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Metamorphosis:
Transforming Non-designers into Designers

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Abstract

In this paper we make the case that there is today a growing number of educational settings experiencing challenges when it comes to transforming non-designers into designers, and in particular, interaction designers. We see this development as a consequence of an increased awareness and recognition of what broadly could be labeled as a *design perspective*. We examine the *transformational process,* the *metamorphosis*, by which non-designer students become interaction designers. We identify and describe the *barriers* that make it difficult for the students to move through this transformational process. We also propose some *pedagogical approaches* that can reduce the barriers and improve the possibility for the transformation to occur. The approach that we have developed and describe consists of three parts. Based on a fundamental understanding of the nature of design, we have developed (i) a tentative *transformational model* of how non-designers become interaction designers; (ii) a special kind of *conceptual framework* used to support students in the transformational process; and (iii) design assignments based on *real-world design problems*. We end the paper with two conclusions. First we argue that there is a challenge in transforming non-designers into designers, but that it is possible if the educational effort is based on an understanding of design and on the transformational process with its barriers. Finally we argue that the experience of trying to turn non-designers into interaction designers is in itself a valuable research approach. Dealing with non-designer students reveals deep insights about the nature of the design process and makes it possible to better formulate what constitutes a designerly approach.

Keywords
Design, Design education, Pedagogy, HCI

In this paper we address the issue of *turning non-designers into designers*, and in particular *interaction* designers. We make the case that there is today a growing number of educational settings experiencing challenges when it comes to transforming non-designers into designers. We see this development as a consequence of an increased awareness and recognition of what broadly could be labelled as a *design perspective*. The ability to apply a design perspective is being recognized as an increasingly important value in traditionally non-designerly fields and disciplines such as business, education, anthropology, psychology, IT and engineering (Thackara, 2005; Cross, 2001). Likewise, many design educators in traditional graduate design disciplines (graphic, interior, architectural design, etc.) do not experience this problem to

the same extent since they teach students that already have a design background; these design educators mentor within an *established design culture* that both recognizes and values design as its own approach, demanding its own way of thinking and acting.

In this paper we examine the *transformational process,* the *metamorphosis*, by which non-designer students become interaction designers. We identify and describe the *barriers* that make it difficult for the students to move through this transformational process. We also propose some *pedagogical approaches* that can lower the barriers and improve the possibility for the transformation to occur. The approach that we have developed and describe in this paper consists of three parts. Based on a fundamental understanding of the nature of design, we have developed (i) a tentative *transformational model* of how non-designers become designers, and (ii) a special kind of *conceptual framework* used to support students in the transformational process, and (iii) design assignments based on *real-world design problems*.

We end the paper with two conclusions. First we will argue that there is a challenge in transforming non-designers into designers, but that it is possible if the educational effort is based on an understanding of design and on the transformational process with its barriers.

Finally, we will argue that the experience of trying to turn non-designers into designers is in itself a valuable research approach. Dealing with non-designer students reveals deep insights about the nature of the design process and makes it possible to better formulate what constitutes a designerly approach.

Design as an Educational Core

Any educational approach aimed at developing design thinking is grounded in some kind of fundamental understanding of the *nature of design* and how design relates to the specific field in question.

Our paper is based on the assumption that several academic disciplines are debating if the traditional way to teach students in their field would or could be improved if the students were more aware of and maybe even skilled in a design perspective—a designerly way of doing things. Within our own field, Human-Computer Interaction Design, such awareness has been growing over the last few years. HCI is a discipline that has its roots in different academic fields. HCI is grounded in computer science, engineering, and (cognitive) psychology. Over time these different fields have influenced the development of HCI, but now that is changing. Design has become recognized as a potential tradition in combination with the other fields. This has to some extent influenced the way HCI research is conducted. But there have not been any elaborate and tested ideas and examples on how to transform a HCI education to be more designerly.

