as a part of the conceptual process (Meneely & Danko,

2007). This compartmentalized view potentially eliminates drawing as a vital component of the design process, along with the associated cognitive benefits such as enhanced memory related to potential solutions, speed and efficiency in the evaluation of ideas, and increased propensity for creativity and innovation as a result of exploration (Kantrowitz, 2012; Schenk, 2014; Tversky & Suwa, 2009).

As students are increasingly expected to utilize computer aided design programs to articulate design solutions, they are quick to abandon traditional hand drawing techniques (Meneely & Danko, 2007; Tan, Peek, & Chattaraman, 2015). Research implies that interior design students continue to value hand drawing skills, indicating an awareness of the perceived importance of the role of hand drawing within the design process (Meneely & Danko, 2007), but not necessarily for reasons related to problem solving or generating ideas. Research indicates students also view hand drawing and proficiency in digital design software as mutually exclusive, which is potentially a result of the distribution of classes devoted to each method in the degree program (Lyn & Dulaney, 2009; Dulaney & Lyn, 2010). Students tend to view hand drawing as a skill to be perfected, instead of as a tool through which they communicate design intent and tend to feel self-conscious regarding their capability to utilize it in the design process (Meneely & Danko, 2007).

The preceding sentiment is not restricted to hand drawing. Similar studies attempt to assess the efficacy of various types of digital design tools. Reports indicate students expend higher cognitive loads in an attempt to learn to use the software, when they should be immersing themselves in the design process (Meneely & Danko, 2007; Tan, Peek, & Chattaraman, 2015). The divide among educators as to the importance of drawing could have major implications for the way in which design curricula adapt to an increasingly digital world. While computer software is

prevalent in the design profession, hand drawing skills continue to be valued as a foundational aspect of the design process (Edwards, 2005; Schenk 2014). This compartmentalized nature of design curricula is potentially at odds with professional practice (Edwards, 2005; Pable, 2006; Schenk, 2014). In order to provide students with a complete education that prepares them for day-to-day operations as designers, teachers and administrators must re-examine the role of drawing and its perceived importance within curricula to better prepare students for the hybrid experience indicative of the current professional environment (Edwards, 2005; Pable, 2006; Schenk, 2014).

Unfortunately, the reorganization of design curricula to incorporate drawing as a part of process-focused activity is difficult when an overwhelming percentage of faculty correlate hand drawing with the ability to design (Lyn & Dulaney, 2009, Dulaney & Lyn, 2010). This feeling among faculty seems counterintuitive at a time when research indicates professionals are concerned that today's graduates do not possess the critical thinking skills necessary to successfully work through concepts resulting from a lack of an ability to hand sketch (Cross, 2001; Edwards, 2005; Schenk, 2014). Additionally, an increasing amount of research details implications related to hand drawing techniques, computer aided design programs, and the connection to cognitive abilities related to critical thinking, innovation, and problem solving (Belkofer, Van Hecke, & Knopka, 2014; Seitamaa-Hakkarainen, et al., 2016; Kantrowitz, 2012; Meneely & Danko, 2007; Tan, Peek, & Chattaraman, 2015; Zuo, & MaloneBeach, 2010). As students increasingly depend on computers to work through ideas, are they forfeiting these benefits to the detriment of their design ability? Design faculty could bridge the divide by diverting more focus to drawing as a part of the process, encouraging students to explore and innovate outside the limitations of computer software (Cross, 2001; Schenk, 2014). In an attempt to understand the

effects of the role of hand drawing in design, the researcher is compelled to investigate the following research questions:

- In what ways do hand drawing techniques used in the conceptual design process affect the collective strength of final design solutions created by interior design students?
- How could educators use the information gleaned from this study to reorganize curricula within interior design programs to better serve the needs of students?

Preceding research attempts to determine the advantages of hand drawing techniques versus computer aided design programs through various lenses (Brandon & McLain-Kark, 2001; Lu, 2009; Konkel, 2014; Zuo & MaloneBeach, 2010). However, studies primarily focus on hand drawing in the context of a final design plan rather than on their importance as a part of the design process (Brandon & McLain, 2001). A review of published literature indicates a key gap wherein studies do not assess the ways that students perceive the value of hand drawing techniques in their own design processes (Meneely & Danko, 2007). Collective responses do not seem to indicate students see added benefits of hand drawing skills in relation to their cognitive output in terms of increased problem solving ability throughout facets of their ideation process. More importantly, research does not make the connection between the role of drawing in the conceptual design process and its implications for impact on final design solution. Correlation between a hand drawn, exhaustive design process and higher scores as a part of final design evaluation is extremely difficult to prove. If a connection would exist between students who embarked on a more reflective process and higher scores on a final project, what implications would this have on the organization of design curricula?

Literature Review

The following literature review is an assessment of peer-reviewed articles related to the role of hand drawing in the general field of spatial design. Collected research attempts to generalize factors surrounding the way in which hand drawing is valued through the lens of educators, design professionals, and design students. Research revealed four common themes that provide avenues for study: 1) a rift exists between collegiate design curricula and the way in which design skills translate to a professional design setting, 2) drawing tends to culminate in the creation of a final artifact and is not regarded as a communicative tool for engaging in design dialogue, 3) hand drawing bolsters a thought process unique to design students, and 4) design educators struggle to define a cohesive method for the assessment of design projects related to critical thinking in the conceptual process.

Key limitations of research design point to a gap in the literature by which hand drawing is viewed as an object unto itself (Cross, 2001; Edwards, 2005; Schenk, 2014) rather than a conduit for ideation. The vacuum created by the perception of the appropriate place for hand drawing techniques as a part of the academic skill set could have broad repercussions for the way in which students execute their individual design process (Schenk, 2014; Beacham & Shambaugh, 2011; Razzouk & Shute, 2012). The following analysis attempts to identify the perspectives that shape the perception and study of hand drawing techniques in design research and how they might be adapted to shape more definitive outcomes.

1.1 Rift Between Curricula and Translation of Skills

Design educators have a "responsibility to teach media relevant to the needs of the profession" (Tan, Peek, and Chattaraman, 2015, p. 41). However, faculty and administrators appear to be at odds as to the ways in which hand drawing techniques and computer aided design

programs coexist within interior design degree programs (Lyn & Dulaney, 2009). A study conducted by Lyn and Dulaney (2009) surveyed faculty and administrators employed in colleges belonging to the Association of Collegiate Schools of Architecture (ACSA) regarding their inclusion of hand drawing techniques and computer aided design programs within their curricula. Results indicated faculty valued hand drawing techniques and proficiency in the computer in an equal manner. Yet, despite the appreciation for both techniques, responses showed the number of classes solely devoted to each visualization method is disproportionate in favor of digital design programs. 83% of participants indicate that digital media techniques were offered as a dedicated course, in contrast to 68% who included hand drawing techniques in a specific class. Additionally, despite compartmentalizing each technique within individual classes, faculty and administrators continued to value hand drawing as a foundational skill that must be mastered in order to create successful design concepts using computer software. Although educators tended to perceive the value of the techniques in an equal manner, they are treated in mutually exclusive terms when dispersed throughout design degree program requirements (Lyn & Dulaney, 2009).

The initial study conducted by Lyn and Dulaney (2009) outlined a general case for hand drawing and its place within the architectural academy curricula. Responses provided much needed insight into the perceived importance of hand drawing through the experience of design faculty. Additionally, results indicated this rift between educators, as evidenced by the distribution of courses devoted to the respective skills amongst degree programs. While these initial results provided avenues for further study, there were no empirical data to reinforce these sentiments on an individual level. Additionally, the collection was narrowly focused on the perceptions of educators and did not attempt to reconcile the results with the broader context of the design profession. In an effort to provide a context for this argument, and the ways in which

it translates into post-graduate employment as a designer, Lyn and Dulaney (2010) performed a more formidable study to determine if these sentiments simply existed in the vacuum of the collegiate environment. They developed two surveys, one that evaluated the importance of hand drawing and digital media within architecture academies, and another that evaluated the same criteria among professional architects. Researchers distributed the survey via an online format to 134 ASCA member schools in the United States and Canada (Lyn & Dulaney, 2010). Surveys were also sent to the 2,300 full, associate, and allied members of the American Institute of Architects (AIA) that comprised the chapters representing Virginia and West Virginia. The educators had a considerably higher response rate than that of the professionals, with 39% participating. Of the 2,300 members of AIA, only 7% responded, with a total of 151 participants. Both survey formats addressed "sketching," "hand drawing," and "digital design media" as a part of their respective career fields.

Results indicated that the rift between educators was not only persistent in design curricula, but is also perpetuated by professional designers in the industry. Similar to their previous study (Lyn & Dulaney, 2009), there is overwhelming sentiment amongst educators and professionals who believe that the ability to draw is a direct indicator of the ability to design (Lyn & Dulaney, 2010). Conversely, academics are almost evenly divided as to whether a proficiency in digital media is related to design ability. However, the majority of professional designers who responded did not believe there is a correlation between proficiency in digital media programs and design ability. Surveys asked educators and practitioners to rate the importance of hand drawing and use of digital design media as a part of specific questions related to engagement and practice by students and novice designers. Respondents rated the importance of each skill on a Likert scale of 0 to 3, where 3 is *"most important"*. Professionals did not necessarily evaluate the

ability to draw in potential employees. In fact, the composite rank fell below the middle of the spectrum in terms of importance, with a score of 1.93. However, in terms of "achievement of project goals," the ability to hand draw or sketch was ranked with nearly equal importance as proficiency in digital media with scores of 2.28 and 2.76, respectively. Results indicated that while professional viewdd the ability to use computer aided design software with high importance, the ability to hand draw or sketch as a part of the design process continues to be valued as a part of daily operations in firm environments. Similarly, professionals valued student engagement with the respective skills on a nearly equal basis, indicating the importance of ideation as a part of the design process (Lyn & Dulaney, 2010).

More importantly, practitioners valued the mastery of hand drawing and the use of computer aided design programs as they relate to the "formation of a young architect" (Lyn & Dulaney, 2010, p. 285). This sentiment is echoed by academia, as evidenced by the distribution of courses dedicated to each skill within the respective degree programs reported by respondents (Lyn & Dulaney, 2010). The contradictory sentiment between perceived value of hand drawing and the ways in which it manifests in the professional world perpetuates the assumption that proficiency in each of the two skills is mutually exclusive (Lyn & Dulaney, 2009). Responses from professionals as a part of the more recent study by Lyn and Dulaney (2010) indicated that ability in both dexterities is valued in the completion of project goals, indicative of a more hybrid process. Unfortunately, the researchers did not provide any qualitative data to give context to the compiled rankings.

As post-secondary educational design programs struggle with this dilemma, the professional design world perpetuates a largely hybrid process in terms of executing design concepts (Edwards, 2005; Pable, 2006; Schenk, 2014). A qualitative study conducted by Edwards (2005)

interviewed 10 prominent architects in the United Kingdom regarding their incorporation of hand drawing techniques in the design process. Results indicated that for 9 of the 10 architects surveyed, freehand drawing remained the "pre-eminent tool" for solving design problems in the beginning phase of design projects (Edwards, 2005), indicating that design professionals saw it as a valuable skill. Architects evaluated the importance of hand drawing using a Likert-type scale. Evaluations were then categorized according to the Royal Institute of British Architects (RIBA) Plan of Work, a model used in the United Kingdom to steer design projects from conception to construction. Ratings were specifically limited to the parts of the plan concerned with conceptual and design development. As drawings become more refined, hand drawing techniques were rated as less important, occupying the middle portion of the scale. Although the value of hand drawing in the design process decreases as a result of moving through the plan of work, ratings indicate that hand generated techniques are still a valued presence as a part of the conceptual process, even though drawings tended to be completed using computer aided design programs such as AutoCAD (Edwards, 2005).

Preference for hand generated design concepts is attributed to personal beliefs and context of training. Professionals interviewed by Edwards (2005) were primarily trained in hand drawing techniques prior to the advent of formidable design software that dominates today's market. However, despite personal preference, a subsequent study indicated professionals also valued hand drawing for practical benefits that cannot be afforded by digital design programs (Pable, 2006). As a part of a larger, quantitative study, 8 professional interior designers were interviewed to assess their attitudes towards freehand drawing versus computer aided design software. Participants responded to open-ended interview questions regarding their feelings toward the respective techniques as design tools, as well as a way to visualize design concepts in

various types of presentation quality imagery. Responses captured from the design professionals were coded for positive and negative associations.

Negative connotations were most heavily associated with digitally created graphics. Respondents cited that digital graphics were often "costly," "may provide too much information," and are "cumbersome for early concept phase exploration" (Pable, 2006). In contrast, hand generated graphics were perceived to "permit more freedom during the design process," "permit more equal collaboration," and "allow for more spontaneous communication" (Pable, 2006). Similar to the study conducted by Edwards (2005), design professionals indicated an appropriate place for hand drawing in their individual design processes. The sentiments expressed by the professionals suggested that freehand drawing remains a relevant skill that should be imparted to design students within the course framework of post-secondary curricula.

The prevalence of computer technology in the design process has transformed the role of hand drawing as a part of professional practice (Schenk, 2014). A longitudinal, broad based study examined the role of hand drawing through the lenses of design professionals, educators, and students in order to understand the implications of the reconciliation of hand drawing and use of computer aided design in professional practice (Schenk, 2014). Schenk (2014) originally conducted a multi-year study in which she surveyed practitioners, educators, and students within the field of graphic design to examine their daily use of hand drawing. Near the conclusion of the data collection, she expanded her research to include the practices of the allied design fields of textile design and communication design, in order to compare more current results with earlier findings related to the subject.

Professionals expressed concern over the computer creating 'mechanized copiers' rather than innovative designers (Schenk, 2014). More specifically, they alluded to the ability of computer

aided design programs to allow for the manipulation or repurposing of original content, thus impeding the advent of innovative design ideas (Schenk, 2014). Professionals further indicated that computer design programs facilitate repurposing in comparison to the "active manipulation" engaged through drawing. By eliminating various forms of hand drawing throughout the ideation process, professionals expressed concern over the inability of novice designers to capitalize on the reflective nature of the design process. Content produced via digital design programs is "based on what is already known and established" (Schenk, 2014, p. 49), leaving little room for reflection and reinterpretation. The permanent nature of content produced through digital means leaves little room for reinterpretation. Thus, novice designers limit the ability to evaluate ideas in the creation of a well-rounded design concept that is creative, yet satisfies project requirements. While this is a supplementary component to a much larger study, responses from designers allied with the field of graphic design yielded categories of sketching and their association with various stages of the design process. Rather than viewing drawing as a monolithic entity, results show there are types of drawing associated with reflective aspects of the process, including the recording of ideas, response to visual sources, visual thinking, and experimentation (Schenk, 2014).

Despite findings in the more recent study by Lyn and Dulaney (2010) that indicate a rift in terms of the use of hand drawing and computer aided design programs and the space they occupy in architectural degree programs, research suggests hand drawing continues to be valued by design professionals with regard to the completion of project goals. However, the compartmentalized nature of design curricula fails to embody the hybrid process that appears to be more prevalent in the context of professional practice. Based on findings by Schenk (2014), it seems design educators could restructure degree programs to emphasize the design process and

its reflective qualities, where hand drawing and computer aided design programs work in concert to complete design development, rather than exist as mutually exclusive, opposite ends of the skill spectrum.

1.2 Drawing as a Technical Skill, Not as a Communicative Tool

Research surrounding the comparative debate between hand drawing and the use of digital design software by interior design students is somewhat limited. However, related studies contain compelling information that could have broad implications for shaping future research on the subject. A seminal study conducted by Brandon and McLain-Kark (2001) explicitly compared the efficacy of hand drawing techniques such as sketching, drafting and rendering to the use of AutoCAD in the initial phases of concept ideation. The project culminated in the production of a rendered furniture plan for presentation at the conclusion of the design development phase. Prior to the experiment, 40 students were assessed for baseline levels of inherent creativity, as well as for preference for the respective techniques. Students were then divided into groups, based on their preference for the use of hand drawing or AutoCAD. The final design solutions were assessed for merit along dimensions of appropriateness, complexity, creativity, liking, novelty, originality, and thematic expression. Brandon and McLain-Kark (2001) found no significant difference between students who completed the requirements by hand as compared to those who created their design concepts using AutoCAD.

