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EPISTEMOLOGY OF DESIGN

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ABSTRACT

Since the last decade there has a wide range of discussions on the deficiencies of the analytic methodology. This paper intends to review the classification of design and its potential applications as a base for a synthetic methodology, here referred to as the epistemology of design. Accordingly, design is organized under three tiers: **Design as activity**, **Design as planning**, and **Design as epistemology**. This review then explores the application of the above classification to explicate the epistemology of design.

Design as activity relates to the conceptualization (pre-execution) stages of making new products, classified further under four main groups: fine arts, industrial design (applied art), architecture and engineering.

Design as planning relates to the systematic mental processes prior to actions and conceptualization (pre-execution) stages for planning, composing and decision making. Design as planning is more affiliated with the management of a wide range of fields from business to military and from hospitals to the academy.

Design as epistemology relates to the synthetic methodologies needed for change. Design epistemology is distinct from analytic methodologies, which is crucial to develop scientific initiatives.

INTRODUCTION

Since the last decade there has a wide range of discussions on the deficiencies of the analytic methodology (Gibbons, 1994; Nonaka, 1995; Argyris and Schon, 1996). This paper intends to review the classification of design and its potential applications as a base for a synthetic methodology, here referred to as the epistemology of design. A better understanding of the epistemology of design can enhance the role that design methodology may play to link engineering activities with the relevant scientific endeavors.

Design is a broad and deep concept; consequently, proper articulation and application of its classification requires relevant attention and elaboration. Design can be organized under three tiers: **Design as activity**, **Design as planning**, and **Design as epistemology**. While the exact border between the three tiers of designs is fuzzy at best, this classification for design constitutes a conceptual structure that can delineate the epistemology of design.

DESIGN AS ACTIVITY

Design as activity is mostly related to the conceptualization (pre-execution) stages of making new products, usually organized under "art versus technique" or "form versus function." Industrial design, engineering design, art design, and architecture are typical examples of design as activity.

Design as activity traditionally is further classified under two main headings: **Form** and **Function**. This classification for design activities is traceable to the "Bauhaus," the school of design, architecture, and applied arts that existed in Germany from 1919 to 1933. The Bauhaus was founded by the architect Walter Gropius, who combined two schools, the Academy of Arts and the School of Arts and Crafts, into what he called the Bauhaus, or "house of building," a name derived by inverting the German word *Hausbau*, "building of a house." Gropius's "house of building" included the teaching of various crafts which he saw as allied to architecture, the matrix of the arts. By training students equally in art and in technically expert craftsmanship, the Bauhaus sought to end the schism between the two (Encyclopedia Britannica Online).

Since the 1950s, "ergonomics" has gained attention in the studies about or related to design. Ergonomics or human-factor design deals with the physical or psychological characteristics or impacts of human beings

related to design of devices and systems for human use. Because of its broad scope, ergonomics design draws upon parts of such social or physiological sciences as anatomy, anthropometry, applied physiology, environmental medicine, psychology, sociology, and toxicology, as well as parts of engineering, industrial design, and operations research (Encyclopedia Britannica Online). However, ergonomics is not yet an equal partner with 'form and function' in the traditional classifications for design as activity.

Consistent with the major classification of design into form and function, the academic disciplines and professional fields for design as activity are organized along four main groups: 1) fine art, 2) applied art and industrial design, 3) architecture and 4) engineering. These four groups are practically located along the spectrum of form to function. Art is mostly about form, and engineering mostly related to the function part of this spectrum. Between them, industrial design and architecture hold the middle part of the spectrum, from form to function.

DESIGN AS PLANNING

Design as planning is mostly related to the conceptualization (pre-implementation) stages of decision making, planning and strategizing. Design as planning is regarded as a plan or scheme conceived in the mind and intended for subsequent execution. This wide process of "systematic thinking initiated prior to action" requires an interdisciplinary approach among a range of disciplines, such as art, industry, management, military, and so forth. Archer's view (1965) that "designing is the formulation of a prescription or model for a finished work in advance of its embodiment" is related to the planning aspect of design. This is because the "work" is not confined to art, industrial design, architecture and engineering.

While design as activity is more related to professional endeavors like art or engineering, design as planning is more affiliated with management of a wide range of fields from business to military and from hospitals to the academy.

My studies on definition of design guided me to other terms synonymous with design as planning, such as programming, composition, strategy, and problem solving. All of the above terms imply a "systematic process of thinking prior to action and its implementation" in fields much broader than the traditional domain of design (i.e. art, architecture and engineering.) Goldschmidt (1999) indicates "At the base of investigations of the design process is its definition as a problem-solving process, in the widest sense possible."

Friedman (1997) asserts that "the different forms of professional design practice require a process incorporating the strategic and managerial aspects of design as well as the hands-on development application of design." This point of view seems to be related to the interaction between design activities and design planning.

