The Chaotic Nature of Human Experience:

Insights on the Subject Matter of Design towards Establishing a Science of Design

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A Thesis Essay Submitted in Candidacy for the Degree of Master of Design in Interaction Design

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"It is quite true what Philosophy says: that Life must be understood backwards. But that makes one forget the other saying: that it must be lived—forwards. The more one ponders this, the more it comes to mean that life in the temporal existence never becomes quite intelligible, precisely because at no moment can I find complete quiet to take the backward- looking position"

Sören Kierkegaard, 1990.

Abstract

Design, once considered solely as a practical planning activity for handcrafts, has evolved into a comprehensive human-centered *thinking* activity. The next step in this evolution is establishing *a Science of Design*, an endeavor that fascinated design theorists including Herbert Simon and Horst Rittel. However, even terminologically, Science and Design have long been considered as the opposite extremes of the spectrum of human thinking. Traditionally, Science exploits strictly analytical and deterministic approaches, while Design embodies more intuitive, empirical, and pragmatic perspectives. Therein lies a fundamental conflict between the approaches of Science and Design in the traditional understanding.

However, recent developments in Natural and Social Sciences, in particular in physics and mathematics on chaos and instability, have shown that deterministic Science is not relevant to explaining the subject matter of Sciences that is the complexity in natural and social systems. Instead, a new perspective has emerged that goes beyond classical deterministic orthodoxy, and leads to “a new kind of knowledge” in Science based on the idea of “events” and probabilistic reasoning.

Design problems, on the other hand, in their very nature, are ill-defined and complex. Richard Buchanan calls design problems “indeterminate” and “wicked,” as Design has no fixed subject matter but the entire scope of human experience. I argue that human experience, the subject matter of Design, is similar in nature to natural and social systems, and possess a similar complex structure. Therefore, this new perspective in Sciences might have a say in understanding the subject matter of Design, furthermore, help establishing a new research framework for the field of Design.

Nevertheless, this similarity may seem arbitrary at first. The explanation lies in looking at “the nature” of the subject matter of design that is

"human experience." My thesis essay is an attempt to explore this nature and discuss its implications for a new research framework for the field, hopefully a *Science of Design*.

Table of Contents

List of Figures and Tables

1. Introduction

Design has evolved into a comprehensive human-centered thinking that has its primary concern as human experience and environment. The next milestone in this evolution is the establishment of a more extensive and formalized research framework, a Science of Design, which is the main concern of this thesis essay. However, due to the highly speculative and complex nature of this topic my thesis essay is limited to exploring the rationale that leads to the reasoning to establish a new framework.

Rationale for a New Research Framework

I argue that there is a fundamental similarity in the nature of the subject matter of the field of Design and that of Natural and Social Sciences. Herbert Simon (1996) points out the main concern for Design activities as attaining goals by adapting the environment (outer world) to human experience (inner world). To achieve this, a thorough understanding of the *nature* of human experience is essential. However, an understanding of such an internal (to human) and intangible phenomenon is not trivial. A comprehensive look at human experience reveals the structure of a complex system, which is also inherent to natural systems or social systems. Then understanding a complex system becomes the main matter of concern for the field of Design, which is also the core of what concerns Natural and Social Sciences.

Recent advances in Natural Sciences, in particular in physics and mathematics on chaos and instability, provide a new approach and tools to tackle the challenge of understanding complex systems. The field of Design, on the other hand, does not have formalized means for understanding its own subject matter, the complexity in human experience. Therefore, the current research paradigm in Design need to be expanded to bring in some

of the approaches and tools from Natural and Social Sciences that would help understand the complexity in the subject matter of the field of Design.

The necessity for a "new" research framework for the field is perhaps arguable[1]. However, it is essential first to expand and formalize the means of reasoning for design thinking and second, to establish a ground for interaction between the kind of Science that explain existing phenomena, and one that describes how things ought to be, namely between the Natural and Social Sciences and a proposed Science of Design. Simon (1996) points out the need for a new framework by arguing on the "intellectually soft, intuitive, informal, and cook-booky" nature of the current Design paradigm. He suggests that a Science of Design is "a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process." Simon, as well as Horst Rittel, proposed the establishment of a Science of Design. However, their insights are underrated and not-well-understood by the majority of the Design community. Here, I aim to pursue their efforts and contribute in formalizing the rationale for a new framework for the field of Design in the context of my Design thesis essay.

Structure of the Essay

The essay briefly brings together the ideas that lead to the above-described reasoning in a step-by-step fashion. In Section one, the context of the research question is introduced. As mentioned above, the scope of the essay is limited to exploring the complexity inherent to human experience. Therefore, Sections two and three are concerned with providing a background on human experience and emotion, and suggesting a new framework for human experience that helps uncovering the complex

[1] An existing framework for research in the field of Design is "Design Research." However, the phrase is confusing in the sense that it often refers to theoretical research activities that aim to create knowledge in the field, whereas it also refers to practical human-centered research activities that provide an understanding of a particular design space (i.e. context of use for a particular product). The "Science of Design" paradigm, which was initially proposed independently by Herbert Simon and Horst Rittel, is not an alternative, but a more formalized expansion of the current paradigm, which is solely concerned with creating theoretical and methodological knowledge that is useful for the practice of design.

structure of human experience. Following this, fourth Section looks at the structure of experiences from a (complex) systems perspective. Once a complex system is under consideration, the main concern becomes which approach to take for a better understanding of the system. Section five is mainly concerned with discussing different approaches to understanding complexity. In conclusion, implications of the discussed topic on establishing a new research framework for the field of Design are discussed in Sections six and seven.