However, it should be noted that key limitations of the study could have influenced findings. First, design software has become increasingly more powerful and sophisticated since the inception of this experiment conducted by Brandon and McLain-Kark (2001). In order to assess student outcomes in concert with current professional trends, future research would have to

analyze hand drawing techniques against a more powerful design program that includes three-dimensional modeling capabilities, such as Revit. Additionally, students were not randomly assigned to use the respective techniques. While this may not have been an appropriate practice in the context of this seminal study, random assignment would be a more scientific method for isolating the effects of hand drawing as a part of a hybrid process where final design concepts are imported into computer design software.

Professional designers have made adjustments to the ways in which the design process is executed as a result of improvements in design technology. Subsequent research investigates the implications of a hand generated design process and how that affects the outcome of the final concept. In contrast to the study conducted by Brandon and McLain-Kark (2001), qualitative research conducted by Lu (2009) investigated the effects of hand generated and digital methods through the lens of student preference. 22 participants were organized into teams of two and three. Teams were assigned two projects to be completed using manual or digital media, including relevant exercises in three-dimensional modeling techniques. Students were allowed to use both manual and digital forms of media to complete their design concepts, with 59% of them engaging a hybrid process. Throughout the duration of the projects, students provided experiential feedback via posting blog entries and participated in interviews conducted by the researcher; responses were coded into common themes. The majority of students responded in a positive manner to the inclusion of digital and hand techniques throughout the entire design project, indicating a preference for a hybrid process, shaped by student proficiency and preference (Lu, 2009).

The study created by Lu (2009) does not prove any one design method as unequivocally superior. The qualitative nature provides insight into inherent student traits that potentially shape

research outcomes. However, in order to design a more experimental study, future strategies might confine various hand techniques related to drawing and model building to the conceptual process in order to observe ways in which they influence final design solutions. Additionally, the researcher did not assess final design solutions in terms of merit. While it is helpful to understand student perspectives regarding the use of different manual and digital techniques, it is difficult to ascertain what effects, if any, a hybrid process had on the ability of students to produce more creative, functional ideas (Lu, 2009).

Lu (2009) found that students appeared to enjoy incorporating hand drawing and digital design techniques as a part of a hybrid process, although responses indicate that computer methods are preferred as a result of perceived deficiencies in hand drawing techniques. Students appreciate three-dimensional modeling techniques because these methods allow them to more accurately visualize the space (Lu, 2009). It is important to note that student proficiency is a significant factor in the choice to use hand drawing or digital techniques (Lu, 2009). Students with an ability to draw felt more comfortable with hand generated techniques, and provided comments such as “I prefer hand sketches and rendering. I feel like I have more control” (Lu, 2009, p. 12). Additionally, students implied their attitudes toward hand drawing were perpetuated by the way in which hand drawing is taught in design curricula. However, it is also pertinent to note these preferences and attitudes pointed to a distinct gap in how research was conducted that may better articulate the benefits of hand drawing techniques in the design process.

Subsequent research investigated more conventional hybrid processes, defined by the simultaneous use of hand drawing techniques and digital design programs (Zuo & MaloneBeach, 2010). Contrary to the preceding investigations, Zuo and MaloneBeach (2010) observed the

implications of using digital design tools in a design process with foundations in hand generated methods. Eighty students were selected as a convenience sample to complete the same design project. One group was limited to the use of only hand drawing techniques. The second group used a total of three design programs (AutoCAD, SketchUp, and 3D Studio Max) to create digital models that were subsequently printed and affixed to structural frameworks to create three-dimensional concepts. In contrast to the comparative study by Lu (2009), upon completion of the project solutions were evaluated along dimensions of merit and creativity. Results indicated a significant difference in the ratings of the two groups, with the hybrid process returning higher evaluation scores in terms of merit as compared to the group that used only hand generated visualization techniques. Contrary to the study conducted by Brandon and McLain-Kark (2001), this study expanded hands-on techniques to include building.

It is important to note that the hybrid process in the aforementioned study (Zuo & MaloneBeach, 2010) referred to the creation of hand made models rather than to incorporating hand drawing and digital programs in the same project. Similar to earlier research, the analog group was again required to use drawing in the creation of final artifacts, rather than shape loosely defined ideas into technical output with the assistance of computer programs. Students whose hand drawing abilities are inherently weak were at an immediate disadvantage when tasked with completing these illustrative images, which required an entirely different skill set (Lyn & Dulaney, 2009). Findings indicated that educators could bridge the philosophical divide between hand drawing and digital graphics by incorporating them into a hybrid process, rather than as stand-alone courses (Zuo & MaloneBeach, 2010).

Collegiate interior design programs are governed by the Council for Interior Design Accreditation (CIDA). As the body that develops standards for interior design programs, CIDA

does not provide a specific framework that dictates the degree to which hand drawing techniques and computer aided design programs are incorporated into degree programs. Design curricula tends to include media that are relevant to the needs of the profession (Tan, Peek, & Chattaraman, 2015). Yet, it appears that design programs are shaped around the philosophies of those in charge, rather than what might be of most benefit to the student (Lyn & Dulaney, 2009). Design firms often employ a hybrid process (Edwards, 2005; Pable, 2006; Schenk, 2014), yet collegiate interior design programs continue to compartmentalize these techniques, perpetuating the perception that they are mutually exclusive (Lyn & Dulaney, 2009, 2010). In order to properly equip interior design students with the tools for success in the professional world, educators must have a clear understanding of factors that affect student propensity towards the use of hand-drawing and digital techniques and their implications for critical thinking skills related to the development of "design thought."

1.3 Hand-Drawing Supports "Design Thinking" Among Students

Design does not have a subject matter, and is, rather, a way of looking at any given topic (Orthel, 2015). Design is an endeavor through which early process work is intertwined with final design solutions (Carmel-Gilfilen & Portillo, 2010). In order to understand the potential impact of a hand generated design process upon the merit of a final design solution, it is important to understand the nature of design thinking and its implications for student success in terms of cognitive development.

Very little information exists related to the measured cognitive output produced by people during participation in creative processes (Belkofer, Van Hecke, & Konopka, 2014; Seitamaa-Hakkarainen, et al., 2016). Much in the way of idea development and perceived design prowess is measured by educators and professionals through their inherent experience (Edwards, 2005;

Lyn & Dulaney, 2009; Dulaney & Lyn, 2010; Schenk, 2014). But neuroscience can give insight into the existence of the hand to mind connection and its correlation with creative activity. A study published by Belkofer, Van Hecke, and Konopka (2014) recorded the residual existence of alpha activity in the brain after engaging in a creative exercise. According to the study, alpha activity is associated with "relaxed states of conscious thinking" (Belkofer, Van Hecke, & Konopka, 2014, p. 62). The waves are further associated with "visualization, working memory, and self-regulation" (Belkofer, Van Hecke, & Konopka, 2014, p. 62). While the researchers conceded that detailed read-outs measuring technical data related to brain function are beyond their capabilities, they did point to additional studies where increase in alpha activity had previously been recorded in association with subjects tasked to compose a drawing (Belkofer, Van Hecke, & Konopka, 2014). As previously mentioned, research in this area of emphasis is very limited, due to expertise and feasibility of study.

Seitamaa-Hakkarainen, et al. (2016) detailed an overview of the implications of neuroscience related to design research. Often, qualitative accounts from professionals are subjective and make it difficult to systematically evaluate cognitive development among designers (Seitamaa-Hakkarainen et al., 2016). Rather than study residual brain activity resulting from participation in simple, repetitive tasks, the researchers examined the implications of neuroscience as it related to the entire design process, through the lens of "embodied cognition" (Seitamaa-Hakkarainen et al., 2016). Embodied cognition is characterized as processes that involve and are enhanced by "sensorimotor experiences" gained through interaction with the surrounding environment (Seitamaa-Hakkarainen et al., 2016). Through this specific lens, the researchers aimed to correlate levels of brain activity with various stages of process in craft and design, as a way to

provide a more scientific context to research related to cognition and the conceptual design process.

Seitamaa-Hakkarainen et al. (2016) summarized an experiment that attempted to employ neuroscience to gauge cognitive output among designers. The study involved students in their first year of a textile design program. Similar to the study by Belkofer, Van Hecke, & Konopka (2014), an electroencephalogram (EEG) was used to observe changes in brain activity as students performed tasks related to textile production. The researchers examined residual brainwave activity in 15 participants as they learned two textile techniques: crocheting, with which they were familiar, and either filet lacing or tatting, with which they were completely unfamiliar. In the first phase, participants viewed a series of photos illustrating the instructions for the aforementioned textile techniques, with brain activity measured through EEG readings. To illustrate a comparison, students were then taught how to crochet, in addition to one of the techniques with which they were unfamiliar. As a part of reflective practice, participants were asked to keep a journal of their experiences. At the conclusion of the instructional period, the researchers performed another EEG reading on the participants. When students were shown the series of instructional photos a second time, researchers were able to notice a positive increase in cognitive activity, indicating that they recognized the hand motions associated with the previously learned skill.

While the results are not highly specific, this experiment is an introduction to ways in which neuroscience can illuminate student engagement with the design process at a biological level. It is important to note most of what Seitamaa-Hakkarainen, et al. (2016) observed related to craft skill rather than hand drawing. Participants were required to keep a journal, which involved reflection through writing. However, those detailed responses were not included as a part of the

report. Regardless, the findings indicated this method offers a potential avenue through which a more systematic understanding of cognitive development in design can occur among participants. While this is an exciting premise for future research, there are significant limitations that prohibit it from being widely employed by design researchers. First, use of the measuring apparatus is likely confined to a laboratory setting. This stipulation could have broad implications for convenience and comfort for participants in future studies. Second, and most importantly, interpreting results from this perspective requires expertise in the field of neuroscience. As it relates to drawing, design researchers are likely better served to pull from related literature as to behavior indicative to cognitive development and its manifestation in the design process through hand drawing and sketching.

Fortunately, there many sources to draw on to gain related insight, offered by the world of visual art in addition to design relative to the cognitive benefits of drawing (Cain, 2010; Kantrowitz, 2012; Tversky & Suwa, 2009;). One study in particular, by Kantrowitz (2012) detailed the implications of hand drawing, studied through the lens of metacognition, or an ability to detect one's own thought processes. It is a method for articulating the "unknown unknowns" (Kantrowitz, 2012).

Drawing provides a space wherein ideas and perceptions take physical form so that ideas may be explored and manipulated (Schenk, 2014). The reflective nature of drawing enhances memory and observation (Kantrowitz, 2012). Additionally, the ambiguity of drawing provides opportunity for innovation, and avoids the practice of "mechanistic copying" (Schenk, 2014). While the effectiveness of drawing is subjective, these facets can be applied to a broader framework that could potentially be measured: the concept of "design thinking."

There is not a single consensus typifying the process of design thinking (Beacham & Shambaugh, 2011). However, selected literature agrees upon some general characteristics that could potentially serve as a way to measure cognitive development through drawing (Beacham & Shambaugh, 2011; Razzouk & Shute, 2012). For example, much like drawing itself, the practice of design thinking is intensely reflective. Designers use information to produce creative work and through the production of that work, gain knowledge (Razzouk & Shute, 2012). In a general sense, the concept of design thinking allows for a big picture thought process, in which a designer not only attempts to define the problem and satisfy requirements, but takes a holistic view of cultural context, in which people are a central feature of focus (Beacham & Shambaugh, 2011). Constraints are seen as opportunities, and designers navigate between analysis and synthesis in a nonlinear fashion to solve design problems. Then, as a designer gains additional experience, a range of tools is at their disposal to assist in the completion of project goals (Beacham & Shambaugh, 2011).

Regardless of detailed interpretation of the components typifying design thinking, there is a general progression in which design problems are solved through ideation (Beacham & Shambaugh, 2011). Preparation or problem identification is the first phase. Designers use this time to define the relevant issues at hand and focus their efforts on analyzing specifications and identifying constraints. In these early stages, it is important to begin to visualize a solution through the lens of constraints and new ideas. As the idea takes shape, designers must then reconcile the concept with feedback from the surrounding environment. Feasibility, material considerations, and observation of relevant examples are important to making a proposed solution workable for the environment as well as satisfy specification requirements. As a concept is fleshed out, it is fine tuned to align with project goals (Beacham & Shambaugh, 2011).

Based on the preceding description of design thinking, it seems this process continues to be implemented throughout design curricula. But, are students actually engaging in the design process in a meaningful manner? Feedback from the professional world would indicate otherwise (Schenk, 2014). Professionals indicate hand drawing is a valuable tool in the beginning stages of the design process (Edwards, 2005; Schenk, 2014). Educators and professionals tout drawing as an indicator of design ability (Lyn & Dulaney, 2009, 2010). Additionally, professionals indicate that it is more important for students to master the use of computer aided design programs in terms of completing project goals (Lyn & Dulaney, 2010). However, when examining the literature involving course distribution devoted to the respective skills in design curricula (Lyn & Dulaney, 2009; Dulaney & Lyn, 2010), classes devoted to hand drawing and computer aided design programs have nearly equal representation in the class schedule, perpetuating the belief that these skills are mutually exclusive. However, the "general to specific" framework of design thinking could provide a framework in which hand drawing serves as a conduit for innovation in early stages of the design process (Schenk, 2014).

Literature also speaks to the power of drawing in regard to the way it allows designers to develop finely tuned skills of observation (Schenk, 2014; Tversky & Suwa, 2009). As mentioned by Schenk (2014), sketching allows for the implementation of tacit knowledge, or "unknown unknowns" and "unknown knowns." These details are interpretations that may be present in the design process, but only articulated when the designer transfers the information from the mind to paper (Schenk, 2014). Moreover, drawing provides a conduit through which to interpret these tacit details in ways that potentially improve existing design ideas. For example, Tversky and Suwa (2009) spoke of sketching as a tool to emphasize relevant details, and minimizing those that detract from achieving project goals. This process of layering ideas is much more difficult to

achieve through the use of computer programs as they allow designers to only manipulate what is "already known or what is established" (Schenk, 2014, p. 49).

Conversely to the use of computers, drawing allows for the reinterpretation of forms, marks, and shapes to potentially become meaningful design concepts or details (Schenk, 2014). Drawing assists designers in fighting "fixation," or the inability to move beyond the visualization of a specific detail (Kantrowitz, 2012). The ambiguity of sketching in this manner allows for prolonged re-interpretation, ensuring the designer has as many opportunities as possible to explore ideas. These augmentations are often spurred by something as simple as a stray mark or scribble, again, the potential to articulate "unknown unknowns" (Kantrowitz, 2012). Drawing allows for this spontaneous innovation in an era when computer generated concepts tend to look similar, despite the originality of design ideas.

Computer aided design software is incredibly dense with processing power, and with immensely powerful capabilities in terms of visualization. However, it has not evolved to the point of artificial intelligence, with an ability to generate design ideas (Cross, 2001). Concern from professionals indicated a deficiency in the ability to draw and sketch in entry level designers could potentially point to too much dependence on the computer to generate ideas (Schenk, 2014). As Cross (2001) explored the replication of computational thought using humans as processors, he discovered that while computers had immense power for solidifying final design solutions, they continued to require original input from their human users in order to create design concepts (Cross, 2001). While the advent of new software has allowed for more finite human input in recent years (Meneely & Danko, 2007), programs such AutoCAD and Revit are merely tools through which to input data and refine that information as part of a concept. In order to provide a streamlined transition from ambiguous idea to finite solution,

faculty could bridge this gap in creative process by explicitly utilizing tenets of design thinking as a part of design curricula, wherein drawing functions as the pre-eminent tool for the creation of design concepts (Edwards, 2005).

The conceptual process is rife with the potential for cognitive development (Schenk, 2014), as it is the traditional context for solving design problems and creating design solutions. Research related to design thinking is limited in terms of definitions and application. While studies incorporate principles related to the framework as a part of context, very little information exists related to student experience and not enough focuses on reflective practice. A study conducted by Caramel-Gilfilen and Portillo (2010) attempted to gauge intellectual development among interior design students as they transitioned from foundational classes to upper division studios. The study evaluated 32 students using a theoretical framework called the Perry Scheme of Development in order to measure the evolution of intellectual thought and design prowess. According to the creator of this framework, a connection existed between cognitive development and engagement in creative activities (Carmel-Gilfilen & Portillo, 2010).

