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Paradigm shift in industrial product design: Generative design

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Abstract

Generative Design is an up to date topic in recent decades in areas such as industrial product design, architecture, and interaction design. It can be defined as finding the basic codes of “creating” and presenting a flexible implementing plan for design with certain algorithms. Examining the roots and reasons of Generative Design is the subject of this article.
Nigel Cross’s article “The Coming of Post-Industrial Design" which investigates the paradigm shift at industrial product design after “Modern Movement” and puts forward suggestions for future, has taken as basis. In collaboration with Cross and his contemporaries comments, revealing factors of generative design will be analyzed.

Keywords: post-industrialism, paradigm shift, generative design, industrial product design.

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1. Introduction

Industrial Design profession has been influenced by the rapid socio-technologic changes. Definition and the scope of the profession evolved and the need for creating new approaches aroused. Cross states at his article "The Coming of Post-Industrial Design", design is at the threshold of a paradigm shift. He maintains that conventional design methods were the result of modern movement which characterizes design as rationalistic, reductionistic and mechanistic (Cross, 1981).

With the crisis of Modern movement, design methods began to search a new revolutionary paradigm. Cross associates the crisis of Modern Movement with crisis of technology. Technology had to change paradigm because of the lack of energy and sources. Design as connected to technology entered the new paradigm with technology.

According to Kuhn the crisis will born a new paradigm; but not totally differs from the old one, on the contrary the new can be settle up on the construction of the old (Kuhn, 1977). If the Modern Movement is in crisis, a Post Modern Movement should be born from the ashes of Modern Movement.

James Robertson forecasts two types of Post-Industrial concept: HE (hyperexpansionist) and SHE (sane, human, ecological).

Table 1. Comparison of HE and SHE

HE Concept	SHE Concept
quantitative values and goals	qualitative values and goals
economic growth	human development
organisational values and goals	personal, inter-personal values&goals
money values	real needs and aspirations
contractual relationships	mutual exchange relationships
intellectual, rational, detached	intuitive, experiential, empathetic
masculine priorities	feminine priorities
specialisation/helplessness	all-round competence
technocracy/dependency	self-reliance
centralising	local
urban	country-wide
European	planetary
anthropocentric	ecological

One vision of post-industrial society the 'HE' vision of the future can be described as superindustrial. It is a vision of a future based on big science, big technology and expert know-how. By contrast, the 'SHE' vision of the future anticipates, not acceleration along the same path of development that followed during the industrial age, but a change in the direction of development. According to this

view, the industrial revolution marked a huge advance in the capacity of human beings to control and harness the material world (Robertson, 1985).

With analysing the Post-Industrial concepts of Robertson, Cross created the possible manners of Post-Industrial design. According to Cross, Industrial Design at Post-Industrial Era should be named as Post Industrial Design. Because of the lack of energy and sources, products should be generalized, multi-purpose and repairable. In brief "Industrial Design" represents a mechanic approach and the "Post-Industrial" represents the organic approach.

Table 2. Contrasting features of industrial and post-industrial design

Industrial Design	Post Industrial Design
Products	**Products**
specialized	generalized
single-purpose	multi-purpose
short-lived	long-lived
replaceable	repairable
mass-produced	short-run
standardized	customized
optimum	satisfactory
Process	**Process**
autocratic	democratic
internalized	externalized
exclusive	inclusive
intensive	extensive
rigid	relaxed
Designers	**Designers**
creative	collaborative
individual	anonymous
professional	participatory

Pink (2005) proposes that humankind is headed into a new age, the Conceptual Age, which have strong implications for desired knowledge, attitudes, and skills. Handy (1990) anticipated this shift with a call for "upside-down" thinking to cope with a patternless, discontinuous post-modern world. Kurzweil (1999) concludes these socio-cultural changes are unlikely to slow down anytime soon. Wolk (Pink, 2005) suggested that, as a result of ubiquitous access to information, a new kind of society of creators and empathizers, of pattern recognizers and meaning makers is rising.

Pink characterizes new paradigm as "Conceptual Age" whilst Cross defines it as Post-Industrial Age; intellects briefly states similar concepts like generalization, customization and satisfaction.

1.1. Biomimicry

The capability of machines prevented the human intelligence. Human mind, which was fascinated with the machine-made artifacts, convicted to what machines can do. With the evolution of compute

technologies, machines gained similar capabilities with human kind and this situation forced human kind to a new paradigm.

Designers rediscovered the organic approach and Biomimicry began to be mentioned at design medium as of 1990's. Since ancient ages biomimicry topics were discussed by lots of thinkers like Goethe, D'Arcy Thompson and Cristopher Alexander. In 1997 Janine M. Benyus published a book called "Biomimicry: Innovation Inspired by Nature".