2. Background in Human Experience

The Subject Matter of the Field of Design

Several arguments could be produced about what the subject matter[2] of the field of Design is, given that there are several different approaches.[3] Nevertheless the human-centered Design paradigm would lead to a single explanation. I argue, along the lines of what the Design education and research at Carnegie Mellon University is based on, that the subject matter of the field of Design is human experience and environment. Simon (1996) provides an excellent description of design activities along these lines. He argues that the main concern of design activities is attaining goals by adapting outer environments to inner environments. In other words, design activities are concerned with helping people shape their environments in order to have fulfilling experiences. To achieve this, a thorough understanding of this subject matter is essential.

Dewey's Views on Experience

Among all literature on human experience, John Dewey's "Art as Experience" has been the most influential for design researchers. Dewey's views shed light on how experience unfolds as an internal process, shaping the quality of human experience. His ideas are particularly important to understand the relationship between human experience and emotions. For Dewey, the experiencer and what is experienced are a part of the

[2] The American Heritage Dictionary (2000) describes "subject matter" as "*matter under consideration in a written work or speech; a theme*." Therefore, subject matter is not the action (i.e. of problem solving, opportunity seeking, etc.), but what we act on, the raw content or the *subject* of the action.

[3] Different approaches would explain the subject matter of design in different ways. One with a problem solving approach would argue that the subject matter of the field is any identifiable design problem. Whereas, one that approaches Design as a value-adding tool in Marketing terms would suggest Design as an opportunity seeking activity, therefore the subject matter of this activity is the potential for a new use. I argue that none of these arguments would be wrong. Nevertheless, they highlight an activity, an output, or an attribute specific to the field of Design, instead of the central matter of concern for Design activities.

experience, and both contribute to shape the quality of the experience. The experienced object contributes the quality of the experience with its intrinsic material to shape the experience into an intellectual, emotional, or practical form. According to Dewey, intellectual experiences involve drawing intellectual conclusions from signs and symbols that have no intrinsic quality of their own but stand for things that may in another experience be qualitatively experienced. An art piece with political references could be an example to an experience with intellectual conclusions. Practical experiences involve consistent, overt doings with an anticipated final outcome. Concrete actions, such as driving a car to get form point A to point B, are considered as practical experiences. Emotional experiences bear subjective evaluations of objectively expressed esthetic content. Experiencing a personal attachment to an esthetic quality could create an emotional experience. An experience integrates these different forms in an intact form with an overall experiential quality (Dewey, 1934). Figure 2.1 is an iconic representation of the qualities of different forms of experience and their integration as an overall experience.

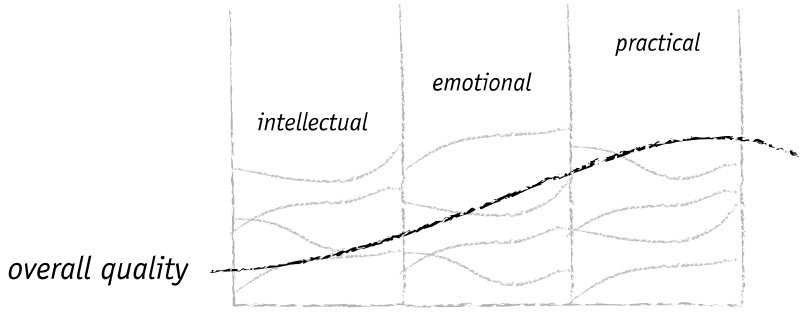

Figure 2.1. *Dewey's different forms of experience as they create an overall experiential quality.*

The Coupling between Emotion and Experience

Dewey suggests that an experience has two major components; the object[4] that is being experienced, and the experiencer. For him, the experienced object does not have emotion for its significant content. He argues that an emotion is "*to or from or about something objective*." Therefore, emotion is integral to the latter component, the experiencer, while the experienced content is a medium for esthetic qualities to evoke emotions. Dewey emphasizes emotions as the moving force to all experiences.[5] For him, it is emotion that "*evokes, assembles, accepts, and rejects memories, images, observations, and works them into a whole toned throughout by the same immediate emotional feeling*" (Dewey, 1934). Hence, emotion steers the experience to lead the experiencer to a satisfying emotional experience.

[4] Here, I use the term *object* as an object of the act of experiencing, which could represent an artifact, an environment, an event, or a system of these.

[5] Henri Bergson (1910) associates this internally-driven conscious moving force with free will. He discusses that it is nothing but free will that underlies the decisions that human make among *equally possible* choices, which corresponds to Dewey's explanation of an *objective* content. This idea of equally possible choices leads us to look at probabilistic reasoning to explain the nature of experiences.

3. An Event-Based Framework for Human Experience

Dewey's ideas are fundamental to an understanding of human experience. However, they are mainly concerned with the internal components of experience. Simon's definition of design activities emphasizes the interface between an individual's inner and outer environments as the focal point of all design activities. Therefore, human experience could not be considered free from external occurrences and the internal and external components of human experience should be considered as an integral system.