In the context of the Perry scheme, findings indicated some students do not make the connection between sketching as a vehicle to develop thoughtful ideas during the beginning stages of the design process and the quality of the final design solution. Moreover, findings indicated educators must work to understand the unique abilities of each student in order to help bolster the connection between an exhaustive conceptual process and decisions made in subsequent phases of the design project (Carmel-Gilflen & Portillo, 2010). Various hands-on techniques were identified as a part of the ideation phase of the design process: sketching, diagramming, and model building. Aligning individual thought processes with analog design techniques could provided a conduit for improving the critical thinking skills of design students.

"Everyone uses computers now and therefore it is something I need to be more comfortable with" (Meneely & Danko, 2007, p. 81). Research examined the use of digital drawing tools such as the mouse, or tablet pens for cognitive benefits typically inherent in hand drawing techniques (Meneely & Danko, 2007; Tan, Peek, & Chattaraman, 2015). The same sentiments were evident in research examining the use of various hands-on methods that could integrate both techniques in ways that are more meaningful to students (Meneely & Danko, 2007; Konkel, 2014). In light of changing technology, educators might consider alternate methods that offer a nexus of technology and hand drawing that enable students to see the ways in which drawing contributes to the creation of ideas. A study conducted by Meneely and Danko (2007) observed various groups of interior design students and their experiences related to using various types of design drawing software. Groups of sophomore, junior, and senior level interior design students were recruited to test drawing tablet software via a series of five exercises that included conceptual design, rendering, and drawing related to the design process. Upon completion of each task, students were asked open-ended questions regarding their experience of using the various tools in completion of the projects.

Students indicated a positive response in completing exercises with the various types of software, and cited feelings of ease and comfort in terms of ability to effectively complete tasks, as compared to using traditional pencils on tracing paper (Meneely & Danko, 2007, p. 86). However, 20% of the students indicated they experienced a learning curve in regard to practical use of the technology, which made it difficult to complete the assignments. Additionally, responses indicated that participants seemed to emphasize learning technology for its own sake, implying motives for learning technology are guided by the minutiae of the actual software and not the process of design (Meneely & Danko, 2007).

Findings suggest that students do not necessarily engage their cognitive skills while learning to use computer programs to execute their design process. Researchers advise that students constantly question the role of technology within their design process in order to ensure alignment with their intended project goals (Meneely & Danko, 2007). The researchers formed a compelling argument for digital drawing tools that have the potential to replace pen and paper. Respondents indicated a potential place for such methods within design curricula. However, findings from previous studies indicated digital software may be more appropriate to exist alongside drawing, rather than to replace it, in order to preserve cognitive processes related to conceptual design (Meneely & Danko, 2007)

A similar study conducted by Konkel (2014) investigated the concept of "build to learn" classes in which students utilize hand techniques related to creating scale models in the early stages of conceptual design. While these projects focused largely on construction based exercises, the researcher asserted that the "hand to mind" connection still existed in terms of the development of critical thinking skills (Konkel, 2014). Konkel (2014) chronicles 40 interior design educators who employed "build to learn" projects in their classrooms. As a part of their curriculum goals, professors indicated specific learning objectives they expected students to achieve: understanding of space, volume, scale, and three dimensionalities, as well as construction methods and sequencing (Konkel, 2014). Completed projects were evaluated according to positive and negative learning outcomes. The study had overwhelmingly positive responses in terms of improved understanding of design solutions. The study also included a qualitative component of interview questions designed to capture the experience as perceived by the students. Similar to the instructors, students reported a largely positive response to the entire

process, as 64% reported being most excited about building the model. However, only 36% of respondents indicated enthusiasm towards related drawing analysis (Konkel, 2014).

In contrast to previous studies, Konkel (2014) did not look at improving student design processes through drawing, but examined methods responsible for bolstering the hand-to-mind connection in a holistic manner. While the results were not statistically significant, the study did indicate a definitive increase in understanding of the design as it relates to scale and proportion, as reported by the professors. Previous research produced largely vague results (Brandon & McLain-Kark, 2001; Lu, 2009), other than insight into student preference towards hand drawing or digital techniques. Findings indicated previous studies were not structured to evaluate solutions based on learning outcomes that provide more insightful information related to how students are engaged in terms of cognitive benefits (Konkel, 2014).

It is difficult to assess cognitive benefits of drawing in a purely scientific sense (Seitamaa-Hakkarainen et al., 2016). As mentioned, a large barrier to employing this type of research is a lack of expertise in the field of neuroscience. However, a scientific understanding is not necessarily the point of future research related to the cognitive benefits of hand drawing as it relates to the design process. It is more important for educators to understand the unique qualities of design thinking and the ways in which development of ideas are bolstered by hand drawing throughout the various phases of ideation.

1.4 Assessing the Efficacy of the Conceptual Design Process

Literature points to a gap in regard to the ways in which hand drawing and digital drawing techniques enhance or hinder student ability to generate ideas in the conceptual process. Related literature explores the implications of design thinking as a result of enhanced cognitive processes potentially afforded by working with hand generated techniques (Beacham &

Shambaugh, 2011; Konkel, 2014; Razzouk & Shute, 2012). Literature also provides insight into the preferences of students related to inherent ability, ease of use, and perception of various types of analog and digital techniques in order to enhance the organization of design curricula (Lu, 2009; Meneely & Danko, 2007; Tan, Peek, & Chattaraman, 2015; Zuo, & MaloneBeach, 2010). However, only one study attempts to assess the efficacy of these techniques in terms of "design merit" (Brandon & McLain-Kark, 2001). The quasi-experiment observed the design processes of two groups of students. One group completed the design development phase of an interior design project using only hand drawing techniques. The second group completed the same project requirements using AutoCAD. Final solutions were evaluated by interior design faculty who scored students along dimensions of appropriateness, complexity, creativity, liking, novelty, originality, and thematic expression (Brandon & McLain-Kark, 2001). Scores were analyzed using a T-test to determine if one group scored significantly higher along the previously mentioned criteria.

Brandon and McLain-Kark (2001) plainly state there were no significant differences between the two visualization techniques along the seven dimensions that typify design merit in this study. They admit many factors could have influenced experiment outcomes, such as project duration, inherent student capability, inherent level of creativity, and student preference. However, they did not discuss the subjectivity of design assessments in studio classes and what characteristics constitute creative design solutions. In order to determine effective methods for organizing design curricula to provide the best student experience, assessment could be a very important tool in illuminating specific ways in which hand drawing contributes to the ability of students to solve problems in a creative, yet practical manner.

The dilemma as to how creativity is assessed in design studio projects (Williams, Ostwald, & Askland 2010) is an issue that runs parallel to the broader debate surrounding the presence of hand drawing and computer programs in design curricula. Among the design disciplines, there is no common understanding of how creative processes apply to learning and teaching experiences (Williams, Oswald, & Askland, 2010). The literature review by Williams, Oswald, & Askland (2010) attempted to shed light on the division between philosophy relative to project assessment and its inclusion of process-driven work. The act of design is a subjective process; solutions are a synthesis of information and project requirements that culminate in the creation of previously unimagined solutions (Williams, Oswald, & Askland, 2010).

Although creativity is often seen as a crucial component to the success of a design concept, it is ambiguously defined by educators in an attempt to assess overall design merit (Williams, Oswald, & Askland, 2010). In terms of instruments, trends have shifted to detailed, requirement-driven rubrics in an attempt to communicate a concise, transparent explanation of deliverables in the interest of clarifying mutual expectations between teacher and student. While this method helped to minimize stress related to expectations on the part of the student, it is often believed to over-define project goals to the point of stifling creativity. As a result, the project focused on quality assurance related to deliverables while minimizing the importance of the design process (Williams, Oswald, & Askland, 2010).

The study conducted by Brandon and McLain-Kark (2001) illustrated this point, as student design outcomes are assessed through the creation of a single artifact: a rendered floor and furniture plan. Not much regard is given to the process by which students arrived at their chosen solutions. The seven dimensions of design merit were not assessed in terms of the design process as a whole and as a result do not provide much insight into how individual solutions

were shaped through either hand drawing techniques or computer aided design programs. Research indicates that a more holistic method of design assessment is required to capture the essence of factors that influence the success of a concept.

Design does not attempt to define a single correct answer. Instead, the very nature of the design process pushes students to explore solutions that reflect their inherent knowledge and ability of the field (Williams, Oswald, & Askland, 2010). Creativity is commonly defined as an ability to solve problems. However, in context of the design process, the level of creativity is more dependent on a student's ability to define the problem, rather than to solve it (Williams, Oswald, & Askland, 2010). The design process is defined by specific reflective actions through which students synthesize and apply information in the culmination of a final artifact, or design solution. Despite the notion that concept and solution are intertwined, creative assessment tends to emphasize the tangible output, while failing to consider the preceding creative process through which design intent is established (Williams, Oswald, & Askland, 2010). As a result, this reinforces a system of evaluation that places significantly more importance on artifacts, where a greater amount of emphasis is shifted to the final outcome rather than on evaluating the process through which students incorporate knowledge, skills, and perception of environment in the creation of thoughtful conceptual ideas.

Over the years, researchers have attempted to develop assessment models and techniques that more effectively evaluate design solutions in a holistic manner. One example created by de la Harpe and Peterson (2008) provided a flexible framework for evaluating creative projects based on outcomes, and knowledge, as well as on reflective and professional practice. Although this model preceded the research conducted by Williams, Oswald, and Askland (2010), it expresses the same sentiment regarding inadequate tools for assessment amongst design

educators. De la Harpe and Peterson (2008), however, took a broader approach and created a model intended to encompass fields within visual art and design. The Model for Holistic Assessment evaluates student work on three equally weighted levels: outcome dimensions, knowledge and skills, and reflective and professional practice. Outcome assessment focuses on traditional components of a design project relative to final product and the student, in terms of their role in facilitating the development of the design solution. Knowledge assessed proficiency in a range of skills related to visualization tools and techniques. In other words, this portion of the assessment model aligned proficiency in various types of skills that were applied to visualize or execute the design concept. Finally, the reflective level infuses the design product and learned skills with the professional development of the student.

The holistic model ensured that rubrics are not too narrowly focused on final artifacts or visualization content. Rather, this is an opportunity for the student to explain the design concept in terms of thought process and desired goals, in contrast to explaining the elements of a rendered image as an object separate from the design process. The model was designed to be flexible so that individual levels can be emphasized or de-emphasized, according to desired goals for project outcomes. For instance, outcomes could be weighted more heavily in terms of assessment within the core of the model, devoted to design process and the ways in which students implemented the concept as a part of the final design solution. Technological skills could be assessed as a separate entity so that proficiency could be evaluated apart from design intent. The holistic model could prove an effective way to isolate the ways in which visualization techniques affect the student's ability to successfully execute the design process in tandem with an assessment of proficiency in visualization techniques. The model did not contain any sort of quantitative scoring apparatus related to project grades. However, it could be applied to a scoring

rubric for use in the evaluation of design solutions from different groups for superiority in design merit.

A limited number of studies indicated positive learning outcomes from a hybrid approach to the design process (Zuo & MaloneBeach, 2010; Konkel, 2014), implying that some research may not be isolating the intended behavior for study. Moreover, seminal research did not consider the implications of design thinking and the role of hand drawing in the development of critical thought (Carmel-Gilfilen & Portillo, 2010; Orthel, 2015). A student's experience can be quite subjective and is dependent upon many factors such as inherent design ability and propensity towards hand drawing or digital design programs (Brandon & McLain-Kark, 2001; Lu, 2009; Meneely & Danko, 2007). However, no study attempts to evaluate hand drawing and digital techniques as a part of the conceptual design process in order to examine the implications for formation and exploration of ideas. Moreover, research did not examine the ways in which hand drawing and digital drawing techniques can contribute to a more fruitful design process and the potential positive implications as a part of the final design solution. Additionally, previous research does not consider the implications of design thinking and the role of hand drawing in the development of critical thought (Carmel-Gilfilen & Portillo, 2010; Orthel, 2015). However, it did imply that hands on techniques, not limited to drawing, provide for positive learning outcomes related to reflective learning practices (Konkel, 2014).

The proposed research study aims to synthesize conceptual output with evaluation techniques in order to more accurately illuminate the ways in which the use of hand drawing methods and computer aided design programs affect the development of ideas in the context of the conceptual design process. It is not the goal of the researcher to distinguish drawing techniques and computer aided design techniques as mutually exclusive components of the

design process. Rather, the intent is to demonstrate the communicative power of drawing in the creation of ideas and the positive implications for the development of final design solutions.

A broader goal of this study is to gain insight as to how faculty might better streamline curricula to provide a framework where drawing is used in concert with the powerful design software students must learn to become successful designers. In order to properly allocate resources, design curricula must also incorporate the unique experience of the students. Previous studies clearly articulated the importance of accounting for individual student learning preferences and backgrounds and how these factors affected their propensity towards hand drawing techniques or computer aided design programs (Lu, 2009). Parallel with development of critical thought through engaging in an appropriate conceptual process, subsequent research must take into account the experiential factors that affect a students' engagement with various types of design techniques (Meneely & Danko, 2007).

Through analysis of the preceding four themes, the researcher arrived at the following research questions: 1) In what ways do hand drawing techniques used in the conceptual design process affect the collective strength of final design solutions created by interior design students? and 2) How could educators use the information gleaned through this literature review to reorganize curricula within interior design programs to better serve the needs of students?

Beyond the practical implications for research and curriculum development, the greatest potential beneficiaries of this research are the student participants. This study presents an opportunity for them to discover more about themselves as interior designers. The framework of the experiment provides a practical, safe space to explore their own strengths and weaknesses so they might carry that information into future projects, and become more thoughtful, creative designers. This study intends to illuminate potential benefits that will last well beyond their

collegiate experience, propelling them forward as efficient problem solvers, poised to take their places in the professional design world.

Methodology

Although the quantity is somewhat limited, research detailed in the preceding literature review analyzed a complex set of factors influencing a diverse array of descriptive and analytical outcomes associated with hand drawing and its place in the design profession. Research does not provide a definitive answer as to the optimum arrangement of hand drawing and computer aided design programs in a collegiate setting (Lyn & Dulaney, 2009; Dulaney & Lyn, 2010). However, it does support the assumption that hands on techniques, not limited to drawing, provide for positive learning outcomes in terms of engagement in reflective learning practices (Cain, 2010; Konkel, 2014; Schenk, 2014). Research also suggested ensuing revisions in design curricula must align with the unique experiences of the students (Meneely & Danko, 2007; Lu, 2009).

It is clear that individual student learning preferences and backgrounds affected student propensity toward hand drawing techniques or computer aided design programs (Lu, 2009). Parallel with development of critical thought by participating in an exhaustive conceptual process, future research must take into account the experiential factors that affect a students' engagement with various types of design techniques (Meneely & Danko, 2007, Schenk, 2014; McAuley & Brooker, 2017).

Collective research related to the topics of hand drawing and cognitive development is diverse in terms of method and perspective (Cross, 2001; Brandon & McLain-Kark, 2001; Lu, 2009; Seitamaa-Hakkarainen, et al., 2016). However, studies indicated positive learning outcomes from a hybrid approach to the design process (Konkel, 2014; Zuo & MaloneBeach, 2010), and implied quasi-experimental efforts may not have isolated the effects of hand drawing

techniques and digital drawing techniques on the design capabilities of students. Additionally, earlier research does not consider the implications of "design thinking" and the role of hand drawing in the development of critical thought (Schenk, 2014; Kantrowitz, 2012; Carmel-Gilfilen & Portillo, 2010; Orthel, 2015).

For these reasons, the following mixed-method study was designed to observe the effect of confining hand drawing to the conceptual process rather than culminating in the production of a final artifact. Development of a method focused on hand drawing as a communicative tool could provide more profound insight as to the role of hand drawing and its association with aspects of critical thinking, such as reinterpretation and reflection. Additionally, through the lens of student preference and perception, results also provide avenues through which educators could streamline interior design curricula, ensuring design programs cultivate thoughtful, effective designers poised to take their place in the professional world.

The study was crafted to gain valuable insight into the implications of hand drawing in the conceptual process, through the perception of student experience. The data was organized around semi-structured interviews where participants could describe their own conceptual design process within the confines of the class project. Research offered little information related to the use of hand drawing in the conceptual design process as told from the perspective of students. Lyn and Dulaney (2009; Dulaney & Lyn, 2010) summarized their efforts to assess the importance of the two methods through the lens of design faculty and professionals by exposing a void where students could provide valuable information related to their perception of curricula and the ways in which they learn and synthesize ideas. In order to analyze participant responses through an objective lens, it was important for the researcher to be able to verify their perception of accounts with actual output produced as a part of the class. Quantitative instruments in the

form of rubrics and surveys were developed to validate student responses through their level of effort.

