

# Technology and Design Thinking: A Look at Interior Design Students' Conceptualizations

Lori A. Brunner  
Iowa State University  
Department of Art and Design  
158 College of Design  
Ames, IA 50011-3092  
lbrun@iastate.edu

## ABSTRACT

The purpose of this qualitative study is to explore interior design students' understanding of their design thinking, and to investigate how they view digital technology's role in these activities. The research questions are:

1. How do interior design students conceptualize interior design as a discipline?
2. How do these students conceptualize their design process?
3. What value do students place on the "process book"<sup>1</sup> as a representation of their design breadth and depth in a given project?
4. How do students view computer technology's role in their design thinking and their design products?

Participants viewed interior design as more sensitive to the human condition than architecture. AutoCAD was one software package that was used both in the process and the end product, but other more common software programs (word processors, spreadsheets) were only minimally utilized. Hypermedia and databases were not mentioned by any participants as tools in their design processes.

---

<sup>1</sup> The process book acts as a way in which the professor or outside critics could view the students' process. It, theoretically, is supposed to capture some or all of a students' thinking, rationale, investigations, and evaluations that are inherent in design projects.

## KEY WORDS

Technology, design thinking, student conceptions

## INTRODUCTION

### BACKGROUND

An interior designer must incorporate a breadth of knowledge in search of creative, safe, innovative, appropriate, aesthetically pleasing designs that are in accordance with codes and standards (Harmon-Vaughn, 2002). In order to educate interior design students for these later responsibilities, the design studio provides an educational venue to develop these skills and knowledge areas. The studio is the center of design education in this area, so it is crucial to inform both faculty and students on practices and theories that help to improve learning and instruction within this given context.

### PURPOSE OF STUDY

The purpose of this qualitative study is to explore interior design students' understanding of their design thinking processes, and to investigate how they view digital technology's role in assisting with this task. Is the nature of their computer technology use more for visualizing their design solutions and for preparing formal presentations rather than as a tool to expand their cognitive capabilities? In a previous study, Brunner (2004) found that students exposed to schema-based learning tools had more organized, more theoretically-based design decisions, and better design solutions overall than students who did not use such learning tools. However, in a follow-up study, Brunner and Fowles (2006) reported that there were no noticeable or lasting effects of this learning tool. Unless students practice such strategies and realize that they in fact are important in their learning, they will not continue to build these "habits". Thus, an important aspect of lasting effects may be the students' conception of the importance of these learning strategies in their personal growth as design students.

### RESEARCH QUESTIONS

The focus of this study explores the meaning of design thinking in the studio learning environment and the role of technology in these endeavors. Therefore, this study poses the following research questions:

1. How do design students conceptualize the important aspects of interior design as a discipline?

2. What value do students place on the “process book” as a requirement, tool, and representation of their design depth and breadth?
3. What types of information do students put in their process book and how well aligned is this structure and contents with the natural flow of activities in the students’ design process?
4. How do students view computer technology’s role in their design thinking and their design products?

To begin to explore how students conceptualize central aspects of interior design as a discipline, three questions from the semi-structured interview targeted this area. These questions asked what *activities* they associate with design, what *qualities* make a good designer, and what is it about design that interests them. Each of these questions addresses different aspects of the phenomenon of design, but more importantly, interior design in particular.

The next two research questions are important to the study of students’ conceptualizations of design thinking because the “process book” is a current educational practice that is intended to capture all of a students’ work, investigations, and thoughts for a given design project. The researcher believes that there is existing confusion from both the students and the faculty on its importance, role, and structure in design studio education. Therefore, this study intends to explore the students’ perspectives of this artifact.

The last research question explores students’ perspectives on various computer technologies and their educational value from both the design process and design product roles. From the researcher’s previous experiences teaching in these studios and her work in instructional technology, she believes that interior design students lack the exposure and therefore the practice of using technology in ways Jonassen (1996) describes as mindtools. This lack of exposure has then limited the interior design students’ educational experiences. Therefore, this research question aims to explicitly investigate this phenomenon.