The word biomimicry is composed of two words, one being bios that means life and the other being mimesis that means to imitate. Benyus described biomimicry as best learning and understanding of possible solutions and potential solutions at nature. Human kind who previously was observing the nature and gaining new experiences now sees the nature as a model, a benchmark or a mentor. Benyus states that if this approach will disperse in various disciplines in the coming years a revolution could occur (Benyus, 1997).

Goethe believed in entity between qualitative and quantitative properties of nature. He realized, at his investigations of general model, that form is something transforming and do not have stability and says that: Investigation of forms is the investigation of transformations (Propp, 2001).

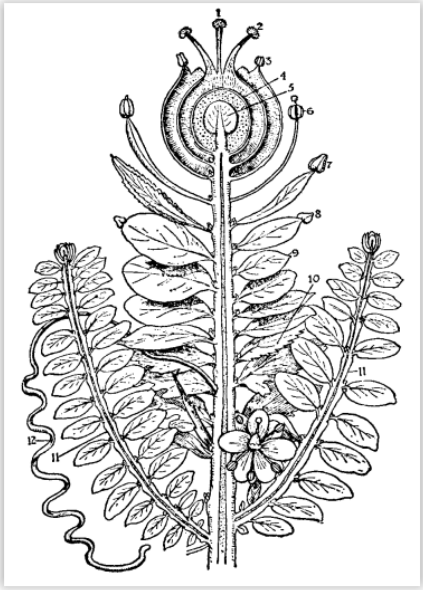

Fig. 1. Goethe's Urpflanze

Goethe describes the Archetypal Plant, or the Urpflanze (Archetype) at his letters to Charlotte von Stein. He indicates:

"Here where I am confounded with a great variety of plants, my hypothesis that it might be possible to derive all plant forms from one original plant becomes clear to me and more exciting. Only when we have accepted this idea will it be possible to determine genera and species exactly." (Gabor, 1998)

D'Arcy Thompson, a Scottish biologist, mathematician, analysed the evolution as the fundamental determinant of the form and structure of living organisms at his book "On Form and Growth". Most remarkable thoughts in this book can be seen as considering a flexible module for forms instead of a fixed module (Thompson, 1992).

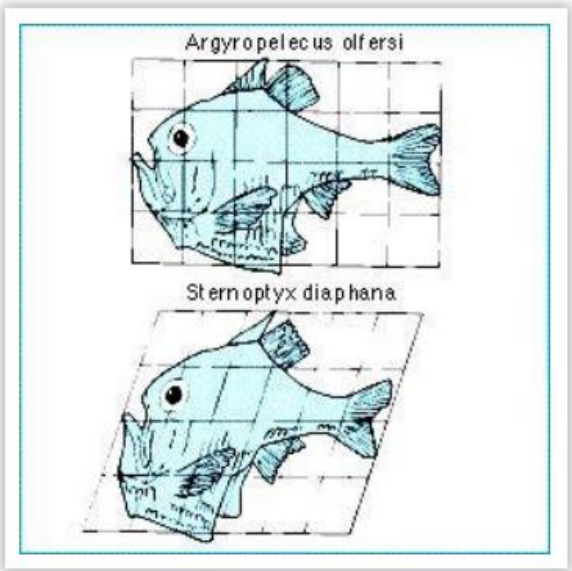

Fig. 2. Illustration of the transformation of Argyropelecus olfersi into Sternoptyx diaphana by applying a shear mapping (URL-1)

This flexible approach at plan created a new vision for designers and engineers. Architects Lars Spuybroek and Patrik Schumacher have referred to this flexible approach at plan (URL-2).

Fig. 3. VorteXX Chandelier (URL-3) designed by Patrik Schumacher at the left and Three Graces designed by Lars Spuybroek (URL-4) at the right.

Another significant intellect who deals with the basis form is architect Cristopher Alexander. He stated that a pattern concept can be used at architecture. He created a "pattern language" to empower anyone to design and build. His studies inspired architects and computer engineers for the usage of a flexible plan (Alexander et al. 1977).

1.2. Generative Design

The usage of biomimicry with lots of data taken from nature is hard to handle. Herein a general and comprehensive concept comes across: Generative Design.

Generative Design is a morphogenetic process using algorithms structured as not-linear systems for endless unique and un-repeatable results performed by an idea-code, as in Nature (Soddu, 1992).

The trace of generative design can be seen in 1971 at Jencks' forecast on the concepts which will affect 20th century architecture. At 1970s and 1980s the rise of Parametric and Cybernetic studies, refer to the developments at multidisciplinary and flexible studies. The rise of Biomorphic at 1990s shows the intellectual revolution. Generative design can be seen as the synthesis of technical (Parametric and Cybernetic) and theoretical (Biomorphic) (Jencks, 1971).