Our approach has been built on the assumption that design as a generic discipline consists of a general set of skills that can be applied to or combined with approaches of other disciplines. Our view of design is compatible with the theoretical foundation of design as an approach of inquiry and action that over the last years has been developed by a number of international design researchers (Krippendroff, 2006; Nelson & Stolterman, 2003; Buxton, 2007; Cross, 2001). These developments rest on a tradition of design research that can be traced back to the famous and influential work of Simon (1969), Alexander et

al (1967), Rittel and Webber (1974), and Schön (1983). This tradition advocates a unique designerly approach with its own approaches, methods, techniques, and skills appropriate for dealing with real-world, complex, design challenges involving the creation of new technology in a human-centered way. This understanding of design constitutes the foundation for our educational approach.

A Case Study - Background

Human-computer interaction is an academic discipline that is rapidly changing from being grounded in the two disparate traditions of engineering and cognitive psychology to becoming a design oriented discipline. The practical challenge for us in our master's program in interaction design is that we begin with 30 first year students coming from fields as diverse as social sciences (e.g., psychology, journalism, and anthropology), sciences (e.g., biology, geology), and technology (e.g., computer science, informatics) with little exposure to design or fine arts; and in two years time, we must educate these students to think and act in a designerly way as interaction designers.

The purpose of the program is to educate the students to understand the nature of design, to think and act in a designerly way, and to be reflective practitioners that can be advocates for a designerly approach in HCI design. In many ways these goals are completely unknown to students when they arrive and even more challenging, they are contradictory to what they have experienced in their earlier education. Often their earlier education was mostly rule-based, procedurally driven, and they were used to working with well-defined problems with "correct" answers.

Based on our understanding of the nature of design, we developed a three-part approach: (i) a tentative *transformational model* of how non-designers become designers; (ii) a special kind of *conceptual framework* used to support students in the transformational process, and (iii) design assignments based on *real-world design problems*.

A Transformational Model – Phases and Barriers

We will focus on the first phase of the process – the first 15 weeks or first semester of the curriculum. Our model and identification of barriers is based on our own experience through teaching, advising, and mentoring the students. We have now followed five groups from the day they enter the two-year program until their graduation (and also after that), which has been important in order to understand the process during the first 15 weeks. To support our notion of developmental transitions and barriers, we present and discuss a set of empirical observations and student self-reflections maintained throughout the 15-week period.

Phases

During the 15-week period we see the students moving through three transitions: *Pre-emergence* (P); *Transitional* (T); and *Designerly Thinking* (D).

Characteristic of each of these transitions is a *penetration of barriers* – intellectual, practical, psychological and social. Rather than progression along a smooth continuum, these students penetrate these barriers in a step-like function. We have identified 15 barriers, moving from early barriers such as

best solution to *many solutions, technology-centred* to *human-centred,* and *me* to *we,* to advanced barriers such as *research* to *philosophy, objects* to *systems,* and *external* to *internal.*

Barriers

As non-designers enter the curriculum, they exhibit a kind of naïveté with respect to designerly behavior; these naïve thoughts and behaviors become barriers for sound designerly thinking and action. Letters in parentheses indicate the transitional stages where the barrier occurs –
Pre-emergence (P); Transitional (T); and Designerly Thinking (D):

- **Design definitions**. Naïve designers' conception of HCI design includes mostly graphic design and interface design; experienced designers also include interaction design, experience design, emotional design, and systems design. (P)

- **Best solution**. Naïve designers hold onto the belief that there is a *best solution*; experienced designers believe there exist many solutions and judged by critical criteria and presented through a design argument or explanation. (P)

- **Technology-centered vs. human-centered**. Naïve designers focus on the technology; experienced designers study human behavior, motivation and need. It's very difficult to "let go" of gadgets and things; there's an over-fascination with techno-fetishism among naïve designers. (P, T)

- **Me and we**. Naïve designers defend their own designs; experienced designers look to their team for inspiration and solutions. (P, T)