Events and Experience

Here, I extend Dewey's ideas on human experience and introduce the concept of "events" as an aspect of experience. I borrow the idea of events from theories of time and change, particularly probabilistic reasoning, and apply to human experience.[6] Events are breakpoints in an experience, often "initiating," "directing," "maintaining," or "terminating" a specific experience. They take place with or without conscious action of the experiencer. Moreover, events are often nodes that connect experiences of different experiencers to form shared experiences. Events have no subjective experiential quality inherent to them, but they evoke emotions to produce emotional conclusions. In other words, events are a set of objective and universal occurrences that experiences are structured on with the steering of emotions.

[6] The idea of an event-based model aims to go beyond providing a time-based framework for experience. The idea of events incorporates a probabilistic explanation to the emergence of experience. Ilya Prigogine (1996) describes probability as a basic probability of nature. The occurrence of every future event features a certain probability, which is determined by the occurrence (or not occurrence) of other events. In a complex system, the exact probabilities for single events become incomputable due to the complex dependencies among events.

Events and Time

Theoretically, the existence of an event comes from its realization. However, if we avoid the observer's perspective[7] when looking at time, we can talk about "actualized" and "not-yet-actualized" events, which if mapped to time, resemble to "past" and "future" events.[8] Figure 2.2 is an abstract representation of events as they map to time.

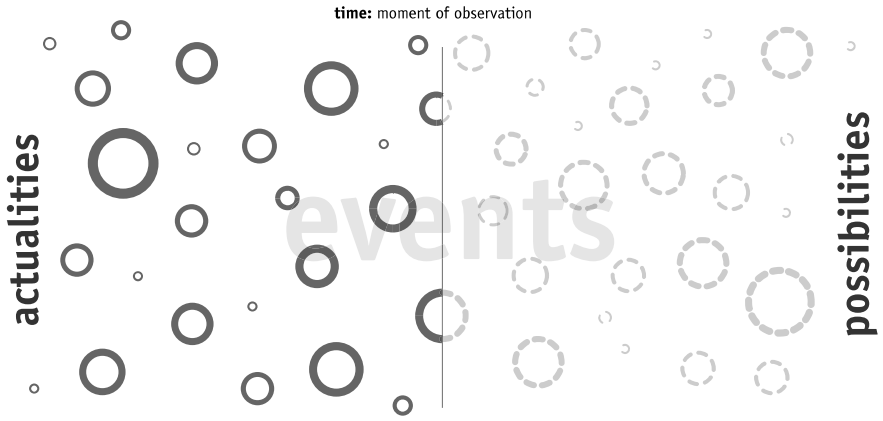

Figure 3.1. *Events as they are mapped to time.*

This twofold nature of events explicitly maps to human experience in a way that "experiences" in human life are reminiscences of past events, while intended experiences or "goals" are cognitive constructions of future events. Here, I suggest a twofold model for human experience, based on the actualization of the events that make the experience. Dewey's (1934) views on the form of experience also support the idea that experience is

[7] In the causal approach to explaining time, given a point of observation, time is symmetrical. That is to say, when present time is taken as the point of observation, the portion that stretches to the past and the portion that extends to the future are similar and reversible. However, theories on instability introduce the concept of irreversibility and break the notion of a time-symmetry universe. Therefore, the idea of an observer becomes unnecessary, which allows us to talk about actualized and not-yet-actualized (possible) events within a probabilistic framework.

[8] Here the definition of a future event needs particular attention since the existence of an event comes from its actualization. However, human experience also consists of expected events, occasionally expected unexpectedness. Therefore, we prefer to name expected events as *possible* events.

associated only with the past.[9] Dewey draws a line between a complete, unique experience, which "terminates itself," and interrupted, "inchoate" experiences. This introduces the idea that experience is an unbreakable, unstoppable unique whole, which doesn't have a unique "form" until it terminates itself. Therefore, all (unique) experiences relate to the past, thus associated with recollections of what is experienced and the quality of the experience, in other words, the form of the experience.

The connection between events and experiences becomes clearer when future events are considered. As noted previously, the existence of future events is often free from thought. However, humans cognitively construct a plan for the realization of a certain set of future events, which then become "expected" events. These expected events have a similar, yet more flexible structure to that of an experience, which is structured on a set of past events. Richard Carlson defines these constructed experiences as "goals." For him, a goal is a cognitive construction of the structure and the quality of experience that one intends to realize (Carlson, 1997). Therefore, goals, like experiences, possess a certain form. Figure 2.3 illustrates the rough events in an intended and realized experience.

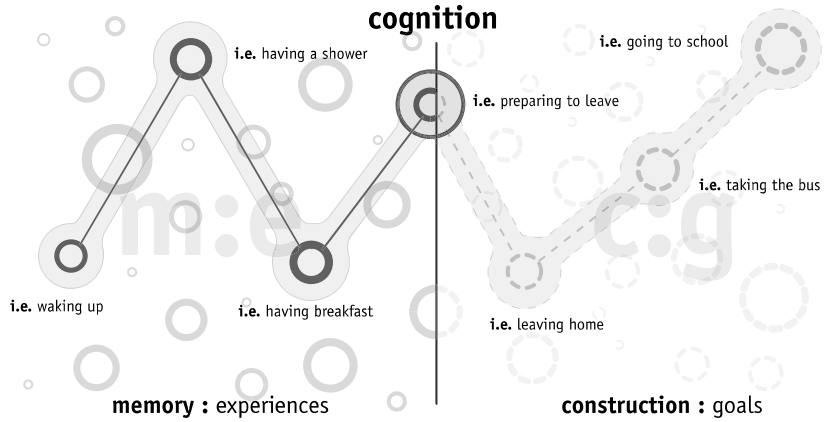

Figure 3.2. *Events as they form experiences and goals, an example of going to school.*

[9] Time-related concepts such as past, present, and future vary in different cultures and languages. Here we consider time as to bear no beginning, and no ending, and comprise an actualized half, and a not yet actualized half separated from each other by the moment of actualization.