It was also important to incorporate feedback from the instructor to ensure students were being truthful in regard to their actions and their level of active participation related to the overall project. Rubrics developed by the researcher were used to evaluate visual information with statements related to activities associated with the design process along Likert-type scales as a way to assign a level of engagement to student efforts. Likert-type scales were chosen for their latitude in assessing the nuances of information to counteract the subjective nature of design and the unique thought processes of students. The same assessment method was used for the instructor surveys as a way to quickly provide an account of classroom activities as a context for participant interviews. The mix of quantitative and qualitative data collection methods were used so that participant responses could be viewed through an objective lens.

In order to weight the accuracy of responses in regard to student engagement with the conceptual design process, and overall effort expended in completing the project, the researcher also analyzed content generated as a part of the conceptual design process in the form of bubble diagrams and block diagrams, although the instructor also included related images such as mind mapping diagrams and sketches. Visual content was evaluated using a rubric developed by the researcher that assessed information along facets of design thinking such as “exploration,” “observation,” “production,” and “evolution” as a part of the pre-schematic process. The four categories were derived from research related to the conceptual process as a part of design thinking. While there was no consensus as to what “phases” constitute a generic description of the design process, design-researchers agree there are definite stages at which specific types of work takes place (Beacham & Shambaugh, 2011; McAuley & Booker, 2017; Schenk, 2014). The

four categories are a composite of research related to what constituted the ideation phase of the conceptual design process as a whole. The labels were intended to encapsulate actions that typified the evolution of a design concept in an attempt to assess the level at which students were engaging in the rigorous development of design ideas. Statements corresponded to key actions as a part of each category that theoretically correlated with visual output as a way to objectively analyze content that could otherwise be subjective due to the inherently dynamic nature of design.

Research related to the tenets of design thinking and the cognitive benefits associated with hand drawing served as a key component in the development of evaluative criteria used in the rubric, professor survey, and student interview questions. Neuroscience provided an empirical framework through which researchers can observe cognitive enhancements as a result of hand drawing. While results showed promise in terms of assessing creativity in a purely scientific manner, there were many limitations as to the way in which these phenomena were explored by design researchers. A background in the field of neuroscience was required to not only design effective experiments, but also to effectively interpret results. However, literature related to the study of thought processes specific to design students provided a more controlled perspective through which to study the cognitive benefits associated with drawing related to enhanced memory, evaluative skills, and engagement in reflective practice.

Evaluative statements included in the rubric to assess output associated with the conceptual design process and the final design solution (Appendix A) did not express these facets of design thinking in explicit terms. Rather, they centered around visual content and the ways in which what is contained within the artifacts translated to the final design solution; specifically, the statements consider the ways in which participants begin with a general,

ambiguous idea, and refine it into specific details woven into the final schematic solution. Design thinking is also denoted by an awareness of this process as well as outside factors that may shape design solutions, which seemed appropriate to explore as the project for this class involved a boutique hotel, located in an international city of each student's choosing. Statements also evaluated artifacts in terms of evolution of ill-defined bubble shapes as they are refined into defined spaces, with some semblance of scale. The researcher believed there would be enough visual content to see a clear progression between ambiguous ideas to clearly delineated interiors, per program requirements. The final design concept included in the presentation was evaluated for continuity in terms of the way in which ideas present in the visual content manifested in the final design solution. Additionally, the researcher looked for ways in which the students were able to reflect upon the evolution of their design decisions and the ways in which these decisions are synthesized with contextual information and program requirements.

The interview questions were the most important facet of data collection as they provided the greatest insight into the ways in which students used, or did not use drawing as a part of their conceptual design process. Specifically, semi-structured questions allowed participants the latitude to articulate awareness of their decisions and the ways in which they explored them as a part of the design process. Questions were designed to encourage students to reflect upon their process and examine the ways in which it impacted their final design solutions. Open-ended questions were incorporated to allow the researcher could probe for additional information related to the project as a whole. Additionally, the researcher included a question related to the role of hand drawing as perceived by participants. The researcher theorized students who engaged in hand drawing in the early stages of the design process would potentially view it as a communicative tool as opposed to a technical skill.

The research largely centered around qualitative information gathered from participants in the form of semi-structured interviews in order to gain first-hand insight as to the ways in which the ideation process shaped final design solutions. While research aims to define an agreed upon framework describing the concept of design thinking (Beacham & Shambaugh, 2011), process and methods associated with generating concepts were varied, and were dependent on the preferences of the individual (Lu, 2009). Theoretically, participants had honed their own design processes through the progression of classes in their degree program. However, instruments had to account for the possibility that they may have modified that process over time and with additional experience, to best suit their needs, which may or may not have involved hand drawing and sketching as a component of earlier stages of ideation. Additionally, it was important to corroborate the accuracy of the responses by analyzing the content alongside the perspective of the professor. The researcher trusted participants to give an accurate account of their experience in completing this project. However, validation from the professor was necessary to ensure students were giving honest responses and not what they felt the researcher *wanted to hear.*

It is common among researchers to define the earliest stages of the conceptual design process as a time designated for problem definition and analysis – a phase in which designers gather information and evidence to support subsequent ideas derived from their conceptual design process (McAuley & Brooker, 2017). This study did not look at the information gathered as a part of analysis, in this case related to a specific location, as a stand alone artifact. The category of "Exploration" looked at the output related to that synthesis of information and ideation through the creation of bubble or block diagrams. The researcher hoped to examine the ways in which student drawings incorporated the surrounding context of their location through

the manifestation of physical ideas present in their concepts, as arrangement of space and consideration for basic ideas related to circulation and function.

One specific benefit of hand drawing described by researchers is a heightened awareness of one's reasoning in decision making, or metacognition (Schenk, 2014). The researcher believed that if students were truly exploring the connections between context and design ideas, there would be evidence of that awareness in the form of consideration for external conditions such as building orientation and the physical environment that would impact their reasoning in making decisions related to design elements. A heading under Observation was included to assess the ways in which students are aware of their decisions throughout the conceptual design process. Theoretically, findings derived from extensive research of location and socio-economic conditions should have some effect on decision making in terms of design elements included in final concepts.

The category of production is the inevitable synthesis of ambiguous ideas backed by concrete information derived from analyzing the surrounding context. The ambiguous nature of hand drawing is a tool to bring "tacit knowledge into articulate focus" (McAuley & Brooker, 2017, p. 3). The ambiguous nature of initial sketches allows for the exploration of ideas conceived through the synthesis of research and creativity (Schenk, 2014). Through constant refinement, a simple stray mark could inspire a completely different idea or direction to be explored (Schenk, 2014). In order to glean the most creative content, designers must actively work through the repetitious process of drawing and re-configuring ideas in order to determine their relevance related to the broader concept that forms an answer to the problem at hand, in this case, the design of a boutique hotel (Schenk 2014). Through production of many conceptual schemes, the designer can validate or invalidate ideas related to their overarching idea at broad or

finite scale (Razzouk & Shute, 2012). Through active participation in the conceptual design process, the researcher believed students would be able to articulate the synthesis of research and consideration of external environment to produce a diverse breadth of ideas for their hotel.

Finally, the visual content was evaluated in terms of Evolution, or the ways in which ambiguous ideas were refined into realistic interpretations of space and function. At this stage, participants worked in a pre-schematic mode where concepts took the form of bubble or block diagrams, without the presence of defined walls. However, the researcher was eager to examine the ability of participants to synthesize vague ideas generated in the initial stages of production with real-world constraints associated with the function of a space. Although students were not expected to translate bubble or block diagrams into hand drawn schematic plans, there was an expectation that they would evaluate scale along with ideas for arrangement of space. More importantly, the researcher hoped to see a clear evolution of rough, inarticulate ideas to a workable concept with a clear definition of spaces and circulation patterns.

The completed design concept was evaluated at final presentations for the project, through an additional section included in the same rubric used to assess the strength of artifacts produced from the conceptual design process. The researcher attended and observed final design presentations for two of the three parts of the semester-long project. The same rubric was used to evaluate the strength of design solutions presented for Part Three and observe the ways in which they were potentially enhanced or hindered by engaging in the conceptual design process. Finally, at the conclusion of the semester, the professor provided the researcher with final cumulative class grades for each participant as a way to gain a more accurate picture of overall student engagement and the ways in which it positively or negatively impacted the strength of final design solutions.

It was there that designs were evaluated on the basis of Continuity related to their conceptual design process and the ways in which it was evident in final solutions for the hotel, assessed through the presence of final visualization content included in presentation boards. The researcher looked for connections between content generated as a part of the initial conceptual design process and the final solution in terms of organization of space, use of form, and incorporation of contextual research. Additionally, the researcher observed the way in which participants presented content related to their design concepts. The researcher expected to hear a logical progression from broad based, contextually driven ideas to specific ideas present in design solutions that supported the overall concept (Razzouk & Shute, 2012).

In terms of data analysis, bubble diagrams and other artifacts shared through the professor were evaluated according to a series of statements related to production and ideation, scored on a four-point Likert-type scale. Points ranged from *"poor"* to *"excellent"* so that evaluations accounted for level of detail and refinement among artifacts in the communication of design intent. Professor surveys functioned in a similar manner, with a series of statements related to student performance and participation in the conceptual design process, evaluated along a five-point Likert-type scale, ranging from *"strongly disagree"* to *"strongly agree,"* with an option to provide a "neutral" answer. The range allowed student participation to be evaluated in a more nuanced manner, and gave the researcher another method to further validate student interview responses and content displayed in final design presentations. The researcher also theorized that higher scores along the scale contained within the rubric would correlate to a higher overall grade in the class. Information collected through professor surveys was used purely as a tool to provide a context for student responses. The professor was also given space to

write additional commentary to expand on facets of student performance related to the conceptual design process as a part of the project.

Participants

Junior level interior design students (n=9) enrolled in their sixth semester of the degree program at the University of Central Oklahoma were recruited as a convenience sample to participate in this study. These students were chosen because they had completed a significant amount of their core classes in the degree curriculum and were enrolled in a class that would produce a large-scale project, where students would utilize computer aided design software to visualize final design solutions. Classes offer instruction related to the creation of design projects through non-digital processes, as well as through the use of computer aided design software. Up to that point, students have also completed a multitude of residential and commercial projects, varying in scale and complexity.

Participants from this class were recruited specifically because the researcher believed they would exhibit expert behavior in the execution of design projects. In the context of design thinking, researchers began to analyze behavior associated with expert and novice designers as a way to provide insight into the ways in which students analyze and synthesize information (Razzouk & Shute, 2012). According to research on the related topic of behavior, experts were said to work solutions from the "top down," entertaining "breadth-first approaches," while novice behavior was focused on more cursory details, without deconstructing the problem beneath the surface (Razzouk & Shute, 2012).

The conceptual design process executed by design experts is generally typified by an organized effort where phases of analysis and synthesis are carefully executed in concert with an awareness of visual and technical elements contained within the design solution. An expert

approaches a design problem in the context of previous experience. Research indicated a greater level of experience denoted a greater propensity to solve problems through the use of inductive reasoning (Razzouk & Shute, 2012). This behavior is in stark contrast to novice designers, who tended toward deductive reasoning, and approached the creation of design concepts from a process of trail and error (Razzouk & Shute, 2012). The researcher believed that although participants continued to hone expert design skills throughout the remainder of the degree program, they should approach the conceptual design process in varying degrees, from broad to specific terms.

Through collective experience, these participants have theoretically developed their own design process using the two methods in varying degrees, depending on project parameters and preference. Based on their skill sets, the researcher believed these students should be able to efficiently execute the conceptual design process utilizing their proficiency in the use of different types of hand drawing techniques and digital design software. Additionally, the researcher believed students should be able to articulate thoughts related to their conceptual design process and the ways in which it is manifested in the final design solution created at the conclusion of each project.

According to course documents from lower level classes, this particular group of students began with extensive training in hand drawing techniques to visualize space. Previous course projects focused on the production of plan, elevation, section, and perspective drawings. These artifacts are often associated with what is referred to as illustrative quality, or drawings not used in the construction of space or design details. They are purely used to visualize the overall function and aesthetics of interior space. As students advanced within their degree program, they were exposed to increasingly powerful computer programs to complete their projects, such as

AutoCAD and SketchUp. Students learned to use software to produce orthographic drawings such as plans, elevations, sections, three-dimensional renderings, and working drawings. The intent of the interior design program is to develop proficiency in possible tools needed to succeed in the realm of professional practice, with drawing in a technical manner, serving as the foundation for projects created in upper division classes. With a solid foundation in place, students began their junior year by learning to use Revit, a construction program with sophisticated three dimensional visualization capabilities.

Students who participated in the study were enrolled in Interior Design Studio IV, where they were expected to culminate training to date in the creation of a concept and drawings for a large scale, boutique hotel. In this course, students used Revit to satisfy project requirements in terms of working drawings, and provide illustrative renderings to explain their design decisions. However, they were also allowed to use other methods from their breadth of experience to illustrate design concepts, such as hand drawing or SketchUp.

Research Design

As students learn computer aided design programs, they tend to abandon the hand skills that are so vital to the effective exploration of ideas as a part of the conceptual design process (Lyn & Dulaney, 2009; Schenk, 2014; Kantrowitz, 2012). The mixed-method study was designed to assess the ways in which hand drawing and computer generated techniques used in the conceptual design process affect the cumulative grade of the final concept and its components. The overall goal was to assess the ways in which hand drawing contributes to the creation of more innovative, functional, and thoughtful design concepts. To conduct this study, the researcher worked closely with the professor assigned to the class to create a framework to

provide the desired information without causing undue stress to the students by disrupting project schedules or the creation of extra work.

Students were required to design a boutique hotel as a part of their Interior Design Studio IV class. The boutique hotel was a single project divided into three parts, or stages at which sections of the collective design concept were due. Students were allowed to choose between two floor plans, provided by the instructor, for their hotel. Each building plan had approximately 25,000 square feet of floor space. While students were tasked with space planning the entire building, each part focused on specific areas within the hotel for which the students were supposed to engage the conceptual design process at a more detailed level. These areas of focus served as the framework for the study. Part One included the design of the hotel lobby area and restaurant/bar area, as well as an additional common area such as a swimming pool. Part Two focused on the design of guest rooms as well as the design of another common area. Part Three included the design of an office area to house administrative and functional staff, in addition to another single common area. Students determined specific common areas as a function of their research and subsequent design programs. Common areas could include, but were not limited to: coffee shops, restaurants, bars, indoor or outdoor pools, computer resource rooms, and physical fitness facilities.

Project Description

In an effort to minimize undue stress on the student, participants completed the conceptual design process using the same techniques at each individual part of the project. As a class requirement, students were to create at least two different bubble diagrams to potentially develop into a detailed design concept in order to receive credit for fulfilling project requirements. Although they were only required to submit two concepts as a part of their final

deliverables, they were not restricted from producing additional conceptual drawings to visualize design concepts for each part. Participants completed the conceptual design process through the creation of bubble diagrams using hand drawing techniques. Once they arrived at an acceptable organization of space (per their research and program requirements) students could choose to continue to refine their concepts by hand or import them into the computer for the full schematic phase. Part One included a presentation of the design concept by the student, after which the professor introduced the second project. For Part Two, students created block diagrams using Revit. As with the previous project, students were required to create at least two diagrams as a part of the conceptual process using AutoCAD.

The block diagrams contained scaled rectangles within the chosen area of the hotel floor plan. Again, students could move through their diagram process and continue the development of the full schematic phase in Revit` once they arrived at their optimum concept. As with Part One, Part Two was followed by a student presentation of the design concept. Part Three allowed students to complete the conceptual process using their preferred method: hand drawing, AutoCAD, or Revit. Students were also required to create at least two conceptual ideas in Part Three. However, it was their decision as to whether or not that information was generated by hand or by computer. The researcher was not present in class to observe student engagement of the conceptual process. The decision to refine ideas in Revit was purely at the discretion of the student, with guidance from the professor. The study had no bearing on the progression of conceptual ideas and the timing or method through which students entered the schematic phase of their projects.