- **User research**. Naïve designers underplay the role of user research; they *know* what people want. Tools such as *personas* are resisted rather than embraced naturally in the design process. Experienced designers do not make assumptions about human desires and motivations; they *study* it instead. (P, T)

- **Algorithm / design paradox**. Naïve designers expect to memorize algorithmic solutions to problems; experienced designers learn to deal with ill-structured problems, seemingly paradoxical situations and design thinking. (P, T)

- **IT domination.** Naïve designers tend to overemphasize efficiency, effectiveness, scalability; experienced designers include experience and emotion. (T)

- **Idea loyalty**. Naïve designers hold onto a single idea; experienced designers engage in systematic exploration of multiple ideas. (T)

- **Critique culture**. Naïve designers worry about school grades; experienced designers welcome critique. (T, D)

- **Notebook**. Naïve designers sketch for a particular project; experienced designers sketch continuously, deriving inspiration from all contexts. (T, D)

- **Role**. Naïve designers are learning what they do and how to do it; experienced designers begin to defend the position of design in a multi-person development team made up of designers and non-designers. (T, D)

- **Research and philosophy**. Naïve designers find solutions in the HCI literature; experienced designers explore philosophical foundations of design as well. (D)

- **Reflective designer**. Naïve designers spend little to no time reflecting on how they are designing versus experienced designers who can look at themselves "out of body" as they design. (D)

- **Omnipresence**. Naïve designers see design embedded in objects; experienced designers see systems that affect designs and designs that affect systems. (D)

- **External / internal**. Naïve designers find external answers to design problems; experienced designers begin to look internally and introspectively for inspiration and resolution. (D)

At the end of the 15-week semester, students were asked to reflect on any or all of these barriers. Included below are some of their reflections:

- *As I went through this list of barriers and started relating them to my own experience during this course, I realized that I had faced a number of them at different stages and points of time throughout the semester. And this realization made me happy, because it indicated that I am growing as a better designer as I come across and overcome each of these hurdles…*

- *During the first two projects, I definitely faced the barrier of best solution and critique culture. Especially while designing the thermostat, I had this notion that the challenge is to come up with the best design that is the solution to the whole problem. I tried hard to understand the problem of the user's mental model and trying to come up with such a design (the BEST design).*

  As different teams presented our ideas, I realized that there is no one BEST solution. There were good ideas in everybody's design and there were so many different approaches to tackle the same problem effectively. I finally ended up acknowledging the fact that it was the deep thinking and argument behind them that make a design a good design.

- *Though (the professor) and the mentors cautioned us about the critique culture, I must admit that I still felt a bit demoralized about the grades in the first two projects. To me it was the grades that mattered the most at that time. I did look into my mistakes and the criticism and accepted them, but I would always think, "if I only knew that earlier, I would not have made such a mistake." However, the course finally made me realize that one cannot know everything beforehand.*

- *Being very detail oriented, I learned and felt that perfection cannot be done in one try or even reached in design. In the beginning of the semester, I admit that I would think waaaay too big - in terms of trying to fit everything in my design concepts.*

- *Gradually progressing through this program, I found that for every feature you place in a design, there should be some justification why we "added it." Before I would say something superficial like, "it looks pretty" or "I think that's what users want." But now, I view design from a different perspective - by listening more, questioning, and always being curious.*

- *My list of things I want to improve on:*
  1. Emotional and experience design
  2. Sketching like a designer rather than a "beginner"
  3. Communication design
  4. Training myself to think of 100 concepts as opposed to 3

- *Two (of many) that I have struggled with: Notebook - Too many (seemingly) good ideas fall through the cracks because I fail to record them. I do feel inspired all the time, so I should be sketching all the time! Reflective Design - I have not yet developed in terms of "out-of-body" reflection and looking at "how" I am designing.*