## LITERATURE REVIEW

### DESIGN THINKING STUDIES

In terms of novice conceptions of design and the implications of these on the design of learning environments, Newsteller and McCracken (2001) believe that design students have well-developed prior conceptions and theories about the nature of design that conflict with understandings held by expert designers. Prior knowledge is an essential variable in design

learning. Chi, Glaser, and Farr (1998) caution prior knowledge, however, is often incorrect. They discuss three types of misconceptions: incorrect, inconsistent, or incompatible. Incorrect misconceptions are relatively easy to change because they are part of false ideas. Inconsistent prior beliefs resist change because they are part of a larger mental model that has structure. When prior knowledge is incompatible with expert understanding, the most radical form of conceptual change is required because such knowledge is highly resistant to change.

In a previous interior design study of student conceptions of design and interior design in particular (Brunner, 2007), the interior design students' responses were very similar to Newstetter and McCracken's (2001) results of 290 freshmen computer science majors at Georgia Tech University. Their top most important design activities included: 1) Understanding the problem, 2) Using creativity, 3) Visualizing, 4) Brainstorming, and 5) Making decisions. The top least important activities included: 1) Making trade-offs, 2) Decomposing, 3) Synthesizing, 4) Generating alternatives, and 5) Sketching. The Newstetter and McCracken acknowledge, while they are important in design, they are generally not considered the critical design activities. Even more enlightening is the list of least important design activities. These activities are generally viewed by design experts as very important (Newstetter & McCracken, 2001).

Lawson (2006) argues that reasoning and imagining are probably the most important types of thinking for designers. He postulates that reasoning is purposive and directed towards a particular conclusion. It includes logic, problem-solving and concept formation. In contrast, imagining is when an individual draws on his/her own experience and merges new material in a more unstructured way. Lawson situates imagining with artistic and creative thought, as well as daydreaming in this category.

## TECHNOLOGY AND EDUCATION

Jonassen, Peck, and Wilson (1999) believe that computers should be seen as cognitive partners for amplifying and reorganizing information, as well as assisting in practice—but the right kind of practice. In addition, technologies should be thought of as tools to help learners transcend the limitations of their minds, such as memory, thinking, or problem solving limitations. When learners use technologies as partners, they off-load some of the unproductive memorizing tasks, allowing them to think more productively. The goal in using technologies should be to allocate to the learners the cognitive responsibility for the processing they do best while allocating the processing that technology does best. Learners should be responsible for recognizing and judging patterns of information and then organizing them, while the computer should perform calculations, and store and retrieve information.

Jonassen, Peck, and Wilson (1999) argue the distinction between technology as tutors or teachers versus technology as construction tools, as the effects *of* technology versus the effects *with* computer technology. The former refers to the effects *of* multimedia on the learner, as if the learner has no input into the process. The effects of learning *with* multimedia refer to learners entering into an intellectual partnership with the technology. Learning with technology requires the mindful engagement of learners in the tasks afforded by these tools and that there is the possibility of qualitatively upgrading the performance of the joint system of learner plus technology.

Similarly, Taylor (1980), in his seminal work on computers as tools, tutors, and tutees, provide another means of developing this framework on computers and education. With the computer as tutor the computer must be programmed by “experts” in programming and in that subject. The student is then tutored by the computer executing the programs. With appropriately well-designed software, the computer tutor can easily and swiftly tailor its presentation to accommodate a wide range of student differences. The drawbacks of the tool mode are that the tutor mode typically requires many hours of expert work to produce one hour of good tutoring, for the following reasons. In addition, because humans are intuitive beings and are much more flexible than any machine, it is impossible (or almost impossible) to program all of a human’s possible responses.

In the tool mode the classroom computer requires some useful capability programmed into it such as statistical analysis or mathematical calculation. Students can then use it to help them in a variety of subjects. These tools save time and preserve intellectual energy by transferring necessary but routine tasks to the computer.

Taylor (1980) asserts that the tool mode is probably seen to be the major mode of computer use by most people outside computing and education.