Data Collection Instruments

The researcher collected information from various data streams in order to analyze the efficacy of each method within the conceptual design process and the subsequent influence upon the finalized design concept. First, the researcher retained diagrams and sketches related to the conceptual process completed in Part One, Part Two, and Part Three. Visual information was evaluated using a rubric designed to assess facets of the design information along a Likert type scale (Appendix A). The rubric also contained a small section intended to evaluate the final design solution presented by each student in the context of their conceptual process. At the conclusion of each project, the researcher conducted interviews with individual participants (within a week after their presentations) as a way to gain insight into their perspective regarding the use of hand drawing techniques and computer programs to execute the design process.

Students participated in an interview session that consisted of 11 open-ended questions (Appendix B). Questions were structured so that the researcher could expand on topics related to the project or the conceptual process and probe for more detailed information. Conversations were recorded using a digital voice recorder and later transcribed for coded analysis. Finally, the class professor completed a brief survey as a way to further corroborate students' responses to interview questions at the conclusion of the spring semester. Professor responses were intended to provide a context for the student experience. A survey for each class period was administered during the conceptual phase of the project (Appendix C). Ideally, the professor would have submitted the surveys at the conclusion of each project. However, due to schedule and workload, the surveys were completed and submitted after the end of the spring semester. The final component of data collection included the final cumulative grade, assigned by the professor at the conclusion of each project phase. The class professor agreed to give the researcher access to

this information as a way to determine if the use of different techniques as a part of the ideation process contributed to higher or lower grades on the final project submission.

To ensure that no undue stress was placed on the participants, all identifying information as a part of the study was kept confidential. Students who participated were known as Student A, Student B, Student C and so on in written content, with true identities only known to the researcher and the professor, as she provided the final class grades at the conclusion of the semester.

Data Analysis

1.1 Qualitative Analysis

The researcher observed student presentations at the conclusion of each project, during which they included their complete design concept. Per class requirements, students were to give an oral explanation of their project, including an overview of the concept or reasoning behind their final design solutions. These presentations were not recorded by the researcher. However, the researcher made notes on each participant, examining the ways in which their conceptual ideas translated into concrete design solutions. Per requirements of participation in the research, students were obligated to take part in an interview session where they could give more insight related to their process and the ways in which they navigated project checkpoints. Information synthesized as a result of listening to each presentation was recorded in a latter section of an evaluation rubric (Appendix A) by the researcher to gauge the strength of the final concept, described in detail in the following section Quantitative Analysis.

Each interview was scheduled within a week of the corresponding presentation so that information related to the effort was fresh in the student's minds. Responses were recorded and later transcribed using free online software, and were then edited for content by the researcher.

Answers transcribed from student interviews were analyzed using an open coding technique where themes are assigned to phrases or passages from each response. Coded themes were grouped into categories. Interview responses were mined for information falling within categories derived from the coding process. Feedback contained within the categories illuminated the ways in which hand drawing techniques and the use of computer aided design programs affect the success of the design process through the lens of student experience. Information was analyzed for common themes among students and their respective projects.

1.2 Quantitative Analysis

Instructor surveys were analyzed alongside student interview responses in order to corroborate the tone and context of the statements given as a part of the interview process. Statements related to class observation were answered on a Likert type scale, followed by a space where general comments regarding any significant happenings in class were recorded. The higher the score per statement, the more it supported or corroborated student answers given in the interview sessions. Lower scores indicated a potential discrepancy between the experience purported by the student versus the activity observed by the instructor in class throughout the conceptual design process. It was the original intent of the researcher to code instructor free-response answers in the same way as the student interviews. However, responses from the professor were brief and lacking in detail. Thus, the researcher only looked at the responses rating student performance along the Likert type scale, making it a purely a tool for quantitative analysis in the context of the remaining data.

Lastly, visual information was evaluated using a rubric created by the researcher. The first four categories of Exploration, Observation, Production, and Evolution contain statements related to the successful completion of the conceptual design process, scored upon a Likert type

scale. The researcher collected tangible artifacts such as bubble diagrams and block diagrams, at the conclusion of the ideation phase for assessment using the rubric. The rubric was used to evaluate conceptual information at each phase of the project, whether the design process was completed using hand drawing techniques or AutoCAD.

Professor questionnaires were the same for all three parts of the project. Given the positive nature of the assessment comments, a higher score per section theoretically indicated a more successful conceptual design process. The rubric contained a small section at the end pertaining to the final design concept. As a way to observe the full impact of the design solution, the researcher attended design presentations for all three parts of the project. Final concepts were evaluated along the last section of the rubric for each phase. Through observation of presentations, the researcher examined the ways in which the concept shaped the ultimate design solution, with a free response space where the researcher able to make additional notes regarding each student's presentation.

Rubrics were administered throughout all three projects. However, Part One was evaluated later, due to the timing of Institutional Review Board (IRB) approval. As a result, the rubric evaluated the Part One through a compilation of information communicated as a part of an overview in the second project presentation, as well as information derived from interview sessions with each participant. Upon completion of the entire study, composite scores from each project phase were compared to determine if one method of executing the conceptual design process is superior in terms of creating a more thoughtful, functional, innovative concept.

Additionally, the composite scores from the research rubric were compared to the final grade assigned to the project phase by the instructor. Higher scores indicated greater student success in completion of the project. The goal was to synthesize qualitative and numerical

information to illustrate the importance of the conceptual process and the role drawing potentially has in its success. Student interviews were intended to provide insight into their own design process that could provide valuable information as to how design professors could reshape design curricula to include drawing in a way that promotes the communication of ideas rather than as a mutually exclusive skill applied only to refined visualization materials.

Limitations of the Procedure

There were many limitations due to the implementation of the research study as a part of a daily classroom routine. The professor was quite concerned regarding the causation of any undue stress on participants. As a result, students were not required to adhere to hand drawing or specified computer aided design programs as a part of their design process in Part One, Part Two, or Part Three of the semester-long project. Additionally, students were not penalized for generating content outside of the parameters of hand drawing or AutoCAD within the design process. Although the study aimed to examine these behaviors specifically, the professor did not require students to adhere to a specific process. As a result, visual information submitted to the researcher lacked in detail, which clouded the results related to student intent and idea development. Also, as the project progressed, students submitted fewer conceptual drawings per phase, again limiting the amount of information related to the design process gleaned by the researcher.

Data regarding Part One and its associated conceptual design process was gathered through subsequent presentations and interviews. Additionally, because conceptual artifacts could not be collected from the participants until the completion of each project phase, evaluation rubrics for Part Two and Part Three were completed at the end of the semester. The researcher would have preferred to collect data in real time, as it was being disseminated.

However, due to the IRB approval process and the structure of the class, it was not possible to collect data related to the conceptual artifacts and evaluate presentations in real time, as prescribed by the parameters of the study. As time passed, the potential to forget information surrounding content and context information increased. In order to counteract the potential degradation of memory surrounding the information, the researcher took detailed notes as a part of the presentations to apply to the rubric, after the conceptual design artifacts were distributed, in digital form, by the instructor.

As a result, many rubrics were incomplete, and only included information gleaned as a part of the final project presentation. In addition to the lack of detail in the artifacts, students also made reference to various sketches and diagrams that were not submitted at the completion of the project, per the instructor. The researcher could only take participants at their word in terms of their process and the products produced therein, despite the fact they were not submitted to the instructor as part of the final grade for each project phase. In spite of the smaller amount of visual data, the interview responses did much to bridge that gap and provide a context for the project presentations as well as cumulative grades in the class. Thus, the interview responses showed a marked distinction between those who engaged in their design process through the use of various hand drawing and computer techniques and those who appeared to complete the conceptual design process to satisfy requirements of the class.

Another limitation was the practice of the majority of students to only submit a minimal number of artifacts from the conceptual design process at the very beginning of Part One. As the project progressed, the quantity of conceptual design artifacts drastically diminished for each subsequent phase. The limited amount of visual information made it difficult to accurately assess the role of hand-drawing and the use of computer aided design programs in terms of their output.

Most bubble diagrams and sketches were greatly lacking in detail or refinement, which also made for a challenging evaluation process.

Aligned with this consideration is student propensity towards the use of hand drawing techniques and computer design programs in the creation of conceptual ideas. Some participants may have been more comfortable than others using hand drawing or computer generated techniques to produce conceptual drawings. However, the conceptual process is only defined as the use of bubble diagrams through to the pre-schematic phase, where the production of these visual artifacts are confined to specific deliverables. After the completion of these drawings, students were free to transfer their ideas to computer programs where they complete more refined schematic and illustrative drawings. Confining the study to the framework of the project eliminates the prospect of extra work on the part of the student. In the event a participant was not as comfortable with hand drawing techniques, they were able to complete their design concepts using computer programs with which they were more proficient.

Instructor surveys were another data stream collected as a part of the study. The researcher intended for the instructor surveys to be completed on a weekly basis, in order to provide a context, and help corroborate information provided from participants through post-presentation interviews. However, due to workload as a part of the class, the instructor did not complete the surveys until after the conclusion of the spring semester. Additionally, she completed a single survey, assessing overall student performance for the project, in its entirety, rather than per each project phase. While she relayed information regarding student conduct relative to the conceptual process for each project, it is likely that memory of specific behavior was diminished by the passage of time. The professor provided feedback in a designated free response section in the survey, in addition to rating student performance along a five point Likert

type scale. However, the commentary was very brief, and did not provide detailed insight into daily activities or events that could have affected student engagement in the conceptual design process.

While the researcher was concerned this may have an adverse effect upon the integrity of interview responses, preliminary findings indicated a gap between participants who actively engaged in the conceptual design process and participants who clearly did not. Moreover, the researcher could also judge interview responses against performance as a part of the final design presentation. While evaluation of a design solution in terms of general success is relative, the researcher has an extensive background in teaching design classes as an adjunct instructor. As a part of these classes, evaluating conceptual design process related to the final design solution was a central component of grading schemes. The instruments created as a part of this study were the main vehicle through which information is evaluated. However, the researcher leaned on this background experience as a design educator to process information disseminated as a part of project presentations with a discerning eye towards the application of conceptual ideas in the final design solution, in addition to research and context.

In reflecting upon post data analysis, the researcher is confident that the answers given by participants corroborate their performance in each project and vice-versa. The integrity of the answers is also bolstered by the final grade received for the entire class, as reported by the instructor. Students who clearly did not engage in the conceptual design process produced work that merited a lower final grade in the class. And, although brief, the professor did articulate through free response as a part of the survey, an indication of deficiencies related to execution of the overall design process in the completion of the entire project.

Results

The researcher observed a class of junior-level interior design students at the University of Central Oklahoma, during a semester-long project that was part of the Interior Design Studio IV class. The class was comprised of 12 female students, who were given the opportunity to participate in the research study. Of the 12 students, nine students agreed to take part, which resulted in a participation rate of 75%. At the conclusion of the research study, one participant was excluded from data collection as a result of failure to complete the interview requirements prescribed by the researcher, leaving a group of eight students (n=8), resulted in a 66% final participation rate.

The researcher collected data from numerous avenues in an attempt to gain a complete understanding of factors surrounding hand drawing as a part of the conceptual design process and its potential benefits as compared to the use of computer aided design programs. First, the professor collected creative output generated by participants in the form of bubble diagrams, relationship diagrams, criteria matrices, design programs, and additional sketches in order to observe individual thought processes in visual form. The artifacts were evaluated using a rubric that examined characteristics related to the design process along a five point Likert type scale (Appendix A). Second, the researcher observed the presentations of the final design solution given by each participant at the conclusion of the project.

As a part of that presentation, the researcher used the same, aforementioned rubric to evaluate the final design solution along with information gathered from conceptual design artifacts. Third, the researcher conducted semi-structured interviews with each participant at the conclusion of the second and third project phases in order to understand each individual's design process, and how it might affect the final design solution. Fourth, the professor completed a survey (Appendix C) in order to provide a context for student data gathered from the interview

process. And finally, the researcher collected final cumulative grades for each participant as a way to correlate their class performance and its effects of their individual design processes with the strength of their final design solutions.

As previously mentioned, data was collected through various streams in an attempt to gain insight into factors surrounding hand drawing and its effects upon the conceptual design process. Interview responses indicated a clear gap between those students who actively engaged in the conceptual design process in comparison to those who did not. Participants C, D, E, and F seemed to be much more engaged in their conceptual design process, as evidenced by the way they were able to reflect back on their performance throughout the three projects. Participants A, G, H, and I did not appear to have actively participated in the conceptual design process, as they were not able to articulate the ways in which their activities as a part of the design process contributed to the strength of their final design solutions. Information related to Participant B was stricken from the study, resulting from her failure to complete the final design presentation as well as the final interview session. While there were nuances to the level of engagement, based on responses, and visual content submitted by the instructor, the researcher could see a correlation between the effort to pursue an exhaustive design process and the correlation to final grades in the class, especially when compared to information gathered from final presentations at the conclusion of each project phase.

Of the participants listed, Student F and Student D received a letter grade of A in the class for their semester-long project and seemed to have engaged in their conceptual design process with greater enthusiasm compared to other participants in terms of visual output. Based on information submitted by the professor. They also employed a greater amount of hand drawing techniques as a part of their design process, indicating that because of a new found

comfort with quick sketching, they were able to create a framework in the front end of the project that allowed them to build in detail related to space planning, furniture placement, and material selection as a part of later phases.

The researcher theorized that increased engagement in the conceptual design process through the use of hand drawing would correlate with a higher final grade in the class. While that correlation is evident, relative to the top two participants, it does not necessarily hold true for the remainder of the students. It is important to keep in mind that the researcher did not have access to grades for each part, only the cumulative grade assigned at the end of the class. Students that seemed more engaged with the conceptual design process through hand drawing could have received lower scores on one or all three projects that adversely affected their class average. However, some participants who seemed to be less engaged with the conceptual design process may have better executed the creation of final deliverables, which potentially earned higher points in terms of project requirements prescribed by the professor. Grades could be a composite of high and low scores that may not be totally indicative of the cumulative effort exerted by students in the conceptual design process.

Additionally, the professor had indicated that each project had a significant number of requirements to be satisfied by each student. While the design intent may have been present, based on interview responses from participants, it is very likely they could have failed to meet project requirements in one or all three phases, adversely affecting their grades. For example, Student C and Student E repeatedly referred to time management as a problem, at various points, in both interviews. Yet, they seemed to be enthusiastic about the conceptual design process and the ways in which hand drawing streamlined their efforts, describing the ways in which they applied the conceptual process to their final design solution. However, they could have failed to

meet weighty requirements as a result of inability to execute in Part Three of the project. Conversely, completion of all project requirements could have resulted in a higher final grade, despite potential deficiencies in the final design concept.

Although Student H received an A in the class, it should be noted that the actual score was 90.1, or two-tenths of a point above a grade of B, on a typical grading scale with A given to 90.0 and above. While Student F and Student D received scores of 97.1 and 96.5, respectively in terms of interview responses there was a distinct difference between the ways in which Student F and Student D reflected on their design process and the ways in which it manifested within their design solutions and the answers given by Student H. While Student H appeared to have strong ideas, they were not strongly rooted in a conceptual framework shaped by the synthesis of research design as a part of the ideation process. Based upon answers given in both interviews, Student H often rambled, and was not able to clearly articulate a macro-level concept, instead focusing on individual components such as material selection, furniture selection, and rooms independent of the overall space plan.

Despite the apparent correlation, there were nuanced findings that indicated the complex nature of the conceptual design process and the ways in which it contributed to a strong solution. Of the participants who seemed to be more engaged with their process, Student C and Student E received a letter grade of B in the class. However, interview responses indicated they understood and appreciate the reflective nature of the conceptual design process and the ways in which it contributed to their respective design solutions. Additionally, they both articulated ways in which hand drawing was instrumental in the development of ideas and the speed at which they moved through project milestones. Conversely, Student H produced only the required conceptual drawings at the very beginning of Part One, and indicated an unwillingness to revisit them

throughout the remainder of the semester when executing subsequent phases of the project. Student H alluded to most of this ideation process occurring in her head, through clear visions of what she wanted to see in terms of design within the space, without transferring those ideas to paper in the form of sketches.