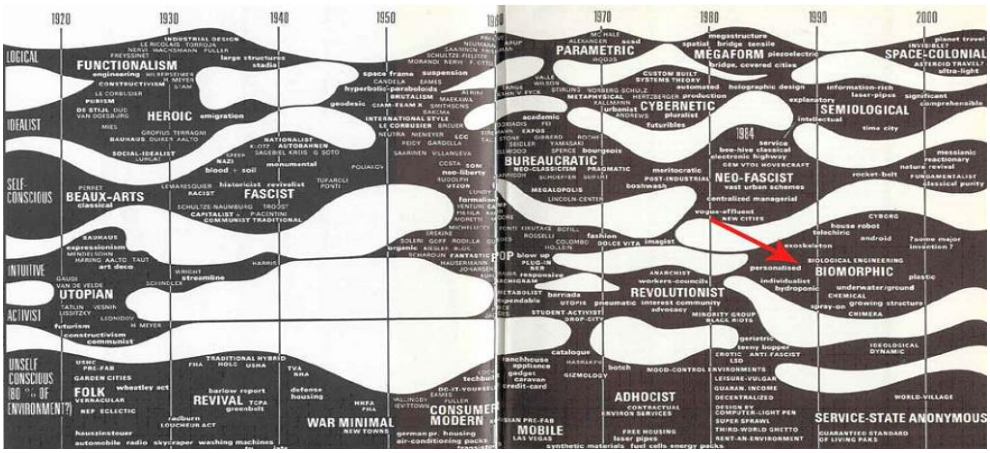

Fig. 4. Jencks forecast on the concepts which will affect 20th century architecture (Jencks, 1971).

Soddu and Colabella suggest that before the industrial era every object was unique, unrepeatable and strongly connected to the identity of its maker or user. At Industrial Era mass production products were made due to less cost, optimization of function and the quality of design idea; but now these approaches are obsolete. With evolving digital manufacturing processes, costs are decreased, by discovering subjectivity (2nd Order Cybernetic) one unique design result is not the optimization of function and cannot symbolize the quality (Soddu & Colabella, 1997).

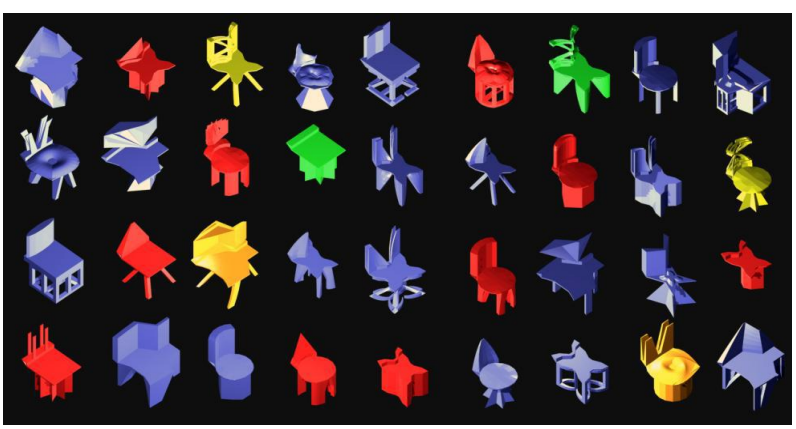

Fig. 5. Generated chair designs by Soddu (Generative design made by Each chair is unrepeatable, as in all scenarios produced by dynamic chaotic systems)

Generative design is undertaken as an important topic at architecture departments of universities; special courses are given and theses are written. At industrial product design profession, use of morphologies (i.e. forms, shapes or structures) taken out from nature has been the object of study for a time, but couldn't get the same amount of attention as in architecture profession. One of the main reasons of this can be seen as the technical constraints of mass production systems (Pearce, 1978). Product examples based on generative design principles are frequently seen with rapid prototyping technologies. Shapeways (URL-5) 3D Printing Service enables consumers to design or customize their own products. To create these generative designs, softwares like Grasshopper (URL-6) (a plugin for Rhinoceros 3D Software) or CellCycle (URL-7) (online parametric tool designed by Nervous System) should be used.

2. Conclusion

With the paradigm shift at technology a metaphysical shift has been occurred at society. By this shift, subjectivity (2nd Order Cybernetic) and the possibility of other views or solutions are comprehended; such as the flexible grid of D'Arcy Thompson, not only looking to plans by top or right view but seeing the model from every angle can show an ocean of solutions.

Generative design is not the last solution. A new paradigm can be built up on it or can be destroyed completely. Academics like Soddu are forecasting that with the branch out of Generative Design, society can download any basic object from world wide web, customize it with digital technologies and produce their own unique object with digital printers at their homes.

Human being always tried to match itself with a concept like homo faber (humans using tools) or homo politicus (humans interested in public good). With widespread use of digital fabrication and generative design "creating-designing" can be seen as a basis property of human being. By all means, this situation can affect the definition of designer but do not eliminate.

In order to cope with the new paradigm, designers should be equipped with contemporary needs. Generative design addresses the importance of generative algorithms, parametric design and digital fabrication. Computer Aided Architecture Master Programs can be seen at universities but this kind of a specialization cannot be seen at industrial product design departments. These topics should be introduced to design students at universities.

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