However, Taylor (1980) viewed the tutee mode of the computer as the most promising and most effective for education practitioners and scholars. Here, the student tutors and must learn to program or to talk to the computer in a language it understands. Taylor argues that the computer as tutee can shift the focus of education in the classroom from end product to process, from acquiring facts to manipulating and understanding them. This goal fits suitably into design studio education discussions. More interestingly, though, do others in design education take this perspective, too?

## METHODOLOGY

This study was a basic interpretive qualitative research design to better understand how participants make meaning of their design thinking and their conception of computer technology in this process. A qualitative research design was selected because the aim of this study was to explore certain meanings, values, and roles of a particular phenomenon in-depth. It was also important to further investigate this area, based on previous results from a quantitative study addressing these similar topics (Brunner, 2007).

### PARTICIPANTS

Semi-structured interviews were obtained from six undergraduate students (two sophomores, two juniors, and two seniors) in the interior design program. The six participants were selected from the group of students currently enrolled in the undergraduate interior design program. Students were selected based on the following criteria: 1) able and willing to articulate their design experiences and reflections to others (good verbal communicator), 2) considered by faculty within the program to be a dedicated and “talented” design student (good designer), and 3) considered comfortable and have at least an average skill level of computer technology (good technical skill level). To obtain a list of potential participants the researcher discussed this study at one of the interior design faculty meetings and asked the faculty for a list of students from each of the three grade levels that met the above criterion. From this list the researcher emailed the students about participating in this study. They were emailed a description of the study, along with a human subjects consent form for their review. Once the consent forms were completed and returned, interview times and locations were established.

### DATA COLLECTION AND ANALYSIS PROCEDURES

The main source of data for this study was one-hour semi-structured interviews. The location for the interviews was the “resource room” in the university building in which the interior design offices and classrooms are located. This location was a central place, very near the participants’ studios, and also considered a neutral location so they would feel more at ease. The traffic flow was such that there was an appropriate level of acoustical privacy, even though it was so centrally located in this particular building. A list of questions (see Appendix A) was emailed to the participants prior to their interview for preparation and reflection as they deemed necessary.

Interviews were audio-taped and later transcribed for coding and interpretation. The qualitative coding entail three basic procedures: 1) noticing relevant phenomena, 2) collecting

examples of those phenomena, and 3) analyzing those phenomena in order to find commonalities, differences, patterns, and structures (Coffey, Atkinson, 1996). A two-stage process of coding was utilized. First, open coding was completed to uncover any themes or categories of interest to the study. A list of 14 categories and 105 codes were developed from the review of the transcripts.

Next, from the open coding, themes were identified in the data. Once several key themes were identified, the next round of coding was focused coding (Esterberg, 2002). After the focused coding, Esterberg (2002) identifies a series of questions (p. 167) that helped guide the interpretations of the data. After the coding, patterns in the data were identified, comparisons of the three participant's data or cases were conducted using a matrix data display (Miles & Huberman, 1994) and finally, typologies were built from the data (Esterberg, 2002). In addition, analytic memos developed by the researcher also served as a source of data, and later used as a supplement to the interpretation of the findings.

## RESULTS

From the research questions there were three main themes that emerged from the analysis of the data. Therefore, the discussion of the results is presented under these three areas. It should be noted that because the "process book" is currently a large part of the design process and its conflicting roles in helping students in their design thinking, a separate area is warranted for the process book.

### STUDENTS' CONCEPTUALIZATIONS OF DESIGN AND INTERIOR DESIGN

Three of the interview questions were designed to explore the students' conceptualizations of design in general, and interior design in particular. One question asked participants what it is about design that interests them, thereby speaking of design as an *entity*. Another question asked them what qualities make a good interior designer, which addresses *human characteristics* that are important for designing. The other question asks participants about the *activities* that are associated with the process of design.

In five of the six participant interviews, being a good communicator and being a "people person" was viewed as very important for a designer and why the students were initially drawn to the interior design profession. Some participants had even mentioned this was one of the main reasons why they chose interior design over architecture. Interior design was seen as more involved with addressing the human condition. One participant says the following:

At first I wanted to do more architecture stuff. But then I started looking at like how this program is done and it kind of steered me more towards interior design because it is a lot of architecture stuff, but it deals more with people. And that's kind of where I want to be is working with people and how they feel when they are in a space or them interacting with their own environment. So it's kind of neat to be able to design that and work with them for what they want in a space. So I guess that is kind of the biggest thing. Another participant continues this theme with this passage, but also includes other human characteristics that they viewed as important for an interior designer.