Marc Hassenzahl (2003) argues that there are two different *modes* associated with the realization of goals. In the "goal mode," there is an overall goal that is expected to be fulfilled in the future. This overall goal predetermines all foreseen actions related to the expectation. Once the experiencer starts realizing this goal, the goal is no longer a unique whole. He calls this the "action mode," in which smaller goals that are needed in order to achieve the overall goal are determined by the action "on the fly." He suggests that these smaller goals have a "volatile" nature. Figure 2.4 is Hassenzahl's illustration of these two modes in the realization of goals.

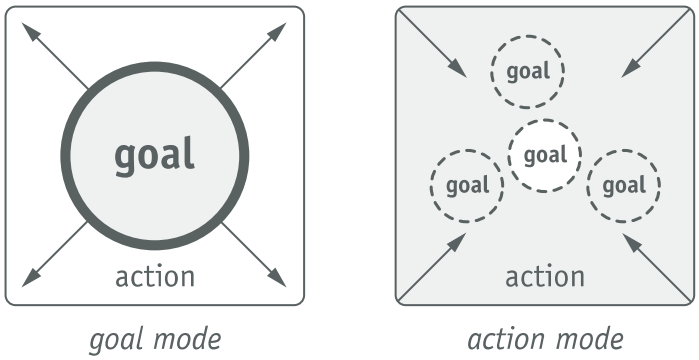

Figure 3.3. *Goal and action mode (Hassenzahl, 2003).*

Hassenzahl's description of the realization of goals is interestingly similar to Dewey's description of how experiences unfold. However, Hassenzahl's description requires particular attention. His point on the volatility of smaller goals points out the unpredictability and complexity in the nature of goals and experiences and in the interaction between self's internal environment and the external environment. I argue that this complexity is the key to the fundamental similarity between the subject matter of the field of Design and that of Natural and Social Sciences.

4. Experience as a Complex System

Experience and Complexity

The event-based framework of human experience provides us a new perspective to look at the *nature* of human experience by revealing the "complexity" in the structure of experiences and goals. Herbert Simon (1996) defines a complex system as "*one made up of a large number of parts that have many interactions*." For Per Bak (1996), systems with large variability could be considered complex. He illustrates his definition as "*the variability may exist on a wide range of length scales…if we zoom in closer and closer, or look out further and further, we find variability in each level of magnification, with more and more new details appearing…in the universe, there is variability in the greatest scale*."

This is an excellent description of what we see in the set of events that make an experience. Every significant and visible event in an experience is led by a set of less significant and less visible events, and such property repeats itself in an infinite number of levels. Experiences and goals integrate a set of events, and therefore inherit a similar complex structure. Dewey (1934) discusses that every unique experience is a stream of smaller experiences. This definition suggests that experiences have a fractal or hierarchic structure, in which every experience has sub-experiences, and a similar structure exists in several levels of detail. An abstract representation of this complex structure could be seen in Figure 3.1.

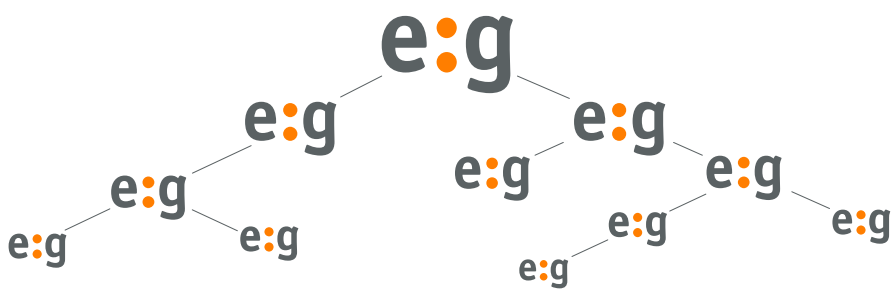

Figure 4.1. *An abstract representation of the hierarchy in experiences and goals.*

Observations on Experience and Complexity

The above mentioned perspective attempts to underline human experience as a complex system of experiences through theoretical reasoning. Here, I would like to support this argument with the results of an empirical study.[10] We conducted a study on the experience of athletic activities using a visual anthropology method (Forlizzi et al., 2004). The participating group was made up of nine women athletes from several athletic fields with ages ranging from 21 to 57. We collected qualitative and quantitative, visual and verbal data on the tangible and intangible qualities of their experiences. The analysis of the data was based on the framework described above. The results of the study were supportive of the above-mentioned perspective. Here, I will provide a few examples from the results of the study. Also Figure 4.2.a and 4.2.b. illustrates a visual description of the different levels of hierarchy in the experiences described in the examples.