- *The one that I am finding really interesting at the moment: Research and Philosophy - This has been very eye-opening in (another professor's) Interaction Culture class this semester. HCI can be pretty conservative and very rooted in 'other HCI research' only. Bringing in theoretical and philosophical perspectives is very important, in my opinion.*

- *Me and we. I've been talking to some groups and have been thinking about different team issues. I found a major irony: As much as we've been talking about human centered design, we don't care about helping each other.*

  We don't give any consideration as to how we can design ourselves to help out teammates. Our teammates are often wrong or narrow minded. Our teammates are unwilling to budge. Our teammates just don't get what I'm trying to say. Our teammates just stop being human, but are just a speed bump.

  But the reality is that our teammates are people too. I'm forced to ask myself, if my design problem was to create the best team dynamic, what would be my solution? Maybe I'm being wrong or narrow minded. Maybe I'm unwilling to budge. Maybe I just don't how to speak to them. What can I do to make sure that I'm helping them with their human needs?

  I've learned over the years that teaching doesn't happen until students learn. You can lecture, but unless the student is getting it, you're doing noting but oration. It's not teaching. In the same way, we're not being good teammates unless our teammates are feeling like part of the team. We're not being good facilitators unless our team is flowing.

  We're not being human-centered unless we learn to be empathetic to everyone, particularly those around us.

> *From here, we can generalize this already interesting principle to our work at large. Thinking about the people "out there" allows us to have a healthy separation between us and them. I don't have to help them, but rather, all I can fix is their problem. Thinking of teammates over ourselves forces us to help a specific person, to think about their needs, they're problems, and solutions to help them. Once we can help the person right next to me, we can learn to help the person 2 places next to me, then 3. Then, and only then, can we learn to think of that homeless person on the street with any real empathy. It is then that we can see the new mother and design a system to help her manage her day. It is then that we can look at an executive and help them increase communication with her staff.*

Based on the reflections from the students as well as our own observations over our many years of teaching interaction design, we are convinced that the notion of barriers is helpful, both to the educator and to the students. It helps the educator to design and develop teaching approaches and assignments that can specifically target barriers; it also helps to explain why students might have problems with seemingly simple assignments. It also aids students in their understanding of their own development. It is crucial to remember that these students are used to being top students and are suddenly experiencing that they don't perform well, that they don't get the assignments, that they don't get great grades on the assignments. They need support in their effort to understand and reflect on their own intellectual development.

A Conceptual Framework – The Seven Themes

As an example of pedagogical support that can help students face and overcome the barriers above, we have developed a conceptual framework, which we have labelled the *Seven Themes.* These themes are introduced early in the 15-week course. The themes can be seen as "big concepts," "thought figures," or "intellectual triggers" for the learners. The idea with these themes is that they do not provide a full conceptual framework or theoretical system that requires intense reading and studies to be able to understand the nature of design; instead, they can be seen as condensed intellectual "seeds." These seeds initially can be approached as simple practical guides. But they also have the quality of allowing for continuous reflection upon their meaning and interpretation. By trying to define and understand them, they can "draw" and "push" the students into deeper thinking about what it means to act in a designerly way.

We are presenting the Seven Themes here in the format they are presented to the students. **The Seven Themes** are framed under the notion of *Good Design*, and the themes state that **good design**:

> **1. Is user-centred, not machine-centred**. From Norman and Draper (1986): "Whenever people use computers, there is necessarily a zone of mutual accommodation. This defines our area of interest. People are so adaptable that they are capable of shouldering the entire burden of accommodation to a piece of software. But skillful designers make large parts of this burden vanish by adapting the software to its users. To

understand successful design requires an understanding of the technology, the person, and their mutual interaction."

Commentary. User-centeredness is the core of HCI. We're not designing as much for ourselves as we are for the end-users. It's easy to say this, but very difficult to pull off. Why? It's difficult to know what users want and what they need. Often users don't know what they need (it may not be invented yet!). Also, there's the issue of designing for an individual and designing for a group or a large population. It's very difficult to accommodate the needs of all users.