I think that you definitely have [to be] maybe motivated, organized I think is a very important. You have to be organized, inspiration, creativity. I think you have to be a good communicator. I think you also have to be a people person because you are not only designing for yourself, you are designing for others and you need to be sympathetic to their situations and understand them. I think it is important to not be biased, be open to all ideas, and I know some designers have a set style, but just be as open as possible so you can facilitate other people's needs.

Other, more general personal attributes were discussed by one participant who talked about the value of being both compulsive and obsessive and how these also make a person a good designer. This person says:

Obsession, compulsion, which are two different things. Creativity, but not above versatility. Because a designer needs to have all that and I think an interior designer or an architect or anybody, especially interior designers need to learn so much so quickly and deal with so many facets—psychologically, technically...there are so many objects and things you have to deal with and you have to be willing and able...wanting to learn, but quickly.

The researcher followed up this answer by asking the participant if these two attributes were design specific or more about a successful person in general. The participant responds with the following:

I think most people that are driven have compulsions. I think when you start loving what you do, you have to be obsessed with it. It has to be something you live. To just go in and not try to change it and make it better and work on things. If you just want me to just go in and not change anything and not make it better, I'm a horrible employee. And I think that's what makes obsession and compulsion and those things useful.

Another participant spoke about the importance of both the science and the art in design in this passage, in addition to problem solving. Five of the six participants specifically mentioned problem solving as an important activity in design. One states the following:

Well I think that it's creative but also methodological so you're taking a creative process but then making it kind of scientific or there's ways to do things and there's formulas but you can still be creative. So it kind of takes both sides of what I'm interested in and combines it. So that's kind of what makes design interesting. I like problem-solving a lot.

The other often mentioned activity important to design was sketching. While this seems like a logical and crucial activity to design and a designer, it was the activities and attributes that were not mentioned by this study's participants that prove most noteworthy. Newsteller and McCracken (2001) observed that their novice designers had a superficial interpretation of design by mentioning such activities as brainstorming and coming up with alternatives. In contrast, these researchers reported that *abstracting*, *decomposing*, and *synthesizing* are not mentioned by novice designers, but are acknowledged by expert designers as critical. Similarly, when Newsteller and McCracken's (2001) respondents were asked to draw a diagram of their view of the design process, their graphics also conveyed the same level of superficial or incomplete knowledge of design. This study's participants' diagrams of the design process showed a comparable pattern.

## THE "PROCESS BOOK" IN STUDIO PROJECTS IS NOT EFFECTIVE

An emerging theme that became apparent in the data involved the process book for a given design project and the degree of assistance the book actually has on a student's design process. Students in the interior design program are required to submit a "process book" along with their final solutions. The process book acts as a way in which the professor or outside critics could view the students' process during the duration of the project. It, theoretically, is supposed to capture all of a students' thinking, rationale, investigations, and evaluations that are inherent in design projects. It is also intended to be a tool for the student designer, so that it may help organize their thoughts, ideas, and research activities. However, in many of the participants' interviews, the participants acknowledged that they have witnessed other students who had re-worked their process book in order to make it more "neat", or more fully developed after the project was completed. Some of the participants had mentioned that they, themselves, have done that at least once in the past because of the instructor's requirements or possibly the students' perceptions of these requirements. In one participant's interview, the participant viewed the process book as really *unimportant* in assisting in their design thinking. The following passage from one of the participants speaks to this theme.

[Whispering] And the people that who put a lot of time and effort into those [process books] are just trying to please someone and it has nothing to do with design. I look at them and think yeah, your stuff looks really pretty but, I'm just not that way. If I have to go back and look at my process work...I built it, I designed it. I know what I put into it. I don't need to go back and look at it. You know, I may flip through it when I put it together. But it's meaningless after I do it.