DESIGN AS EPISTEMOLOGY

Epistemology in philosophy is the study of the theory of knowledge, which goes back to ancient Greek and beyond. Since the 17th century the main issue in epistemology of Western philosophy has been rationalism versus empiricism. Rationalism claims that knowledge can be obtained deductively by reasoning and empiricism says that knowledge can be attained inductively from sensory experiences. René Descartes, a rationalist philosopher, argued that the main source and final test of knowledge was deductive reasoning based on self-evident principles, or axioms (Nonaka 1995).

Descartes's work, along with that of Galileo, Newton, Bacon, and others, established the modern analytic-scientific approach towards knowledge. Descartes's method can be summarized as follows:

1. Accepting only what is clear in one's own mind, beyond any doubt.
2. Splitting big problems into smaller ones.
3. Arguing from the simple to the complex.
4. Checking when one is done.

Compared to the analytic methodology of science, design as epistemology relates to the synthetic methodologies of implementation. Design as epistemology has also been referred to as epistemology of design, science of design, and theory of design.

The character of design as a synthetic methodology has recently being examined in more detail. Herbert Simon in "The Sciences of the Artificial" (Simon, 1969:4) compares and contrasts the "natural sciences" and the "science of design." He states, "The natural sciences are concerned with how things are. Design on the other hand, is concerned with how things ought to be." Simon claims design is concerned with "synthesis," science, on the other hand, is concerned with "analysis."

Simon (1969: 55) also takes the following point of view on the action of design:

> Everyone designs who devises courses of action aimed at changing existing situation into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so constructed, is the core of all professional training; it is the principal mark that distinguishes the professions from the science.

March (1984) compared "design" with "logic" and "empirical science." According, he regards "Logic has interests in abstract forms. Science investigates extant forms. Design initiates novel forms." March then continues, "a scientific hypothesis is not the same thing as a design hypothesis. A logical proposition is not be mistaken for design proposal."

Gordon (1973) made a simple comparison between designers and scientists and concluded; "A designer and a scientist travel the same road but sometimes in opposite directions. The designer goes from the abstract to the concrete, scientists from the concrete to the abstract." This description is more related to the comparison of the methodologies for design versus science.

Luckman (1967) classified design under three topics: "Analysis, Synthesis and Evaluation," which seems to be relevant to the epistemology of design. According to Hilleri (1967) "design as we know it can be seen as the socially differentiated transformation of the reflexive cognition of the maker in terms of the latent possibilities of his tools, materials, and object types." This point of view, to a large extent, can be regarded as part of the epistemology for design.

Apparently one can envision design epistemology as a method for expression and change (manipulation) compared with science, which is based on analysis and investigation. In other words, analytic research is the main method of science, and design is the main method of art, technology change and strategy. Science is aimed at searching for "truth;" design, however, is a method for change, expression and implementation. The exploration of truth, which is the main goal of science, has been a long-standing philosophical discussion since the ancient Greeks (Nonaka 1995) and before. Modern science (which is based on the works of Galileo, Newton, Bacon and Descartes) has further streamlined this process under the scientific-analytic methodology.

There are numerous other commonalties between design and technology on the one hand and analytic research and science on the other hand. At the same time, there are very real distinctions between design versus analytic research as well as technology versus science. 1) Science and technology share the empirical-experimental method. Science, however, uses analytic methodology and technology uses synthetic methodology. 2) Science and analytic research are mostly text- and formula-based, while design and technology are mostly graphic-based. 3) Research is mostly deductive, but design is mostly inductive. 4) Analytic research and science are usually based on classification, while design and technology are based on systematic model development (modelification.) 5) The analytic method of science was articulated by René Descartes in his "Method" book, and since then, it has been further elaborated, but the synthetic method of design – which has been in use since the ancient times – has not yet been fully articulated.

Comparing the epistemologies of science and technology, Vincenti (1990) indicates:

> Most people tend to think of engineering as applied science. … From this point of view, studying the epistemology of science should automatically subsume the knowledge content of engineering. Engineers know from experience that this view is untrue. … The character of engineering knowledge as an epistemological species is only now being examined in detail.

After more than a decade, apparently we are not very far from where Vincenti was!

Making a comparison with related contrasted topics may also facilitate the understanding of the distinctions between the three different tiers of design. Design as activity, which is organized along related disciplines or fields of design like art, architecture and engineering, is distinct from non-design fields or professions, for instance, nursing. Design as planning, which is regarded as a plan or scheme conceived in the mind and intended for subsequent implementation, is contrasted with spontaneous processes like natural and biological evolution. Design as a synthetic epistemology is contrasted with other types of methodologies, for instance the analytic / scientific methodology.

As another example, education conventionally is not classified as art or engineering activity, but the "design of an education course," can be classified under design as planning because it is based on a plan in mind, and intended for subsequent implementation. As another example, selective mutation may well be considered as design as planning, but the natural evolution of species, with all its beauty and diversity, is not a design. A spontaneous social revolt is not a design by planning (if spontaneous is applicable to social revolts), but military

coups or operations should be classified as "design as planning," even the military blunders.