The last point is that humans are very good at accommodating "the machine." People can adjust and learn. They tend to blame themselves when technology goes wrong rather than more appropriately blaming the designers/developers. Most software developers have not been trained in user-centred thinking.

2. Employs the computer as a transparent medium. While the first theme focuses on users, this theme focuses on uses. The uses should flow through the machine without the machine getting in the way.

Commentary. If the user is focusing on how the machine works (e.g., as in a word processor), then the user is not focusing on the task at hand (e.g., writing).

There are great examples of transparency in other media: when you read a wonderful book, you forget about the book's physical structure—that you are turning pages, that it has a certain form. You are absorbed instead in the story. The same is true for a great film—you forget that you're sitting in the theatre, that there are people around you; you stop noticing the popcorn crunching, etc. The movie pulls you in. Good design should do this too.

3. Creates computer imaginative interactions. Computer imaginative software exploits the strengths of the medium for particular purposes (e.g., instruction, productivity, organization, entertainment).

Commentary. This is one of the most important themes. We don't want to imitate other media—copying one medium onto another. That usually results in a design that is worse than the original. Example: putting a book online has a few advantages (e.g., searching), but in general, it's an inappropriate use of the medium. Instead one must think deeply about what one can do with the new medium that can't be done easily or conveniently in another medium. A good example is amazon.com. It takes advantage of data mining and large-scale databases to keep track of your buying history and how that compares to others with similar interests. You cannot enter a real bookstore and have someone welcome you with four book suggestions that fit your profile or the profile of others with similar interests.

We don't want flash for glitz alone. There should be some functional value.

We can think of computer imagination (CI) as a multi-level construct:

Standard CI = exploiting the medium (a) + for some purpose (b)

Strong CI = (a) + (b) + that couldn't be done easily in any other medium (c)

Super CI (the "killer" application so to speak) = (a) + (b) + (c) + and it speaks to needs of users that they didn't even realize they had, but once they "see" it they all want it (d)!

An example of this is the invention of the spreadsheet. It clearly took advantage of the computer medium; it made calculations more efficient (it improved productivity); it was something you couldn't do easily in other ways without a lot of tedious work; and once people "got it" they realized it would transform the way people do business. It created a new industry of business projections and analysis.

4. Provides for ease of learning. We will borrow concepts from other design arenas (e.g., instructional design, architectural design, music and dance composition) to lend new points of view to human-computer interaction design.

Commentary. Good design makes the interaction (or product) accessible. It's easy to learn. It is this way because it takes advantage of certain principles. For example, if it follows certain norms or standards, then users know what to expect. If it is consistent, then users can predict what will happen next.

Most often you want to follow these norms; but sometimes it is appropriate to break the norm. But you do this for a good reason. It must "take us to a new place" that is needed or that we will discover we desire.

We look at other design areas: architecture (how form/function/construction) are used to create spaces in which we live, work, and have fun. There are principles here that generalize. For example, look at entryways of buildings (like doors). Certain entryways lead to certain expectations. Some are carefully designed, like the path of a Japanese garden. Again, sometimes you break the norm to create surprise, suspense, but you do this for good reason.

Dance provides other parallels, particularly thinking about choreography. Dancers can do certain things with their bodies, but there are limits. There's an interaction with the audience (the users), etc. Similarly, there are parallels between the seven themes and music composition.

5. Entails continual redesign. First drafts almost never work. Great designs come from many redesigns. Thinking on paper and using powerful mock-up tools are important aids. Redesign is a successive approximation to an unobtainable ideal.

Commentary. Rarely can a designer create perfect design the first time through. We're not all like Mozart! Good design comes from many iterations, many revisions. The problem is that we think this doesn't happen because we only see the finished product. For the most part, we don't have access to all of the early versions and the revisions. If we saw them, then we'd be amazed at how many changes get made and for what reasons. Good design is a lot of work, and hopefully with each version there is improvement towards a theoretically unobtainable goal.