One subject provided the details of an early morning running experience. Her overall mood was described as negative valance and low energy (i.e. due to rainy weather). However, one of the products associated with her experience, a red-colored regular Sony Compact Disc Player, was described

[10] A study conducted in the context of an independent study at Carnegie Mellon University with Jodi Forlizzi and Carl DiSalvo in the spring of 2003 (Forlizzi et al., 2004).

with highly positive qualities. These qualities referred to past positive experiences and product qualities that inherently come with the product (i.e. the red color, a gift from her boyfriend). Here, the broken connection between the experiential quality of the product and the quality of the particular experience described by the subject could only be explained with the complexity that is described above. The overall experience of working out has several layers of sub-experiences, one of which is keeping up the workout rhythm and the motivation to run. The experience of listening to music then is a third level sub-experience of this second level sub-experience. The CD player performs as an affordance for the experience of listening to music, which itself relates to several levels of sub-experiences such as using a specific function. The subject described the quality of the experience of using the CD player to be a proxy of a past positive experience, therefore facilitate a positive experiential quality. However, this positive quality is not observed in the overall quality of the experience of running, which, I claim, is due to the high complexity and hierarchy in the overall system.

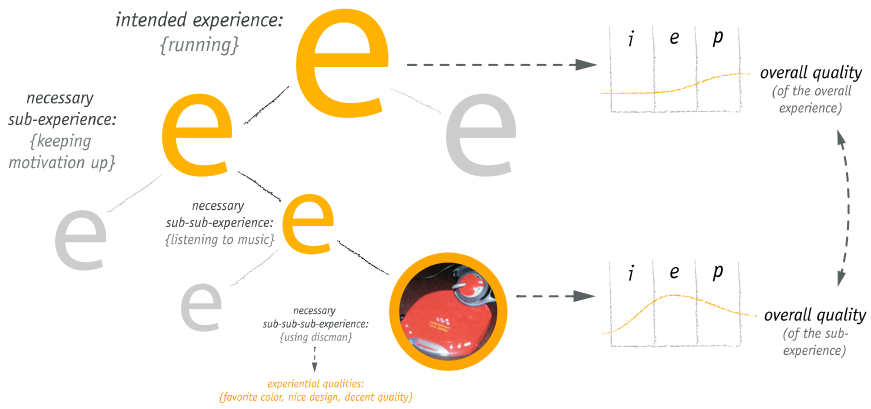

Figure 4.2.a. *An abstract visual description of the different levels of hierarchy in the experience of "running."*

Another subject documented her experience of hydrating after workouts. Her overall mood with the activity of hydrating was stated positive and

high energy. The product associated to her experience was a Nalgene brand water bottle, and the experiential qualities stated with this product were highly positive based on positive past and ongoing experience. In this case, the hierarchy in the overall experience of hydrating is rather low, and the experiential quality of the product contributes more directly to the quality of the overall experience.

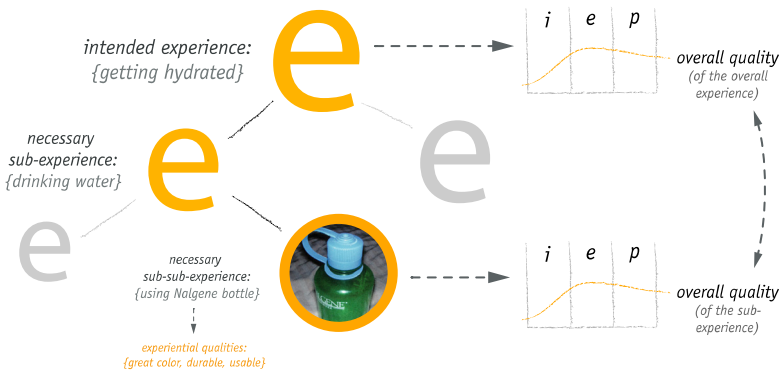

Figure 4.2.b. *An abstract visual description of the different levels of hierarchy in the experience of "getting hydrated."*

The examples above provide empirical results to support the argument that human experience possesses a complex structure. This result may look obvious at a glance. However, it uncovers a fundamental similarity between the subject matter of Natural Sciences and that of Design. Natural Sciences has its foundations on understanding the complexity in natural phenomena. Design, on the other hand, has its primary concern as human experience, which inherently have a similar complexity as I explained this section. Therefore, there may be a space where scientific methods and knowledge could help the field of Design understand the complexity in its subject matter.

Understanding complexity has been a challenge for Natural Sciences as well, where different approaches have emerged to overcome this challenge. A common approach is based on the thinking that all events are inevitable

consequences of antecedent sufficient causes; therefore any future event is expected when its causing events are observed. Moreover, in the case of understanding a complex system, this approach suggests that the behavior of the system could be predicted by analyzing an isolated elementary fraction of the system. Simon (1996) asserts that a complex system as a whole is more than the sum of its parts. He points out the challenge in inferring the properties of the whole system given the properties of the parts and the laws of their interaction. Therefore, the laws applicable to the elementary subsystem at the lowest hierarchy are not relevant to draw conclusions about the whole system. Beyond practicability, this notion brings up the theoretical dichotomy between determinism and indeterminism.