When asked about how this process book might help the instructor evaluate the student's breadth and depth of process, the same participant responds with the following remarks.

They can look at it. And it's my progress. It's not their progress. And so when they look at it, they see how I think. You don't want to be there. I'm just not that person. I'm not a person that's going to think...I'm a very logical in certain points, but other times my mind is going so fast that I cannot keep up with myself. So I don't have those issues. I do crazy things. Just like notes for me. I don't do history classes well because I had taking notes. When I have to go back to notes, I look at them and go I have no idea what I was reading or writing at that point. I have to have some sort of structure. And notes in themselves are inherently structured and I don't do that very well. Because if you look at my notes. One day I will do one space and then the next day it will be all scribbles and the next day it will be all doodles. I just can't do that. I don't know why.

Two of the interview questions asked participants about the limitations of such process books, and what activities or functions an "ideal" process book needs to satisfy for the design student. While no question explicitly asked the participants to list the contents of existing process books as they are currently done in studios, this may be more centrally investigated in a future study. It is also acknowledged that, because the researcher is also an interior design instructor, the researcher is aware of the typical contents.

One participant noted that there is always process going on in their life so it is sometimes difficult to remember to write down these fleeting ideas and place them later in the process book. The following passage speaks to this point, as well as reiterates the previous participant's opinion of the misalignment between the actual process and what gets included in the book:

I do a lot of sketching, and writing and it's not like any order, it's a lot of just thinking about things and writing things down, like it could be in the morning when I get out of the shower and I'll get an idea and I'll put that in my sketchbook. So a lot of my ideas are in my sketchbook and then I like make a process book but I think that is kind of

limiting in some ways because it's always going on there's always process going on so it's hard to put everything down that you're thinking. And sometimes you make the process book after the fact. I've seen people, like I'm making my process book but we're already done, so you know how can you make your process book when you already have a specific product? So sometimes I think that's kind of weird. The process is how you do it, so how can you be making it then.

When asked for further clarification on why they thought the process book was so limiting, this participant said the following with respect to "neat" process books:

I'm so free with the drawings that I do and they are very professional and I think every designer said they have to make sense to you. And actually I ran into a few situations where my professors told me that they were too messy and I left all that work out and for the critique I got in trouble because I had revised my process book because I didn't really quite know. So, that has definitely been a learning experience for me and I think in the future process books won't be as limiting because I think I was trying to follow specific guidelines or it became less about the process and more about how nice I can make this book into a presentation piece.

## LIMITED VIEWS OF COMPUTER TECHNOLOGY AS A LEARNING TOOL

The other major theme that emerged from the data was the participants' narrow views of computer technology as a learning tool. This could very well have been a reflection on how much or how little they have been exposed to such capabilities, but in any case they were limited. Much of the discussion in the interviews focused on specific software and how they used this for presentation purposes in their design projects. A few mentioned such programs as AutoCAD, PhotoShop, and InDesign, but most applications were on layouts for final presentations.

We've used PowerPoint as a presentation tool in our design process. Actually we just did that for our projects. And that worked really well. We had to do a presentation on a designer that we were evaluating and a culture that we were evaluating so that was useful. But using Excel, I have not used Excel. I've used Word to write some papers and to write up some outlines of stuff that I want to have in my project. But I actually haven't used all that much computer technology in our projects.

Another participant spoke of the presentation capabilities of the software programs in their design studio and on the more informal ways students learn different computer skills.

Well for the Postcard<sup>2</sup> project last year, I put all of my images into PhotoShop and then I could arrange them and resize them into a postcard as a collage together on the computer and then printed them off separately and cut them out separately and put them together by hand. But it saved me a lot of time, like organizing it, making everything the right size and how I wanted it. So, I had no idea how to use PhotoShop at that point, but my boyfriend is in Graphics so he basically taught me like all the software things I've learned...

In the cases where these software programs were used other than presentation purposes, like this previous participant, they were predominately focused on the efficiency aspects of the computer software.