6. Is more craft than art. With a craft you acquire a set of rules; you apply them; you extend them. This is not art. Art de-emphasizes rules.

Commentary. We typically don't create designs solely for ourselves. We have end-users in mind. We also must recognize that we're not the first ones creating these designs; there have been many who have gone before us. There's an entire craft, including certain traditions, which we must learn. Good designers learn to stand on the shoulders of giants.

7. Always involves tradeoffs. There is no "best" solution to any design problem; there are only tradeoffs (for example, trading off ease of use for power).

Commentary. No design is perfect. And you're never done with a design. Ultimately you stop designing when you either run out of funding or your time is up! Trade-offs mean that it's almost impossible to optimize everything! Often you need to emphasize one variable over another – like ease of use vs. efficiency.

The themes are used for continuous reflection, contrary to the barriers that can only be recognized by the students after the fact (the experience of going through the whole course). The seven themes (or intellectual triggers) are discussed throughout the semester, and they are introduced as big concepts, "while standing on one foot."

There's an old story about a young student who challenges his teacher. "Rabbi, can you summarize all of scripture while standing on one foot?" The wise rabbi responded, "As you would have others do onto you, so should you do onto others. All the rest is commentary! " While the seven themes are not as pithy as our ancient rabbi's response, nonetheless, these themes pervade all of human-computer interaction design. The rest is commentary.

We are convinced that working with these big concepts or intellectual triggers challenges the students to reflect on their own ideas of good design. In the beginning, the themes are seen as too abstract, too fluid, and not providing any real guidance. However, over time and after some barriers have been passed, the students' designerly thinking is evoked by the themes and they can continue to "use" them for their own development.

Real-world Design

Big concepts and lectures alone will not transform non-designers into interactive designers. Students must engage in a sequence of problems, each designed with specific goals in mind. An unusual strategy that we incorporate into these problem sets is that we design failure into the problem; that is, we create problems with the anticipation that a group of students will fall into a design trap. For example, here is the first problem students are to tackle:

You work for the design department of Honeywell, working on future designs of thermostats.

Customer service has received thousands of questions about how to use a home thermostat. Even the new digital thermostats do not seem to solve the problem. Basically the problem is this: most people don't understand how a thermostat works; that fundamentally it's an on-off switch. See: http://home.howstuffworks.com/home-thermostat.htm .

Nevertheless, when people come home on a hot day, they often walk over to their thermostat and greatly lower the temperature thinking that it will get cooler faster. Thermostats, however, do not work this way, and ultimately it costs the user more money to operate their system. A similar response occurs when it's very cold outside and people walk into a cold house.

Your task is to design an interactive thermostat display that reflects how users think about thermostats without changing the basic operation of the thermostat or the home's heating or cooling system.

For this project, the target user group includes home owners or apartment renters and residents of a home or apartment. Think of specific kinds of people who might use the home's thermostat and under what circumstances that person would use it.

There are other specifications offered, but this type of problem typically yields several design traps: the student will design the product more according to their style rather than a consumer's style ("I like numbers so I created an all digital interface"); an inappropriate use of research ("Studies show that the best temperature for humans is 72 degrees Fahrenheit (22 degrees Celsius); therefore the only temperature allowed should be this); and significantly moving beyond the constraints of the problem (e.g., adding new blower systems to house units to move air faster through the system).

An example of an advanced problem introduced in the final weeks of course is the CHI international student design competition problem

(http://www.chi2008.org/student_design_competition.html):

A home is one's castle, yet not all of the citizens of the planet can claim the kingdom. The UN Human Settlements Programme estimates that there are 3 million homeless in the EU, and the United States Department of Housing and Urban Development reference close to three quarters of a million homeless in the US. Some are temporarily homeless by environmental circumstance, while some are born into poverty; some even elect a nomadic lifestyle rather than participate in the culturally accepted norms of society. Whatever the reason, these people often depend on public services and support for food, shelter, medicine, and other forms of necessary assistance and guidance.