Yet, when viewed through the lens of professor comments, Student F and Student D are described as having *well-developed* and *detailed* design artifacts. Additionally, the professor noted both participants *applied* their concept to design solutions and design development, while Student H submitted no information for Part Two or Part Three, but the professor notes that Student H was able to discuss the design process, indicating the building of a concept likely took place on the computer.

According to interview responses, this is a common theme with all participant in varying degrees. As many of them did not create detailed diagrams as a part of their conceptual design process, many adjustments took place in Revit as the projects neared completion. However, this tendency was most prevalent with Student A, Student G, and Student H as previously mentioned, and Student I. Where the other participants (including Student C and Student E) were very descriptive with the steps of their conceptual design process, and how it related to their final solutions, Student A, Student G, Student H, and Student I largely spoke of their projects in terms of implementation, void of a concrete conceptual framework. They primarily referred to details related to their design, in terms of more finite details such as materials, furniture selections, and room features, where more engaged students spoke of their decisions in broad detail, relaying how their overall concept was infused throughout their design decisions. However, it should be noted that this was not completely the case for Student C and Student E. Although they seemed to understand the ways in which a broad conceptual idea translated into details, their research

was not as concretely aligned with their design solution. As a result, their conceptual framework for their ideas was not as clear and did not manifest in the final design solution in obvious ways.

Student G and Student I did not seem to understand the nature of the conceptual process and its purpose in relation to design development. While Student I seemed to have a better understanding by the conclusion of the final project phase, Student G did not value or see the point of sketching ideas or refining a concept over time. She noted she had a "very clear vision in her head" and rarely, if ever, adjusted that vision once it was input into Revit. Additionally, she did not appear to understand questions intended to probe for information, asking for clarification of the meaning of the term "conceptual design process" in both interviews and was unclear as to terminology regarding the ways in which her ideas translated into their final form as a part of the design solution. Moreover, she rarely, if ever, elaborated as to why hand drawing or facets of her conceptual process did or did not influence her design decisions, making it difficult to assess the impact of her process on her final solutions.

In contrast, Student I seemed to understand the value of the conceptual design process and grasped why hand drawing could be important to generating unique ideas. She indicated that she had created bubble diagrams as a component of the third project phase. However, there were no artifacts submitted by the professor. Moreover, she, like some of the other participants described her design in terms of individual details and not broad based conceptual ideas. The disjointed nature of her project could be corroborated through observation of her presentations at the conclusion of Part Two and Part Three, indicating she did not seem to take the ideation process very seriously from the beginning.

While grades reflect a multitude of considerations related to the completion of a large, complex project, the interviews did seem to clearly indicate which students were more engaged

in their conceptual design process and the ways in which hand drawing and techniques applied through AutoCAD or Revit helped realize project goals. Grades are not a sole indicator of impact of conceptual ideas related to the final design solution and there is not a direct correlation between conceptual development and impact on design solutions across the board. However, the two highest scoring projects included the most well developed concepts that manifested into details of the final design, while students who lacked a broad conceptual framework scored lower in terms of cumulative grade, although Student H achieved the lowest possible A, with a score of 90.1. This is far from a direct correlation. However, based on student feedback, observation of project presentations, and instructor comments, the researcher could see a potential connection between student output and evaluation.

Despite murky results in terms of correlating the impact of conceptual design ideas upon project grades, interview responses yielded rich data, and provided insight into individual thought processes that shaped the execution of concepts as a part of final design solutions. In terms of descriptive content, there were two distinct groups of students: those who were actively engaged with the conceptual design process as it relates to hand drawing and those who were not. As a result, their responses were categorized in relation to how they perceived the importance of that process and the ways in which it enhanced or hindered their ability to complete the project to their satisfaction. While participants provided meaningful insight into their process, the data was not necessarily rich in descriptive terms, which made detailed coding difficult. However, they provided enough information for the researcher to categorize language into four distinct themes related to the role of hand drawing within the conceptual design process and the ways in which it impacted final design solutions: 1) students exhibit facets of design expert and design novice behavior, 2) students articulate the cognitive benefits of drawing as a

part of the conceptual design process, 3) time is expressed as an opportunity and a constraint, and 4) The conceptual design process bolsters confidence among students as designers.

Limitations of the Study

The greatest limitation of the study was the implementation of it as a part of an existing design class. The professor wanted to safeguard against anything pertaining to the study that could potentially cause undue stress on the student or affect their grades in an adverse manner. Additionally, the researcher did not want to impose any additional work on the professor that could adversely affect the class or student performance in terms of grades. As a result, students were not required to employ the prescribed method of hand drawing or the use of computer aided design programs for their conceptual process. The professor implemented methods prescribed by the study as a part of the class but, students were not required to adhere to these methods. Students could move back and forth between hand drawing and computer programs as they saw fit. Additionally, although deliverables alternated between hand drawn and computer generated artifacts, the means through which the participants completed the design process was left open ended, and the method of completion did not have an adverse effect on their grades for that particular section of the project.

The inherent subjectivity of design and the ideation process presented challenges in relation to the success of the proposed study. The most obvious was the inherent design prowess unique to each student. Design is a process that is, by nature, unique to the individual responsible for the idea. Therefore, it cannot be condensed into a specific evolution that is deemed right or wrong. As a result of all of their training, students who participated in this study have developed their own design process that proves effective for the manner in which they work. Tampering

with their tendencies as designers could have affected output in a positive or negative manner that may alter the creation of their final design concept.

Additionally, due to the IRB approval process, data collection, which was intended to occur at a total of three project phases, only occurred in the second and third phase in real-time. In order to analyze the conceptual process for the first project, students included a verbal summary of the initial phase as a part of their second presentation. The researcher also asked questions related to the first project as a part of the interviews conducted after the conclusion of Part Two and Part Three in order to shore the gap between the IRB approval process and the implementation of the study. The researcher preferred to track results in real time, as student memories of their process and design concept were fresh in their minds. As time passed, and requirements changed for the completion of subsequent phases, previous information had the potential to be inaccurate or unclear. This was evident when participants attempted to recall information from Part One during the interview session for Part Two.

The project phases also posed another limitation to the study. Participants completed a single project, divided into three parts over the course of a semester. While the workload was distributed as evenly as possible by the professor, the nature of each project could have presented greater or fewer challenges in terms of ideation and space planning, depending upon the scope of work. Workload per project was a potential limiting factor related to student output. Part One may have been more difficult because it required the design of complex areas such as a lobby and restaurant. In order to minimize divergent levels of difficulty that might affect the ease through which students move through the design process, the class instructor attempted to weight each phase with comparable project requirements. For example, Part Two includes the design of guest rooms, which are considerably smaller in terms of scale, and therefore require less effort in

terms of effort expended in the conceptual design process. However, students are also required to design a second common area that could include a larger, more complex amenity space.

Part Three requires the design of administrative spaces in addition to a final common area. Relatively equal workloads per project help to ensure students are being challenged on an even plane throughout the study and that success in the conceptual design process is not necessarily a result of having to satisfy fewer project requirements. It should also be noted the programs for each project were decided prior to approaching the professor regarding the observation of this class for research. Additionally, any changes made to the project requirements prior to the start of the semester were made independently of the study. The professor ultimately disseminated work for the benefit of the students over preserving the mechanics of the study.

In addition to work required per project, the nature of each part also created challenges for the conceptual design process. Each space carried very specific design considerations that may have eased or complicated the design process. This holds especially true with amenities such as indoor pool areas or spa developments that may have required a greater amount of research in concert with design efforts. The inclusion of more detailed or unique applications of required material, furniture, and equipment may have indicated a more complicated design process that proves more difficult for students to navigate.

Despite the potential limitations related to subjectivity of design and its inherent process, the proposed study was intended as a more focused lens through which designers view the role of drawing in the field. By combining more targeted evaluation rubrics that attempt to peer into the heart of the design solution with student perception, and experience, design educators could potentially gain valuable insight as to how design curricula requirements can better serve

designers moving through their collegiate careers. The research study aimed to synthesize conceptual output with evaluation techniques in order to more accurately illuminate the ways in which the use of hand drawing methods and computer aided design programs affected the development of ideas in the context of the conceptual design process. It was not the goal of the researcher to distinguish drawing techniques and computer aided design techniques as mutually exclusive components of the design process or prove one method of ideation as superior to the other. Rather, the intent was to demonstrate the communicative power of drawing in the creation of ideas and the positive implications for the development of final design solutions.

Findings

1.1 Students Exhibit Facets of "Expert" and "Novice" Design Behavior

As a general observation, student responses in the second round of interviews were considerably more detailed in comparison with the first interviews. This could have resulted from seeing the semester culminate in the creation of a single, large scale project. Seeing the sum of their efforts could have reinforced the importance of the conceptual design process and its role in their success as designers. As mentioned, the presence of expert versus novice behavior was apparent after the analysis of interview content was complete. In terms of raw results, the importance of the conceptual design process was apparent from the beginning in the two highest scoring projects, those of Student D and Student F. For example, Student D could see the most impact on the second project phase because the exhaustive conceptual design process for Part One provided an initial framework to which she could apply her broad concept to more detailed processes such as furniture selection and layout.

Student D chose to locate the hotel in Barcelona, Spain, and following extensive research of the city and its character, wanted to focus on fusing Art Nouveau, a prevalent style of

architecture in that location, with modern design sensibilities. Specifically, she wanted to explore the use of refined, curvilinear forms that were inherent to the structure of the interior. Student D was the only participant to explore the concept in terms of a pre-schematic design, according to artifacts submitted by the professor. Student D added that the hand drawn bubble diagram allowed her to not only explore those forms, but to infuse the architectural style and context of Barcelona throughout the concept. Based upon observations of project presentations, those design elements were present throughout the entirety of her project. She also made reference to the creation of bubble diagrams and the way they allowed her to see space as a volume, specifically in reference to the ceiling height, which was an element that had not been previously included in her conceptual design process. Concurrently, this ability to visualize space along three planes - floors, walls, and ceilings - allowed her to think about the desired function of each space, which helped her not only set heights for her ceilings, but also consider their aesthetic details along with the other elements in her space. This overview from broad ideas to the details of space planning allowed her to infuse research and visualization to determine what was appropriate for her space.

Although not quite as descriptive, Student F also explored the conceptual process in great detail in the initial phase of the project at the beginning of the semester. She saw the conceptual design process as a framework intended to “guide your way” through the details of the project. Much like Student D, she explored ideas through a conceptual design process that used hand drawing for the creation of bubble diagrams, eventually evolving into pre-schematic sketches related to space planning. According to the artifacts submitted by the professor, she engaged in extensive research through word association and mind mapping to provide direction for her concept, in relation to space planning.

And again, as with Student D, she indicated the information related to research and articulated through conceptual sketches, allowed her to build in detail related to more finite processes such as material and furniture selection appropriate to her concept. As she saw it, an intense focus on the conceptual design process allows for the completion "of half of your project" in terms of providing a direction for subsequent phases. As a result, she was able to move through the second and third projects more quickly because she had a clearly defined direction. Moreover, both students indicated they found themselves reflecting back upon that initial concept to ensure subsequent decisions "made sense." Specifically, they indicated that being able to "see" ideas before them through sketches and diagrams was helpful in making decisions related to the mechanics of the design.

Conversely, several students did not engage in that macro-level thought process in order to create a framework for design details. For example, Student A did not indicate a very clear direction, derived from the context of her chosen location: Kilkenny, Ireland. She alluded to using nature as inspiration, as her location is more pastoral, but it was very cursory compared to the decisive vision laid out by Student D and Student F. Student A mentioned more topical ideas such as drawing inspiration from "rocks," "grass," and colors such as "green and brown." Additionally, based on her answers, she articulated inspiration as what she "thought of" personally, rather than making decisions based on concrete research. Perhaps most telling about her results was a total lack of discussion related to the execution of her actual design process. Her answers were focused more on the outcome, in terms of material choices or forms, but did not include much in terms of why she explored those specific directions.

Moreover, in terms of conceptual design artifacts, she submitted minimal information. She appeared to have two bubble diagrams illustrating similar concepts, although it seems the

second image is a hybrid between a bubble diagram and a conceptual space plan, where small shapes appear to indicate furniture. It is possible she could have engaged in additional sketching related to the conceptual process. However, she indicated that changes were almost always made in the computer. As a result, the cumulative assessment of her project did not convey a strong connection to the location in terms of intent. Based on observations of her presentation, the materials shown in the renderings were not well executed.

In terms of creating a concept derived from the natural setting of Ireland, there was evidence to support that intent through the use of various materials and finishes. However, the collective appearance was nondescript, with Part One being the most visually interesting. As her project progressed into Part Two and Part Three, the concept became increasingly generic in terms of aesthetic and structural details. Throughout the final interview, Student A indicated that the project in its entirety was very overwhelming and alluded to a lack of ability to effectively research information and apply it to a design concept. Compared to Student D and Student F, Student A seemed to have no progression of thought from an overall framework as it related to design details.

Student G exhibited similar results. She indicated that bubble diagrams and sketching as a part of the conceptual process were “unnecessary,” and was emphatic about relaying the very “clear vision” in her head, that is “rarely adjusted” as she inputs that information into Revit. Her hotel was located in Rio de Janeiro, Brazil. Despite locating the luxury hotel in such a colorful setting, rich in history and culture, the design of the hotel was somewhat generic. Similar to Student A. The interiors could have existed regardless of the context of the chosen city, and Student G seemed to articulate her design concept in terms of what she wanted as opposed to allowing research to guide decisions. Moreover, throughout each interview, she wasn’t inclined

to offer information related to her research findings or the ways in which they influenced her design decisions. In reflecting on answers given as a part of her presentation, many of her conceptual ideas were based purely in utility rather than in context of a conceptual framework. She could articulate the "what" of material choices, furniture, and finishes. However, she could not articulate "why" those decisions were appropriate, other than speaking in regard to ease of use and cursory aesthetic considerations. This was a stark contrast to Student D and Student F, who clearly articulated their concept throughout their presentation explaining broad based ideas rooted in the context of their location and how those related to functional and aesthetic decisions as a part of their concept.

As a whole, Student C, Student E, and Student H, seemed to straddle this thought process exploring the broad to the specific, whereas student C, and Student E, appeared to appreciate the conceptual design process, according to responses given in the first interview. Student C submitted significantly more conceptual design artifacts than Student E, but, based on final results in the presentation for Part Two, she did not want to articulate her concept from a very clear connection to the context of her location. Additionally, her concept for the final phase of the project seemed completely foreign to her initial concept, which incorporated "Scandinavian" style as a function of her chosen location, of Iceland. As mentioned by many participants, the final project involved the creation of back of house office spaces. The use of systems furniture was a requirement, which was a new concept for students. As a result, this could have altered the ease with which Student C navigated the conceptual design process in order to satisfy requirements of the project.

However, as with Student G, there was no concise direction in a broad sense from the beginning, which led Student C to discuss her project in terms of utilitarian detail as opposed to

the reasoning for her decisions and the ways in which they were appropriate for her concept. Yet, according to her responses in the final interview, she conveyed a concrete understanding of the role of the conceptual design process as a part of her projects and the role sketching plays as a part of that ideation. Student E expressed similar sentiment as a part of her interview responses. And although she had what appeared to be one of the most complete design concepts in terms of considering space as a volume, it was clear she was not able to explain decisions in relation to a broad-based concept, which in her case, was supposed to be "diversity" related to the surrounding cultural context of Toronto, Ontario. When probed regarding her concept, she described her intent to design an "elegant space," to which she gravitates. Further, while drawing bubble diagrams and sketches by hand seemed to help her work through issues related to space planning, it seemed that lack of engagement prevented her from synthesizing the ways in which "diversity" manifests itself as a physical aspect of the interior design.

According to notes in the survey, the professor indicated Student E did not complete many deliverables in the conceptual design phase of each project phase. This is in contrast to the information provided by the student in which she detailed creating a decent amount of hand generated content related to ideation and problem solving. While she could have created much of this content without revealing it to the professor, a lack thereof would help provide a context as to why she, as well, could not explain her detailed design considerations within the broad framework of a strong concept.