By articulating the epistemology of design versus the analytic methodology we can link this discussion with a whole host of studies on: 1) Knowledge Management (for instance Nonaka, 1995), 2) Mode 2 for Production of Knowledge (Gibson 1994), 3) Organizational Learning II (Argyris and Schon 1996) and 4) Diamond Model for Professional Research (Van de Ven 2000).

Knowledge management covers the structure for the generation, sharing, process, transformation and valuation of knowledge resources. Knowledge management, by facilitating human communication and collaboration, behaves like a conceptual and interdisciplinary platform that assists the different sections of an organization to share knowledge and ideas with each other. Knowledge management has the greatest chance of success when firms apply it to their unique strategies and goals and this requires synthetic mythologies.

Gibbons (1994) in comparing Mode 1 and Mode 2 for Production of Knowledge indicates:

> The term scientific implies a distinct form of knowledge production. Its ideal is Newtonian empirical and mathematical physics. … Term Mode 1 refers to a form of knowledge production that has grown up to control the diffusion of the Newtonian model to more and more fields of equity. … For many, Mode 1 is identical with what is meant by science. … Mode 2 is different from Mode 1 in nearly every respect. Mode 2 operates within a context of application in that problems are not set within a disciplinary framework.

According to Argyris and Schon (1996: 36) the ways in which practitioners and academic researchers inquire into such issues are in some ways alike and in other ways radically different.

> Practitioners share with academic researchers an interest in building explanatory models of organizational worlds. Like researchers, practitioners try to account for the data they consider relevant, and they often show a decent respect for disconfirming evidence. But practitioners' models must also serve the purposes of designing. However appealing models may be as tools of exploration or explanation, they are judged by how well they "work," in the sense of enabling practitioners to do something they wish to do. This decisively affects what criteria apply to the reasoning of practitioners, in what sense they experiment, and in what sense their experimentation may be appropriately called "rigorous."

The distinction between "science" and "technology" and their different tracks can be traced back to the different views of "philosophers" versus "artisans" in ancient Greece. Joseph Daniele (from Xerox) has a succinct description of the distinctions between science and technology in Greek philosophy.

> While philosophers and scientists through the centuries have recognized the various types of knowledge, not much emphasis has been placed on know-how. The Greeks recognized the difference between the unwritten, hands-on knowledge of craftsman – or techne -, and scientific knowledge -or episteme. … The techne of production, was derived from tradition, and dealt with approximation, to which neither exact measure nor precise calculation applies. Thus techne belonged to an entirely different realm from episteme, or science, which was based on logical deduction from self-evident first principles.

In the contemporary world a similar distinction may also be made between scientists and philosophers on one hand and artists, composers, designers, engineers, technologists, managers and strategists, on the other one.

Unfortunately, the synthetic methodologies like design have not secured the attention of scientific circles, as much as the analytic methodologies have. Another plausible cause of the poverty of written materials on the design methodology is that drawing rather than writing has been the preferred medium of thought and expression for a designer and in that respect for many professionals (Dasgupta 1996: 13). However, the character of design as a synthetic methodology and epistemology has recently being examined in more detail.

REFERENCES

Argyris, Chris and Donald Schon. 1996. **Organizational Learning II: Theory, Model, and Practice**. New York. Addison-Wesley.

Archer B. 1965. **Systematic Method for Designers**. Appeared in Cross N. (Editor). 1984. **Developments of Design Methodology**. New York. John Wiley.

Dasgupta, Subrata. 1996. **Technology and Creativity**. New York. Oxford University Press.

Encyclopedia Britannica Online

Friedman. K. 1997. **Design Science and Design Education**. Sandvida. Norway. Norwegian School of Management,

Gibbons, Michael, et all. 1994. **New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies**. London. Sage.

Goldschmidt G. 1999. ***Design***. Appeared in Punco M (Editor). 1999, **Encyclopedia of Creativity**. San Diego. Academic Press

Gordon G. 1973. **The Science of Design**. Cambridge. UK. Cambridge University Press

Hilleri Bill, John Musgrove and Pat O'Sullivan, **Knowledge and Design**. Published in Mitchell W. J. (editor). 1972. **Environmental Design: Research and Practice**. San Francisco. University of California.

Luckman J. 1967. **An Approach to the Management of Design**. *Operational Research Quarterly*. 18 (4): 345-358.

March L. 1984. **The Logic of Design**. Appeared in: Cross. N. (Editor). 1984. **Developments of Design Methodology**. New York. John Wiley

Nonaka, I and Hirotaka Takeuchi. 1995. **The Knowledge-Creating Company**. New York. Oxford University Press

Oxford English Dictionary. 1969. London. Oxford University Press

Simon, H. 1969. **The Sciences of the Artificial**. Cambridge. MIT Press.

Van de Ven, Andrew. 2000. **Professional Science for a Professional School**. Appeared in Beer, Micheal and Nitin Nohira (Editors). 2000. **Breaking the Code of Change.** Cambridge. Harvard Business School Press.

Vincenti. Walter G. 1990. **What Engineers Know and How They Know It**. Baltimore, John Hopkins University Press.