Well AutoCAD is one of my favorites because it is easy to lay something out and just shift something a little bit rather than drawing it all out and saying, oh, that needs to move just a hair that way or this way. So it makes it just so much easier to see it differently on the computer. But then again, with process you don't always remember to print off what you've changed so it's like you don't really get a whole lot of process from it if you don't remember. But I've learned to discipline myself to do that, especially last semester when I was doing a computer program to print off every day so I could see my changes.

## DISCUSSION

### STUDENTS' CONCEPTUALIZATIONS OF DESIGN AND INTERIOR DESIGN

The data from the interviews were both domain specific and domain general in terms of conceptualizations of design and a person's general success in a profession. With respect to interior design, students were quite explicit on the distinctions between architecture and interior design. In particular, the participants viewed interior design as more sensitive to the human condition and the importance of wanting to help people or clients. Other important characteristics that a good designer must have according to these participants were being organized, motivated, creative, and open to all ideas or unbiased. While it is difficult to conclude that architects do not need to have these attributes, it is interesting to hear that these interior design students feel they are at least very important to interior designers and interior design as

---

<sup>2</sup> The Postcard project is one of several projects in the design college's "core" design curriculum, in which all freshmen interested in one or more of the colleges programs must first complete.

a discipline. Is it in fact more about scale than about sensitivity to human conditions? Possibly. The view of one participant that a good designer needs to be obsessive and compulsive was an interesting passage. It is may very well be that this participant is correct in that all successful people, regardless of the discipline, need to have some degree of obsession and compulsion.

## THE PROCESS BOOK IN STUDIO PROJECTS IS NOT EFFECTIVE

The interview questions regarding the process books were conveyed to the participants because it was thought this would be a means by which the students could talk about how they design and about their particular process. Interestingly, though, it became apparent that the existing requirements, structure, and meanings of this artifact do not parallel the design activities very well. This artifact, in some respects, is a detriment to the design process. More study is necessary to investigate the instructor's perspectives of the process book.

## LIMITED VIEWS OF COMPUTER TECHNOLOGY AS A LEARNING TOOL

Many education scholars offer numerous useful and creative ways in which computers have been implemented in the classrooms. It was somewhat disappointing to hear about so few ways that computers have been helping design students actually design. While AutoCAD was one software package that was used as both in the process and the end product, other more common software packages seemed foreign to the students in their design thinking. Such software as word processors, spreadsheets, and especially databases, were not used or only minimally used in other classes outside of the studio courses.

## SIGNIFICANCE TO THE FIELD

By better understanding the students' conceptualizations, reflections, and meaning towards their design thinking and the role of technology in their education, design educators will know more about their students. Newsteller and McCracken (2001) believe that design students have well-developed prior conceptions and theories about the nature of design that conflict with understandings held by expert designers. Prior knowledge is an essential variable in design learning. Developing students' reflective and metacognition in design is also crucial. Dewey (1933) argues that the development of reflective thought is the most important goal of education. Reflective thought enables the individual to take control of and responsibility for their own thinking in order to participate effectively as a member of a democratic society. The term "metacognition" has been attributed to Flavell (1976) who states, "metacognition refers to one's knowledge concerning one's own cognitive processes and products or anything related to

them...Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes” (Flavell, 1976, p. 232).

This study and future studies on interior design students’ conceptions begins to provide more focus and insight into the subtle and sometimes distinct differences between the many design disciplines. While this study employed only six participants, it provides a basis for larger scale research designs involving more participants within the program, between interior design programs, and between other design disciplines.

## FUTURE DIRECTIONS

This study begins the explorations of the meaning, utility, and role of the process book in the interior design studio. While the intention of this artifact may in fact be to provide a source of documentation of all of the student’s work in a particular design project, this entity has so much more to offer the students, instructors, and possibly even future employers. What is not yet developed is the value and role the process book has for design instructors. Therefore, a future study will explore these areas from this perspective. In addition, another study will systematically document and analyze the structure and contents of existing process books, and possibly additional interviews from students. Results from these studies will also help inform the development and evaluation of a *digital* process book, where these applications could act as what Jonnasen (1998) describes as mindtools.