Although Student H received an A letter grade in the class, her results were similar to that of Student C and Student E. In terms of her presentation, she did a thorough job of articulating design decisions made in the context of sustainability and environmental considerations. However, it was very clear that her intent in relation to concept changed in Part Two. Like

Student C, she chose Iceland in which to locate her hotel. Part One of the project seemed loosely based on the Aurora Borealis, a natural phenomenon that can be observed from Nordic countries such as Iceland. Through analysis of mind maps and word association diagrams, she seemed to have conducted very thorough research in regard to socioeconomic and environmental conditions. However, unlike Student D and Student F, there was no cohesive vision for how this research manifested within her hotel. Like Student G, Student H indicated that she has an "ability to see a very clear vision in her head" of how spaces should materialize and does little sketching or ideation to explore them further. In terms of the building envelope, she clearly articulated how she oriented spaces to maximize views and sunlight. Additionally, there was clear intent with furniture and material choices under the theme of "sustainability" and what seemed like environmental responsibility.

Those considerations were meaningful and relevant to her concept. However, unlike Student D and Student F, there was no concrete connection that permeated the project as a whole that could potentially provide a framework for the sustainable considerations she explored. Similar to Student G, she too worked primarily in the computer and touts "personal experience" as a motivating factor for design decisions. Much like other participants, creative decisions related to the structure or the space as a volume seemed largely absent from her renderings, making for a somewhat non-descript space, only made unique by an acid-washed concrete floor to mimic the appearance of an Aurora Borealis. Again, similar to other projects, a lack of exploration as a part of the conceptual process seemed to contribute to a lack of connection to a big idea to provide the framework for her reasoning related to sustainability and environmental considerations.

Based on her responses in the interview sessions, Student I seemed to struggle the most with reconciling the size of the project with the conceptual process and synthesis of research. Although she appeared to understand the process through answers given in the final interview, based on her project presentation it was clear that she was not able to incorporate that information into her concept in terms of aesthetics. Located in Paris, her hotel was intended to be a modern interpretation of classic Gothic design. However, based on her second presentation, she was unable to visually interpret that motif in her renderings. Structurally, the interior of the building exhibited a non-descript design aesthetic more indicative of an office building, as compared to a luxury boutique hotel detailed in Gothic style. Materials, surfaces, and furniture were chosen for no apparent reason, other than they had associated Revit files. And in contrast to every participant, the interior space had absolutely no cohesion, much less a connection to the surrounding city and its culture.

Per her responses in the interview, it was clear Student I did not have an understanding of the mechanics of the conceptual design process. Instead of applying a broad based framework in which to house specific design details, she indicated she is "the kind of student who throws things together," and made decisions purely off the assumption of the "certain style" of her city. Furthermore, she indicated that rather than search for Gothic-inspired materials or furniture, as prescribed by research and ideation, she does not "choose things that fit into Gothic. I make them fit to Gothic," indicating a laissez-faire attitude towards what it means to design and the way in which her process manifests in physical form. As with other participants, she indicated a heavy reliance on the computer to generate ideas.

In stark contrast to the initial interview, her answers related to the importance of the conceptual process as it relates to design development had dramatically changed. She seemed to

relay the importance of hand drawing as a part of the ideation context and how that visual information synthesizes with research in order to formulate a conceptual framework. However, she continued to describe products of her design process in terms of small details rather than broad-based ideas related to Gothic design and its modern iterations.

1.2 Students Are Aware of the Cognitive Benefits of Drawing by Hand

Despite the differences between expert and novice behavior, many participants indicated an increase in cognitive benefits as a result of engaging in hand drawing as a part of the conceptual process related to reflective practice, visualizing space, and the ability to see ideas as a result of transferring them from their minds to paper.

Student C, Student D, Student E, and Student F all seemed to indicate an increase in these traits as drawing and sketching made them aware of their own design processes, also known as metacognition. In particular, Student D and Student F described an enhanced ability to refer back to the initial products of their conceptual design process, allowing them to "internalize" and "evaluate" decisions based on their appropriateness within the broader framework. Both participants indicated they referred back to the beginning stages in order to ensure that space planning and selection of furniture, finishes, and equipment made sense as the nature and intent of each project focus changed. Additionally, they both indicated that drawing as a part of the conceptual process was helpful in terms of problem solving. Through internalizing and thinking about potential decisions, they used the process to "work through those problems," which made for quicker input into Revit for final deliverable output. Where participants such as Student A indicated a great struggle with organizing space and furniture elements as a part of later phases, Student D indicated subsequent phases of the project were made "easier" due to the time spent working by hand in the front-end to solve logistical problems. This was also the case with

Student F, who indicated that the overall concept is “the guiding way” and a method through which you can see “all of the branches” of your design.

Similar to internalization, participants report being able to see ideas more clearly through hand drawing as opposed to working solely on the computer. Student E specifically referred to her previous practice “of drawing things and deleting them” when experimenting with her floor and furniture plans as a part of ideation in the computer. Despite the ease of use, she lamented wasted time as a result of an inability to see her ideas in their entirety in order to determine which components worked best within her concept. Student D specifically referenced this premise related to a “layering” technique in which she was able to place conceptual ideas on top of one another to evaluate which solutions were best in relation to her concept, a practice she had not previously employed on other projects. She commented that this technique allowed her to evaluate ideas within the framework of her concept more quickly and efficiently, thus making it easier to meet project deadlines.

Student C expressed similar sentiment through the creation of quick, two-point perspective sketches to help visualize her space in creating office environments in Part Three. Additionally, she used this method to solve problems, indicating she “definitely realized a few major issues when I started looking at it in 3D view on paper versus just plan view.” She mentioned that she had looked at three-dimensional aspects of her design in the past, but that they were usually through the use of SketchUp. Further, she indicated that setting up a perspective is time consuming. Following a new comfort with sketching, she articulated the ways in which it was dramatically faster than spending time to create a three-dimensional view on the computer. Student D expressed the same feelings regarding hand drawing as a part of the

conceptual process, mentioning that as she completed subsequent phases of the project, more time was spent sketching and diagramming by hand, prior to input of information into Revit.

In terms of how these techniques impacted the final design presentation, Student D and Student F were the two participants, who again, were able to manifest more complicated and complete ideas related to structure and aesthetics as a part of their final package of deliverables. However, comparing the two top performing students in the class, although Student D created a collection of more exploratory, refined, conceptual drawings, it does not necessarily indicate her design is superior to Student F. While drawings produced by Student F are fewer in frequency, and significantly less refined than those of Student D, her clear concept as prescribed by her extensive research seems to be the driving force behind her ideas. That research coupled with even minimal exploration of ideas through sketching, seems to help distinguish her project as remarkable from among those produced by the entire group of participants.

While these sentiments toward the presence of hand-drawing were not shared across the entire sample, it is clear that students do see the benefits of hand drawing as it relates to the efficient execution of their design process as a whole. If incorporated correctly, hand drawing acts as a conduit for ideas that can be more seamlessly transferred into computer programs such as Revit where they produce refined artifacts for visualization and ultimately, presentation. Not all participants engaged in the conceptual design process in a manner through which they could see the benefits it provides in terms of visualization and reflection. Additionally, Student A and Student I were the only two participants who did not seem to indicate having a struggle with the production and implementation of design concepts, with Student A later expressing regret that she had not “done more” as a part of the conceptual process to make her project “stronger” as a result. This regret seemed to be a function of seeing the collective results of the class at the

conclusion of the semester, while other students who did not enthusiastically participate in the conceptual design process related to hand drawing did not indicate any struggles with designing directly into the computer. However, through observation of their presentations, it was clear that broader conceptual frameworks afforded by bubble diagrams or general exploration through sketching could have helped solidify design ideas and intent.

1.3 Time is an Opportunity and a Constraint

"It seems like a big time-waster and, like, I totally thought, 'this is the beginning of the semester, like, I don't want to go back to paper because I'll just be wasting my time'" (Student D). Time as an opportunity was one of the most prevalent themes throughout the analysis of the content derived from student interviews. Even participants such as Student A, Student H, Student I, and Student G, who did not engage in the conceptual design process through drawing acknowledged the ways in which a greater focus on the conceptual design process in the beginning phases of a project could afford more time in later stages of production to realize project goals.

In almost every case, participants indicated an increased awareness related to the selection of materials and finishes. Also, the majority of participants noted the improvement in their ability to manage project checkpoints in regard to class deadlines, indicating even modest engagement in the conceptual thought process could have positive effects on final project outcomes. Participants who did not engage more aggressively in a hybrid design process were relatively indifferent to the advantages it afforded them in terms of time savings. Most of them mentioned minimal improvement, acknowledging their process became "a little bit faster," while also acknowledging that it lent more validity to design decisions.

However, students who participated in a more exhaustive conceptual process indicated dramatic differences in time management related to project completion and satisfaction of project goals. Student E was emphatic regarding clarity of concept in the beginning stages and how it acts as a conduit for implementation of ideas and details in later stages of the production process, indicating the conceptual process is where you "complete essentially half of your project" and use it as a platform with which you "build a strong base" through research and context. Student C echoed these same sentiments upon reflecting on her process throughout the entire semester. She indicated she was able to really see the immediate effect of engaging in the conceptual process early as a component of Part One. She indicated that by incorporating those skills in Part Two, she was "able to move quicker" through ideas and concepts, especially when she was on a time constraint as a result of project schedules set by the professor. Her answers indicated that as her comfort with sketching increased, she was able to see ideas more clearly, and evaluated them in the broader context of her concept. As a result, she saved time by avoiding the urge to fixate on a single idea as a result of an inability to visualize additional solutions. She indicated that in the past she has avoided the conceptual process because it seemed like a waste of time. Yet, as a result of participating in this project, she realized she was "saving a lot of time and getting a lot better result" (Student C).

Student E indicated similar results, saying that hand drawing as a part of the conceptual process "really helped me in time management." While she indicated her time management skills were better for Part One and Part Two, the benefits became more clear because of her lack of time management in Part Three. All students, regardless of their level of engagement with hand drawing as a part of the conceptual process indicated a massive time constraint in terms of the schedule for Part Three. As a result, they all indicated feeling too rushed and that they weren't

allowed enough time to fully engage in the conceptual design process related to the remainder of their design effort to complete it as a part of that phase. However, despite that time constraint, Student E, as well as Student D expressed regret over not carving out more time to do more with the conceptual process. Both participants indicated they felt their results were "not as strong" in comparison to other phases of the project.

Participants also indicated an understanding that the amount of effort related to the conceptual process seemed to correlate with the perceived success of the final result. Student D, in particular focused more energy and time in the beginning stages and executed a more complete diagrammatic plan for spatial arrangement that allowed for more streamlined completion of related planning in Part Two and Part Three, and noted that each phase was made "easier" because the "basis was so strong," and that she was "able to focus on furniture planning and quickly move through that process." As a result, she indicated, "I think I have a good solution."

Whereas Student A seems to recognize the potential benefits of exploring the conceptual design process in this manner, in relation to time management, and despite indicating the class "had too much time for the conceptuals," she indicated that she had already generated bubble diagrams for her thesis project, prior to the start of the class the following semester. She indicated contradictory views of the effectiveness of her design concepts; yet, in relation to Part Three, and facets of the project as a whole, she views it as largely unnecessary, but at the same time, indicated that she was disappointed with her result in terms of creativity compared to other students in the class. She translates the lack of creativity to lack of skill, saying she is "very cookie cutter," and could "push it further," but seems to lack that confidence in her ability to explore design ideas. As a result, she felt extremely pressed for time and "just threw it together."

While many participants remained somewhat indifferent towards the benefits of streamlined project management as a result of a more rigorous conceptual design process, findings indicated that if properly engaged, students could visualize and evaluate ideas more quickly, thus affording more time to realize the completion of project goals through the use of computer programs. By learning to synthesize the use of hand drawing skills alongside the efficiency and power of computer aided design programs, students could potentially become capable of more meaningful thought in a compressed time-frame, affording more opportunities for focus on detail, innovation, and creativity within their projects.

1.4 The Conceptual Design Process Bolsters Confidence in Design Decisions

"I think [the conceptual process] will push me farther. Definitely makes me feel more like a designer" (Student C). Regardless of the level of engagement in the conceptual design process as a part of the semester-long project, all participants indicated increased levels of confidence in their abilities related to the creation of ideas, decision making, and justification of actions through the incorporation of research. All participants indicated in one form or another that one or all of these factors worked to reinforce a more comprehensive understanding of their concept as a whole, thus enhancing their ability to articulate it and justify it to an audience.

Those less engaged in hand drawn ideation processes expressed these sentiments in the context of more detailed applications such as material, furniture, and color selection as opposed to assessing the validity of their concept as a whole. All participants in one way or another expressed greater confidence in their understanding of design decisions related to the concept and ways in which they related to research as a whole. Even though participants did not indicate across the board that they would implement a conceptual design process centered around hand-drawing, most mentioned they would continue to incorporate a greater level of research as a part

of their overall design process. For many, the research component bolstered the reflective practice related to the implementation of the concept throughout the entire project.

For example, Student D mentioned she was compelled to incorporate or discard ideas after reflecting on recommendations prescribed through thorough research. Additionally, that reflective practice gave her even more confidence when defending choices as a part of her final presentations. This was a sentiment echoed by Student A, Student C, Student F, Student E, and Student I. To varying degrees, they indicated in responses they did not support design ideas with any sort of meaningful research. As a result, they could only defend decisions based on personal preference. Conversely, participation in the design process allows them to justify decisions through the analysis of data and evidence, enhancing their ability to logically and efficiently think through ideas related to design concepts.

Conclusions

The purpose of this research was to examine the ways in which hand drawing and the use of AutoCAD in the conceptual design process impacted final design solutions. Additionally, the study aimed to illuminate ways in which design faculty could reorganize design curricula to include hand drawing in ways that would be more beneficial to students. Research indicates that faculty are at odds as to the role of drawing in design curricula, they ultimately present a compartmentalized view of its relevance. Moreover, this mutually exclusive arrangement is at odds with the professional world, which seems to engage in a hybrid process, relying on hand-drawing in the early phases of ideation and completing final visualization using computer generated content. As students gain more experience using computer programs, they completely abandon hand-drawing and its benefits as a communicative tool.

The study involved a junior-level class of interior design students as they completed a semester-long project, tasked with designing a boutique hotel. The researcher analyzed data in the form of visual artifacts, student interviews, student presentations, and feedback from the professor for the class to gain insight into the roles of hand-drawing and computer aided design programs as a part of individual conceptual design processes. Student responses and content associated with final presentations were analyzed in the context of final, cumulative class grades in order to determine if more effort expended in the conceptual design process had a correlation with performance across the project as a whole.

The results were not definitive across the whole sample population, but, data gathered from student responses indicated positive impacts as a result of hand drawing to execute the conceptual design process. Effort expended in the earlier stages of the design process, though, did not directly correlate with a higher cumulative class grade. Of the four students who actively engaged in the conceptual design process through drawing, two received a letter grade of A and two received a letter grade of B. And while one student who did not take part in the conceptual design process through drawing, received a letter grade of A in the class, the existence of a more meaningful conceptual design process did seem to yield a higher percentage score in the class. Across the board, students who engaged in the conceptual design process in modest ways reported positive improvements related to time management, incorporation of technical facets such as materials and finishes, and an increased understanding of their design concept as it related to the context of their chosen location. Additionally, the majority of participants reported increased confidence in the ability to present their projects.

The data gathered from student interviews revealed four significant themes that illuminate ways in which hand drawing could be more beneficial when emphasized as a part of

the conceptual design process. First, results indicated that participants exhibited facets of expert and novice design behavior as they navigated through their projects. Second, students were aware of the cognitive benefits of drawing by hand. Third, students viewed time as an opportunity and a constraint. Finally, the conceptual design process bolstererd confidence in design decisions.

Implications

The results were inconclusive in terms of a direct correlation between engagement in the design process and a higher cumulative score in the class. Information gleaned from student interview responses provided insight into the ways students viewed the conceptual design process and the potential role hand drawing plays in its execution. Responses indicated very few participants had developed a sense of their own process and what it means to actually design. While participants are not seasoned professionals in the field of design, they do have a breadth of experience accumulated over the course of six semesters of training. The researcher expected most, if not all, participants to have honed a clearly defined design process based on a logical progression of analysis and synthesis of information and ideas. Yet, most students could not articulate the way in which they arrive at design solutions beyond the mention of engaging in some form of research and the ability to "visualize" design concepts, indicating no need to transfer any ideas to paper.