5. The Dichotomy between Approaches to Understanding Complexity

Background in the Dilemma of Determinism

Greek philosopher Epicurus was the first to address the fundamental *dilemma of determinism*. Karl Popper explains: "Common sense inclines, on the one hand, to assert that every event is caused by some preceding events, so that every event can be explained or predicted...on the other hand,...common sense attributes to mature and sane human persons...the ability to choose freely between alternative possibilities of acting" (Popper, 1982; Prigogine, 1996). In his "Dilemma of Determinism," William James (1956) argues that the underlying reasoning for determinism is an antipathy to the idea of chance, which relates to the meaning of time. Traditional Western thought, from Aristotelian or Kantian Philosophy to Newtonian Physics, in fact with certain dissimilarities, tends to explain the notion of time with a deterministic approach. In determinism, time is a symmetric (reversible) phenomenon which is determined by a set of causes based on universal laws. Henri Bergson (1910) opposes the deterministic point of view that believes that, given certain antecedents, only one resultant action is possible. He asserts that any action that human performs freely is "equally possible" with some other action. For Poincarè (1921), determinism is "a limitation imposed upon freedom." Along the same lines, Ilya Prigogine (1996) points out the impossibility of conceiving of human creativity or ethics in a deterministic world. Bak (1996) uses the existence of the notion of "surprise" to discuss the deterministic perspective. He uses the analogy of a Chinese box to explain the notion of surprise and the uncertainty inherent to occurrences in the world; "In each box, there are new surprises." He writes:

> "...the world that we observe everyday is full of all kinds of structure and surprises. How does variability emerge out of simple invariable laws? Most phenomena that we observe around us seem rather distant from the basic laws of physics. It is a futile endeavor to try to explain most natural phenomena in detail by starting from particle physics and following the trajectories of all particles. The combined power of all the computers in the world does not even come to close to the capacity needed for such an undertaking" (Bak, 1996).

These views on determinism have one idea in common that determinacy fundamentally conflicts with freedom of choice, free will, and human dignity, which supports the fundamental conflict between deterministic Science and human-centered Design thinking. Moreover, they argue on the impossibility of understanding complex systems through a purely deterministic approach, which implies that taking a purely deterministic approach to understanding the subject matter of Design is not tenable. However, some approaches in the design research community attempt to go along the lines of the deterministic perspective using several top-down and bottom-up methods. Tools such as the PrEmo (Desmet, 2003) are used to break particular emotional experiences into their components to define qualities that form the experience and measure the emotional potential of products. While this is one approach to understanding emotional qualities in design practice, it may produce results only for a system of experiences in equilibrium, which consists of a fixed set of events and experiential qualities, and is free from unexpected influences. However, the real world is full of uncertainties. In such uncertainty, presuming that a foreseen set of events would occur to create an expected experiential quality seems highly likely to result in unsatisfactory experiences, product failures, misuses, and so on. Figure 5.1 includes an abstract representation of different sets of events in a goal and a realized experience.

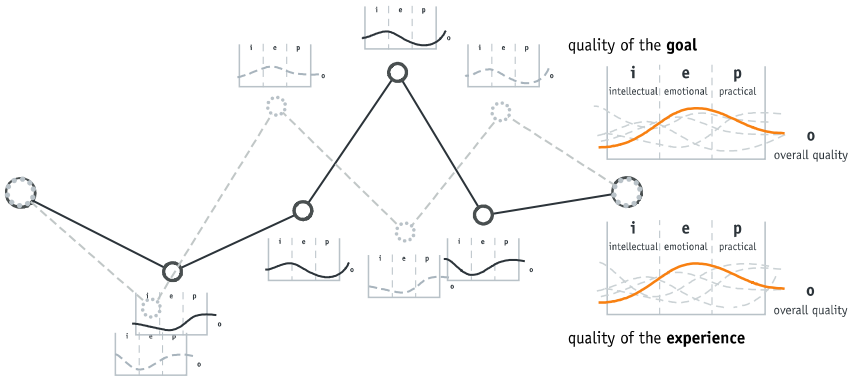

Figure 5.1. *An abstract example of different set of events resulting in similar experiential qualities in an intended experience (goal) and realized experience (experience).*

The above-mentioned ideas strongly disagree with the deterministic perspective in approaching to a subject matter such as that of Design. Buchanan (1992) highlights the impossibility of approaching design problems with the deterministic perspective of Sciences, which he argues is due to the "universal" nature of the subject matter of Design. This opposition brings up an expected question. *Then, how could we approach understanding the complexity in human experience?* The answer to this question is intricate, yet extant.

New Horizons in Science

In "The End of Certainty," Prigogine discusses recent advances in Sciences that offer new horizons in understanding complexity and uncertainty. He argues that time and existence could not be explained with deterministic reasoning, which offers a time-symmetric and time-reversible universe. He suggests an "irreversible" model of time that he explains with "the arrow of time," which is comprised of a complex system of "events" with certain possibilities, where the determined laws of nature are "properties" common to all possibilities, contrary to the deterministic approach, which concludes

that there is a single possibility (Prigogine, 1996; Poincarè, 1921). Prigogine (1996) writes:

> "...we are now able to include probabilities in the formulation of the basic laws of physics. Once this is done, Newtonian determinism fails; the future is no longer determined by the past, and the symmetry between the past and future is broken...Mankind is at a turning point, the beginning of a new rationality in which science is no longer identified with certitude and probability with ignorance..."