## REFERENCES

- Brunner, L.A. (2004). The effects of a schema-based learning system in the interior design studio. Unpublished manuscript.
- Brunner, L.A., Fowles, D.L. (2006). Are there lasting effects of a schema-based learning system? Paper presented at the International Conference of the Interior Design Educators Council (IDEC), Scottsdale, AZ.
- Brunner, L.A. (2007). Student Perspectives on Design, Learning, and Interior Design Education. Paper presented at the 2007 International Conference of the Interior Design Educators Council (IDEC), Austin, TX.
- Chi, M.T., Glaser, R., Farr, M. (1998). The nature of expertise. Hillsdale, NJ: Lawrence Erlbaum and Associates.
- Coffee, A., Atkinson, P. (1996). Making Sense of Qualitative Data. Thousand Oaks, CA: Sage.
- Dewey, J. (1933). How We Think: A restatement of the relation of reflective thinking to the reflective process (Revised Edition), Lexington, MA: Heath.
- Flavell, J. (1976). Metacognitive aspects of problem solving. In L. Resnick (Ed.), The Nature of Intelligence (pp. 231-236). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Esterberg, K.G.(2002). Qualitative methods in social research. New York: McGraw-Hill
- Harmon-Vaughn, B. (2002). "The regulatory organization." In C. Coleman (Ed.), Interior Design Handbook of Professional Practice. New York: McGraw-Hill.
- Jonassen, D.H., Peck, K.L., Wilson, B.G. (1999). Learning with technology: A constructivist perspective. Upper Saddle River, NJ: Prentice Hall.
- Jonassen, D.H., Carr, C., Yueh, H-P. (1998). Computers as mindtools for engaging learners in critical thinking. TechTrends, v 43 n 2 pp. 24-32 Mar.
- Lawson, B. (2006). How designers think: The design process demystified. 4<sup>th</sup> Ed. Amsterdam: Elsevier.
- Mayer, R.E. (1979). Can advanced organizers influence meaningful learning? Review of Educational Research, 49, 371-383.
- Miles, M.B., Huberman, A.M. (1994). Qualitative data analysis: An expanded sourcebook. Thousand Oaks, CA: Sage Publications.
- Newsteller W.C., & McCracken, W.M. (2001). Novice conceptions of design: Implications for the design of learning environments. In C.M. Eastman, W.M. McCracken, W.C. Newstetter (Eds.), Design knowing and learning: Cognition in Design Education (pp. 63-77). Amsterdam: Elsevier.
- Taylor, R.P. (1980). Introduction. In R.P. Taylor (Ed.), The computer in school: Tutor, tool, tutee (pp. 1-10). New York: Teachers College Press.

## Appendix A

### Interview Questions

#### Design Process / Design Thinking

- A1.** What is it about design that interests you?
- A2.** What qualities do you believe make a good designer?
- A3.** What is your definition of design?
- A4.** Could you tell me (and elaborate) about your design process?
- A5.** Describe one of your design processes that you believed was not successful for some reason(s).
- A6.** Describe one of your design processes that you believed was very successful in some way. What was different in this process than the unsuccessful or typical process?
- A7.** How do you organize or manage different elements in your design process? Maybe discuss your process book structure.
- A8.** Have you ever thought about how you learn? If yes, could you explain?
- A9.** Tell me about some of your learning strategies when you need/wish to learn a new concept.
- A10.** Could you list all of the words (activities) that you associate with the process of design?
- A11.** Could you draw a representation or a concept map of the design process using the words you have written down?

-----

#### Computer Technology / Instructional Technology and Designing

- B1.** How would you describe yourself (skill-wise) in terms of computer technology?
- B2.** What computer software programs do you use in your design process?
- B3.** How do you use these programs in your design process? Could you explain?
- B4.** Think about a design process/project where you used computer technology and then think about a design process/project where you relied only on manual sketching/rendering, and physical modeling techniques. How were these processes similar? Different? More successful? Less successful?
- B5.** In an ideal design process, what aspects would you use digital media and what aspects would you use manual techniques?
- B6.** How might you develop a digital process book?

**Do you think there should be any other questions that should be asked?**