The majority of respondents provided no detailed information related to the ways broad concepts were refined into schematic design plans, which implied they may not have engaged in the conceptual design process in a meaningful way through the course of earlier classes. Participants repeatedly mentioned they had never really engaged in this process prior to the execution of this project. While they casually referenced the creation of bubble diagrams or

sketches, they implied never really knowing the purpose of the conceptual design process. A majority of respondents implied they only completed content related to the conceptual design process because it was a requirement of the project deliverables, with one student remarking that it was “unecessary” (Student G), in her view. There could be many reasons as to why students believed this sentiment in varying degrees. Even participants such as Student D, who according to responses, appreciates the value of the conceptual design process, indicated she would engage in these activities in future projects “if she had time.”

Based on content derrived from the interviews, it seems this could be a problem related to the compartmentalization of hand drawing and, in a broader sense, the way in which the components of the conceptual design process are relayed to students. Two students specifically referenced the process of creating “thumbnails” in foundational classes during their freshman year. They described the exercise as being mandated to create a specific number of conceptual drawings as a requirement for the project. However, it was implied that conceptual drawings were only completed in order to satisfy requirements, characterizing the process as, “OK, you need to draw this many conceptual sketches, so that you can show me how much you've thought about this” (Student E). In more explicit terms, Student A confided that she didn’t have a firm understanding of how to work through the process of completing the project in general, implying that it was difficult to synthesize analysis with design ideas.

Responses indicate a potential disconnect between the purpose and the process of design, as perceived by students. The researcher must clarify that all participants expended a significant amount of effort to complete these projects to the specifications set forth by the professor. Students repeatedly referenced the hefty checklist of requirements they had to satisfy in order to receive their desired grade in the class. Additionally, the list of skills they must learn to use,

including Revit and other computer aided design programs, is formidable. However, based on the data gathered as a part of this study, it seemed students placed more emphasis on satisfying requirements and proficiency in the use of these programs, where content is secondary to visual appearance.

Based on research, the inclusion of hand drawing could bridge the gap between the purpose of the conceptual design process and the way in which it is perceived by students. However, based on interview responses, students indicated a significant level of anxiety related to drawing by hand, and thus tend to avoid it as they complete their projects. Six of the eight participants tend to perceive drawing as a technical skill, indicating they did not engage in the practice because they don't see themselves as "good at it" and report being frustrated by the time consuming nature of drawing and the struggle to create visual interest and accuracy. While many respondents seem to respect drawing as an art form, their responses implied that drawing was simply "not for them" and that they did not possess the inherent talent to draw with any sort of efficiency. As a result, responses indicated they have left it behind in almost every capacity in terms of working through a complete design concept.

However, despite the somewhat negative sentiment towards drawing, participants showed inklings of a shift in perception towards hand drawing as a part of the conceptual design process in the time that elapsed between the first and second interview sessions. By the conclusion of their projects, students seemed to realize the implications of drawing as a tool as opposed to a technical skill. No paradigm shift was more apparent than the response from Student C, indicating that "drawing isn't necessarily something you shouldn't learn," but "it should be taught as a tool before it should be taught as a final deliverable." She went on to say that the inherent technical aspects of drawing as a tool for visualization made it difficult to want to draw

as a way to communicate ideas in the conceptual design process. This was also true with Student G, who did little to actively engage in the conceptual design process, saying, “it could be beneficial, I’m just not good at it” and later remarking, that “something quick” could help a client in terms of visualization of proposed design ideas.

These comments are far from a “ringing declaration” from all participants. However, similar sentiment was echoed by other participants, who implied that engagement in the conceptual design process could have an effect on their perception of hand-drawing as a tool. Students who took a more active interest in sketching as a part of the conceptual design process seemed to be more confident in their design ideas as a whole, with a stronger ability to reflect back on decisions and the ensuing implications as they related to the final design solution, whereas students who were more comfortable visualizing ideas in their head did not seem to have a cohesive understanding of their broad concept and its impact on design decisions. Hand drawing could be an effective tool to help students internalize their own process in the creation of stronger design concepts.

Based on results, students were aware of the cognitive benefits of hand drawing related to ideation. Student D, who has a natural propensity toward this skill set, recounted specifics in terms of her ability to internalize her decisions made through this process and assess their implications within her finalized design concept. Additionally, other participants remarked that the ability to see their ideas made the decision making process more efficient, resulted in quicker completion of project deadlines. Through drawing, they were able to determine what works and what doesn’t work in advance of inputting information into Revit, where after a certain point, significant changes become burdensome to implement due to the way the program organizes structural elements such as walls and floors.

The emergence of themes related to the perception of hand drawing and the benefits of engaging in the conceptual design process at modest levels produce benefits that are meaningful to students and the ways in which they complete projects. This notion is articulated by Student E, who says it was better to experience the conceptual process as "an open-ended requirement" where "you could do it your way and get it done." While students must be trained in best practices related to the creation of design concepts, the response from Student E was very telling related to adapting broader design strategies to the unique sensibilities and thought processes of each student. Based on student responses, there was no real awareness of the conceptual design process and the ways in which it influenced decisions made throughout the finalization of design ideas, and that silence was deafening.

Although sentiment related to hand drawing and the conceptual design process are not monolithic across all participants, modest results indicate an opportunity for design faculty to re-organize design curricula around hand drawing as a tool for thought. Research indicates professional designers continue to value hand drawing as a tool for ideation. Therefore, there is a basis for which design curricula can adapt drawing to this need. However, the broader goal is to use drawing as a way to engage students in the conceptual design process as a whole, encouraging them to focus on the "why" of their reasoning as opposed to the "what" of project requirements.

Recommendations for Future Research

The factors surrounding efficacy of the conceptual design process can be seen as subjective. Education, professional experience, and changing needs of professional practice affect the lenses through which future adaptations to curricula are considered. However, this study serves as a foundation for future research that can attempt to provide more objective results

to provide a consistent argument for readapting drawing as a part of a degree program with a greater emphasis on drawing as an integral component of the conceptual design process. As a general recommendation, this study could be reimplimented in a more controlled setting, where willing participants are confined to hand-drawing or the use of digital design programs within their conceptual design process in order to more clearly observe the impacts of each skill set on the final design solution. This more rigid design, combined with the quantitative and qualitative instruments would give a more complete picture of the impacts of engagement on student development.

Additionally, future studies would be best served to include a student generated writing component to be analyzed alongside visual artifacts. Research related to design thinking and student development includes the act of journaling as a part of the research process. Here, participants are compelled to examine the interconnectedness of analysis and synthesis and the ways in which they translate to the execution of design concepts. While the interviews in this study provided very insightful information from the perspective of the student, it may have been more beneficial to understand that impact in the context of various phases of project development, rather than to articulate their thoughts after the fact.

Future avenues for research can also be explored through the lens of the experience of lower-level students in the interior design program. The researcher sought out this junior-level population explicitly for their collective experience and potential embodiment of design expert behavior. However, it became clear through the course of interviews that participants had yet to develop a strong sense of their own unique process. As a result, it would be beneficial to examine the way these behaviors potentially take root in freshman level students, examining activities and class structure to enhance their abilities related to synthesis of research, technical

information, and creative ideas to form meaningful design concepts. Reflective studies involving journaling activities may also be helpful as a way to illustrate the interrelatedness of various foundational classes or as a way to reflect on design decisions through writing as a component of course projects.

Recommendations for Design Curricula

Student participation in the conceptual design process definitely hinged on including the associated artifacts as a deliverable for the class. Participants indicated a willingness to engage in the design process, even at modest levels, because it was a required exercise. However, it is important for faculty to remember that commoditizing the conceptual design process as a grade item in rubrics could have negative outcomes among students regarding their willingness to engage it at proper junctures throughout a project. Presenting hand drawing as a tool in earlier stages could foster engagement in the conceptual design process as a result of curiosity as opposed to a necessary requirement. Faculty can point more directly to the ways in which drawing is used in the professional world to create a more realistic picture of its relevance to student design process. This perception can be reinforced by emphasizing sketching as a pre-cursor to input into digital design programs in visualization classes. This may also require making the process of design more explicit as opposed to implicit. Faculty can draw on research related to design thinking to create a suggested progression of work associated with analysis, synthesis, and production. Through applied practice over subsequent semesters, students have the opportunity to hone their unique design process and discover the ways in which it assists in the completion of project goals.

Class content must strike a balance between the theoretical and the practical in order to groom well-rounded, thoughtful, creative designers. The rift between professors concerning the

importance of hand drawing in design curricula could be a dispute regarding desired learning outcomes. While educators feel strongly about student ability to design, it is equally important for graduates to possess the necessary technical skills to be successful in today's job market, including proficiency in the use of computer aided design programs that are considered industry standard such as AutoCAD and Revit. Students provided a small indication they were aware of the ways in which hand drawing as a part of the conceptual process potentially strengthens their ability to execute final design outcomes. Faculty can use this information to develop a basis on which class structure is organized around drawing as a part of a hybrid process, eliminating the compartmentalized presentation of the respective skills.

The purpose of this study is to provide insight as to the ways in which hand drawing should adapt within design curricula to meet the needs of a profession increasingly dominated by the use of digital software to visualize design concepts. Through the perspective of students, the researcher aimed to gain insight into the potential role of hand drawing in the conceptual design process and the ways in which it impacted the strength of final design solutions. Results varied across the entire sample of participants. While more active engagement in the conceptual design process through hand drawing did not directly result in a higher cumulative class grade, there seemed to be an indirect correlation between those students who created a more cohesive concept as a result of exploration through hand drawing than those participants who did not. Additionally, information gathered from students through semi-structured interviews provided valuable insights into the perception of hand drawing and its benefit as a communicative tool. Through fostering a hybrid process among students, educators can potentially groom designers with more expert level qualities, more prepared to negotiate the complex tasks that await them in daily practice as a design professional.

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Appendix A

Evaluation Rubric: Conceptual design phase into pre-schematic phase,
& the concept as a part of the final presentation

Evaluation Rubric: Conceptual design phase into pre-schematic phase, & the concept as a part of the final presentation

Conceptual design phase:

The following categories are evaluated with a four-point Likert scale rating scale intended to gauge the degree of presence of various elements in the conceptual design process in the lead-up to full schematic design.
1 = poor, 2 = satisfactory, 3 = good, 4 = excellent

Exploration

A. Evidence of research related to the design problem is present in conceptual 'bubble diagrams'.	1	2	3	4
B. Design concepts show consideration for required program elements as required by the project.	1	2	3	4
C. Bubble concepts explore the creation of forms that define boundaries of distinct spaces.	1	2	3	4
D. Bubble concepts clearly consider circulation as spatial relationships become more defined.	1	2	3	4

Observation

A. Conceptual bubble arrangements show consideration for building characteristics that shape design decisions.	1	2	3	4
B. Conceptual bubble diagrams demonstrate an awareness of contextual conditions that shape design decisions.	1	2	3	4

Production

A. A minimum of two conceptual bubble diagrams were completed as a part of the design process.	1	2	3	4
B. A series of bubble diagrams display an emergence of of cohesive idea, in accordance with the design program requirements and physical attributes of the building.	1	2	3	4
C. The creation of bubble diagrams spurred additional conceptual drawings that helped shape a design idea. This can include, but is not limited to: criteria or adjacency matrices, or other drawings such as elevations, sections, and other sketches.	1	2	3	4

Pre-schematic design phase:

Evolution

A. There is a visual connection between amorphous bubble diagrams and more refined block diagram drawings. 1 2 3 4

B. Considerations for project program requirements, goals, and conceptual ideas are evident in the block diagrams. 1 2 3 4

C. The initial concept generated in the previous phase has a clear connection to the block diagrams. 1 2 3 4

D. Block diagrams begin to display functional relationships and show square footage measurements. 1 2 3 4

Final design concept:

The following categories are evaluated with a four-point Likert scale rating scale in order to determine the effect of the connection between the conceptual design process and the success of the final design concept.
1 = poor, 2 = satisfactory, 3 = good, 4 = excellent

Continuity

A. Conceptual design ideas – forms, spatial arrangements, and building considerations are evident in the final design concept. 1 2 3 4

B. The final design is a synthesis of the concept with program requirements, project goals, and research-based ideas explored in the conceptual design process. 1 2 3 4

C. The final design concept is a balance of innovative ideas and feasible solutions, supported by ideas explored in the design process. 1 2 3 4

D. As a part of the final presentation, students articulate design solutions as a part of a broader concept, rather than individual components that form a whole plan. 1 2 3 4

Appendix B

Student Interview Questions

Student Interview Questions:

1. Did your conceptual process change in any way as a result of participating in this study?
    a. Describe the ways in which methods learned as a part of participating in this study altered your design process.
    b. Did the methods enhance or hinder your design efforts?

2. Do you think your conceptual design process contributed to the overall strength of your final design solution?
    a. In what ways did it allow you to create a design solution that connects research and context related to your chosen location?
    b. Do you think you have a more heightened awareness of context and research as it relates to your design solution? If so, describe the ways in which you achieved a more heightened awareness as a result of participating in this study.

3. Did learning to explore the conceptual process in a more exhaustive manner make you more comfortable with the creation of design concepts? If so, in what ways did you become more comfortable with the process?

4. Did the conceptual design process allow you to explore new ideas related to space planning in this project? If yes, describe how the conceptual process allowed you to explore new ideas as a part of space planning.

5. Did conceptual design process encourage you to explore unique forms related to space planning in this project. If so, describe the how the conceptual process encouraged the creation of various forms.

6. Did the exploration a more in-depth conceptual design process allowed you to gain a more comprehensive understanding of your final design solution? If yes, please describe how the conceptual design process deepened your understanding of the final design solution.

7. Were you exposed to new conceptual design methods learned as a result of participating in this study will you continue to use as a part of your design process? If so, how did these new methods influence your existing process?

    a. Do you consider any new techniques you learned as a participant in this study beneficial to your ability as a designer?

8. Did you explore any new techniques that make you feel more empowered as a designer? If so, describe these techniques and the ways in which they contribute to your general effectiveness as a designer.

9. What is your overall perception of hand drawing as it relates to the field of interior design?

    a. Did your perception of drawing as a professional skill changed as a result of participating in this study? If so, describe the ways your perception of drawing as a skill changed as a result of participating in this study.

10. Did the study alter the way in which you will approach future design endeavors?

11. Do you wish to share any additional thoughts related to the concepts explored in the study or the study as a whole?

Appendix C

Instructor survey of daily student behavior and activities

Instructor survey of daily student behavior and activities

Notice of consent: By filling out the survey below, the instructor has given consent to participate in the facilitation of this study. The purpose of this research is to explore the use of hand drawing techniques and digital design programs in the conceptual design process. This study aims to evaluate the ways in which the various techniques affect the overall impact of the final design solution by collecting and comparing conceptual drawings produced using hand drawing techniques and compuater aided design programs. By participating in this study, you are helping to provide the researcher with valuable information that could be used to streamline interior design curricula in the future in order to produce more thoughtful, efficient students. Risk as a result of participation is minimal. You will have no contact with students in the execution of this study other than as their instructor and will not be present for post-project interview sessions. Class surveys will be collected from the instructor at the conclusion of each project, no later than one week after the final presenation date for the project. Surveys will be transcribed digitally to encrypted folders, and hard copy files will be stored in a secure location.

Based on daily class meetings, circle the number on the Likert-type scale that best describes what you observe.
1 = strongly disagree, 2 = disagree, 3 = no answer, 4 = agree, 5 = strongly agree

<u>Observation</u>

A. Students are devoting a significant amount of class time to the exploration of the conceptual design process.	1	2	3	4	5
B. Students appear to connect research and context with design ideas displayed in conceptual diagrams.	1	2	3	4	5
C. Students appeared visibly frustrated with the design as a result of exploring the design process	1	2	3	4	5
D. Students work toward the refinement of clearly defined ideas through the conceptual process.	1	2	3	4	5
E. Students appear to maintain a positive attitude toward the conceptual design process and the exploration of design ideas.	1	2	3	4	5

F. Students consistently ask the class instructor for feedback regarding their conceptual process.	1	2	3	4	5
G. Students explore the implications of building and site characteristics as a part of the design concepts they create.	1	2	3	4	5
H. Students are using a scale in the creation of block diagrams.	1	2	3	4	5
I. Students voice many concerns related to the conceptual design process, as prescribed by the study.	1	2	3	4	5
J. Students appear to enjoy the conceptual design process, as prescribed by the study.	1	2	3	4	5

Free Response

In the space provided below, please describe any happenings in class pertaining to the students and their work on the conceptual design process that is pertinent to note throughout the course of the study.