Prigogine cites Ivor Leclerc (1972) to support his argument as Leclerc writes "In the present century we are suffering from the separation of science and philosophy which followed upon the triumph of Newtonian physics in the eighteen century." Both Prigogine and Leclerc discuss the kind of approach in Sciences that Buchanan highlights as contradictory to Design thinking. What Prigogine is announcing is a new perspective in Science that embraces the uncertainty and indeterminacy. In the words of Rittel and Buchanan, this is the "wickedness" in the subject matter of both Science and Design, therefore complying with human-centered principles that are central to Design thinking. Jacob Bronowski (1978) supports this idea when he writes "The understanding of human nature and of the human condition within nature is one of the central themes of science." Sören Kierkegaard expresses this approach that leaves determinism behind as:

> "It is quite true what Philosophy says: that Life must be understood backwards. But that makes one forget the other saying: that it must be lived—forwards. The more one ponders this, the more it comes to mean that life in the temporal existence never becomes quite intelligible, precisely because at no moment can I find complete quiet to take the backward- looking position (Kierkegaard, 1990).

The advances that lead to this new perspective in Science is fascinating both for scientists who quest for explaining complexity and for people from other fields, which intensely deal with complexity in their subject matters. Prigogine asserts that with this new perspective in Science, we are actually at the beginning of a new scientific era. He writes "We are observing the

birth of a science that is no longer limited to idealized and simplified situations but reflects the complexity of the real world, a science that views us and our creativity as part of a fundamental trend present at all levels of nature" (Prigogine, 1996). What Prigogine is suggesting as a new perspective for Science is amusingly similar to what Simon and Rittel expressed for a Science of Design decades ago. Nevertheless, as I mentioned earlier, their views were underrated at their time by both Design and Science circles. In the next section, I will conclude with a brief discussion of Simon's suggestions for a new Design paradigm in the light of the topics that I covered in the former parts of this essay.

6. Towards a Science of Design

A New Research Framework for Design

The last paragraph of the previous section proclaims that a new perspective in Science is emerging, one that is based on the "indeterministic hypothesis" and a new reasoning using a new form of knowledge. Prigogine suggests this body of knowledge to include events (observable, both qualitative and quantitative body of knowledge) as well as laws with probabilities (analytical, formalizable body of knowledge), which is fundamentally similar to what Simon (1996) suggests for a Science of Design: In contrast to the "intellectually soft, intuitive, informal, and cook-booky" nature of the current Design paradigm, Simon suggests "a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process." Simon stresses the intersection of the theories of probability and utility as a particularly interesting theoretical space for Design. Horst Rittel's work at the *Hochschule für Gestaltung (HfG) Ulm* also supports Simon's argument. Rittel's views are based on the idea that a part of the design process is explicit, teachable, and communicable to others, while the other part embodies tacit information, and "wicked" in nature (Rittel and Webber, 1973). Here, again we can see a combination of an empirical and formalizable body of knowledge. Rittel argues that dichotomies purporting to distinguish systematic versus intuitive and rational versus irrational design are untenable due to the inherently twofold nature of the design process.

Prigogine, Simon, and Rittel's suggestions of a partly empirical, partly formalizable doctrine for the field of Design raise two significant practical conclusions for understanding complexity. It's apparent that actually developing such a comprehensive framework needs further research and a

more formal and sophisticated reasoning. However, in the next two paragraphs, I will attempt to provide brief illustrations of these two conclusions in understanding the complex nature of human experience.

Laws with Probabilities / Formalizable Body of Knowledge: *Generating Alternative Scenarios for Human Experience*

The formalizable body of knowledge integrates the laws common to all the components of the complex system with probabilities to lead towards generating alternative scenarios. Bak (1996) suggests that a theory of complex systems must necessarily be "statistical" or "abstract." A statistical or probabilistic approach to the complexity in human experience leads to generating alternative scenarios of experience. This idea supports conceiving multiple probable scenarios of experience and designing systems that support all probable scenarios of experience. As an example from evolution theory, Bak (1996) illustrates this idea of with "a theory of life" explaining all possible scenarios of evolution. A larger-scale example for this view is the idea of many possible parallel universes.

Observed Events / Empirical Body of Knowledge: *Identifying Patterns of Experiences through Observation*

The empirical body of knowledge comprises qualitative and quantitative observations that lead to generating probabilistic reasoning about the expected behavior of the complex system. Bak (1996) argues that a probabilistic perspective shows that complex systems follow simple "patterns." In a complex system of experiences, goals cannot be predicted in detail, but certain patterns of events or experiential qualities can be identified by observing experiences. These simple patterns provide a basis for all possible scenarios of experience. Bak (1996) illustrates the idea of simple patterns in complex systems with an example from the Catastrophe Theory: "Because of their composite nature, complex systems can exhibit catastrophic behavior…that follows a simple pattern." Figure 5.2 illustrates an example of a simple pattern followed by a set of catastrophic events.