Design an object, interface, system, or service intended to support the state of living without a house. Use methods of ethnography and contextual research to understand the problem space, and develop user-centered design solutions to support, assist, enhance or otherwise benefit your target audience. Your solution could address the environmental state of being without a house, including issues of physical sustenance and safety, or it could investigate the emotional, social and cultural needs of this group of people.

To enter the competition, student teams may present either a concept (a clear, detailed design specification that can be taken to prototype), or a fully realized prototype. Either way, teams must clearly illustrate their design decisions and demonstrate the user centered design processes that have been followed.

A problem of this scale is fraught with challenges and design traps. One trap is to create more technology-centred than human-centred solutions. Another is to create a design that is so large and complex that the core of the solution is sloppily conceived. Of course one of the big design traps for this problem or any others is to "go with your first instinct;" that is, to work on the first idea that comes to mind rather than exploring many alternative designs before focusing on a specific solution.

The overall value with real-world problems is that they match the complexity and richness of the themes. Also, in a practical and concrete way, they manifest many of the barriers. That makes it possible for the educator to raise design issues and design traps that can only be handled if the students have a designerly approach and a grounded understanding of design.

Design Education as Design Studies

We want to mention an aspect of our experience in teaching students that is less about them and more about ourselves as researchers. Over the years we have realized that trying to teach design to non-designers has made it possible for us to gain a deeper understanding of design thinking. So, teaching design to non-designers is a way for the instructors to develop a deeper understanding of what constitutes the nature of design.

When an instructor, in a close and personal way, vicariously experiences the struggles and challenges experienced by the students, the instructor recognizes and reveals aspects of designerly thinking and acting that is difficult to understand and appreciate when not confronted with students who have these fundamental intellectual barriers to overcome. For someone who understands the nature of design, the design approach might seem straightforward and even obvious, while for non-design students the design process can be experienced as both irrational and absurd. In many cases these students react with anger and frustration. These reactions have helped us to form the framework and knowledge about design barriers and the Seven Themes.

It might even be argued that this is why a substantial part of new theoretical contributions to the general understanding of design has come from educators and researchers in traditionally non-designerly fields.

Conclusions

As a result of our study we conclude that it is possible and useful to recognize and describe the process of turning non-designers into interaction designers as a transformational process. We also argue that a model describing the transformational process, identifying barriers and possible barrier penetration approaches, is a useful support for anyone trying to improve the education of novice designers.

References

Alexander, C., Ishikawa, S., and Silverstein, M., with Jacobson, M., Fikidahl-King, I, and Angel, S. (1977). *A Pattern Language*, Oxford University Press, New York, NY.

Buxton, B. (2007). *Sketching user experience – Getting the design right and the right design*. San Francisco: Morgan Kaufman.

Cross, N. (2001). Designerly Ways of Knowing: Design Discipline Versus Design Science. *Design Studies*, 17(No. 3), Summer 2001, 49-55.

Krippendorff, K. (2006), *The Semantic Turn – a new foundation for design*. Taylor & Francis.

Nelson, H. & Stolterman, E. (2003). *The Design Way – Intentional Change in an Unpredictable World.* Educational Technology Publications.

Norman, D. A. & Draper, S. W. (Eds.) (1986). User centered system design: New perspectives on human-computer interaction. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Rittel, H,. W., & Webber, M. M. (1974). Dilemmas in General Theory of Panning. *In Design Research and Methods, 8* (1), 31-39.

Schön, D. A. (1983). *The reflective practitioner.* New York: Basic Books.

Simon, H. (1969). *The science of the artificial.* Cambridge, MA: MIT Press.

Thackara, J. (2005). *In the Bubble – Designing in a Complex World.* Cambridge, MA. MIT Press.

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