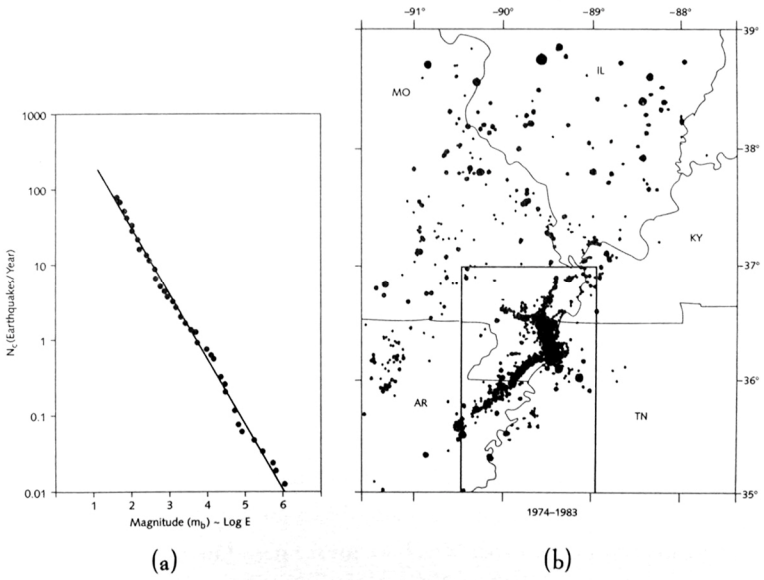

Figure 6.1. *An example of a natural complex system to follow a simple pattern: (a) Distribution of earthquake magnitude in the New Madrid zone in the southeastern United States during the period 1974-1983. The points show the number of earthquakes with magnitude larger than a given magnitude m. The straight line indicates a power law distribution of earthquakes that follows a simple pattern. (b) Locations of the earthquakes used in the plot. The size of the dots represents the magnitudes of the earthquakes (Bak, 1996)*.

As I noted earlier, it is essential to perform further research and reasoning to develop a theoretical and methodological framework for a Science of Design along the lines of the above-mentioned theoretical guidelines. I believe that such efforts should take Simon and Rittel's ideas as the groundwork and combine the approaches and methods of the Sciences and current Design paradigm.

7. Conclusion

There are few Design Researchers within the Design community, who are interested in creating not only methodological but also theoretical knowledge to help develop the field of Design, and only a few of them undertake answering deeply routed questions about Design, such as exploring the nature of the subject matter of Design. Herbert Simon, Horst Rittel, and Richard Buchanan are examples. Furthermore, their work is mostly not-well-understood by the very people who work in the field. As Rittel said, innovative ideas need lengthy incubation before they become integrated into the course of "normal" research and into professional practice.

Simon and Rittel's ideas were innovative at the time, and they remain so. Nevertheless, we now have more means to support and develop their arguments with developments in Science and Design Research. In the context of my Master's Thesis Essay, I attempted to pursue their efforts and contribute in formalizing the rationale for a new framework for the field of Design by looking at the core of the matter of concern for all Design activities, human experience. My ideas and arguments are still premature and informal in a sense. However, I have felt the urge to study this greatly important topic using the context of my thesis essay as an opportunity. My research, which I intend to bring further in the future, will hopefully contribute to expanding Design thinking into a Science, if not, facilitate interest in this topic.

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References

Bak, P. (1996). *How Nature Works*. New York: Copernicus: Springer-Verlag.

Bergson, H. (1910). *Time and Free Will*. Translated by F.L. Pogson. London: M.A.

Bronowski, J. (1978). *A Sense of the Future*. Cambridge, MA: MIT Press.

Buchanan, R. (1992). "Wicked Problems in Design Thinking." In Margolin, V. and Buchanan, R. (eds) *The Idea of Design*. Fourth Printing, 2000. Cambridge: MIT Press.

Carlson, R. (1997). *Experienced Cognition*. Mahwah, NJ: Lawrence Erlbaum.

Desmet, P. (2002). Designing Emotions. *PhD Thesis*. T/U Delft, the Netherlands: Private publication.

Dewey, J. (1934). *Art as Experience*. New York: Perigee Books, The Berkeley Publishing Group.

Forlizzi, J., Mutlu, B. D., and DiSalvo, C. (2004). *A Study of How Products Contribute to the Emotional Aspects of Human Experience*. Paper Submitted to the Design & Emotion Conference, 2004 in Ankara, Turkey.

Hassenzahl, M. (2003). The Thing and I: Understanding the Relationship Between User and Product. In Blythe, M. A., Overbeeke, K., Monk, A. F., and Wright, P. C. (eds) *Funology: From Usability to Enjoyment*. Dordrecht, The Netherlands: Kluwer Academic Publishers.

James, W. (1956). *The Will to Believe*. New York: Dover.

Kierkegaard, S. (1990). *The Diary of Sören Kierkegaard*. Citadel Trade; Reprint Edition.

Leclerc, I. (1972). *The Nature of Physical Existence*. London: Allen and Unwin; New York: Humanities Press.

Poincarè, H. (1921). *Science and Hypothesis*. New York: Science Press.

Popper, K. (1982). *The Open Universe: An Argument for Indeterminism*. Cambridge: Routledge.

Prigogine, I. (1996*).* *The End of Certainty: Time, Chaos, and the New Laws of Nature*. English Translation by Èditions Odile Jacob. New York: The Free Press.

Rittel, H. W, J. and Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*. Issue 4, Pages 155-169.

Simon, H. A. (1996). *The Sciences of the Artificial*. Third Edition. Cambridge: The MIT Press.

The American Heritage Dictionary (2000). *The American Heritage Dictionary of the English Language*. Fourth Edition. Boston, MA: Houghton Mifflin Company