World Applied Sciences Journal 9 (5): 509-513, 2010
ISSN 1818-4952
© IDOSI Publications, 2010

Exploring the Potential to Shape Deconstructive Architecture Through Mass Customization

Özgür Ediz, Yasemin Erbil and Nilüfer Akincitürk

Department of Architecture, Uludag University, Faculty of Engineering and Architecture, Bursa, Turkey

Abstract: Global developments in this century and the information era have made mass production of standard merchandise and services based on a strict organization method and strict distribution channels obsolete. The mass production concept has been transformed into that of mass customization in our century. Mass customization, which is defined as the skill to deliver to customers products that have unique designs in high volumes and at low prices by using flexible processes, suggests that future architectural applications will be based on using local combinations of products that are produced in mass. This paper, prepared in line with this view, examines the change in architecture in the 21st century by taking into consideration the transformation from mass production to mass customization.

Key words: Architectural design · Computer aided design · Computer supported design · Mass customization · Design automation

INTRODUCTION

The 20th century has witnessed the swiftest change experienced in human history. The rapid and intensive developments that have occurred in the field of technology have resulted in the emergence of the third technological revolution, also known as the information age. Computer and communication technology, named as the driving force behind the third technological revolution, have paved the way for radical changes in today's modern society. Information technologies, as well as the differentiation they have brought about in people's living, work and leisure habits, have also fundamentally changed production economies and provided important advantages in the field of product diversity and flexibility.

The change process which began in the 1940s with the invention of the transistor has brought with it a world-changing new set-up. With the introduction of semi-conductor or silicon-chip technology into the data collection, communication and application stages of production, the production and manufacturing processes have become fully automated and design and decision-making functions have been perfected. These developments, which have taken place in the field of computing and electronics, have on the one hand brought about a quantitative increase in the productive capacity of society and on the other have made it possible for the manufacturing of products with differing characteristics and of greater variety. In this study, architectural design approaches are examined about fordism and post fordism in the time line.

In the early 20th century, the dominant production system in the manufacturing sector was the mass production system pioneered by Henry Ford and known as the Fordist production system. During the period between 1945 and 1970, through a rigid organization, the concept of bulk mass production and production organization, allowing for standard production of goods on a large scale, came into force. The Fordist production system, a production concept dominant in the manufacturing sector, is defined as mass production which, through a rigid organization, allows for the standard production of goods on a large scale. During this period the factories, as they mass-produced low-cost goods of limited variety, encountered a situation in which they lost their flexibility and ability to adapt to the rapid changes taking place in the market [1].

From the late 1960s, the Fordist production system, entering a period of depression parallel to the state's economic crisis, gave way to the Post-Fordist production system, the most fundamental distinction of which is to make it possible for a flexible manufacturing structure and for flexible dealings [2-4]. At the root of the Post-Fordist production system lies the possibility of meeting varied consumer demand in a flexible way.

Corresponding Author. Özgür Ediz, Department of Architecture, Uludag University, Faculty of Engineering and Architecture, Bursa, Turkey, Tel: +90-224-2942134

When today's climate of ever-increasing competition is considered, the prerequisite for speedy and effective adaptation to changes in the market is the adoption of a flexible production system. The flexible production system, which first came to the fore in the mid-1960s, implies a production system which bears varied operational and control features and at the heart of which lies microelectronic technology. Within the system and linked to each other by a materials transport network, semi-independent numerically-controlled machines take part in production in a computer-controlled process [5]. In the flexible production system, a system is adopted which distances itself from standardized products and which can respond better to constant progress. The system accelerates the launching of new products and increases product diversification.

What Is Mass Customization: Looking at the recent past, it can be seen that the socio-cultural structure formed along with rapid industrialization has also affected the world of architecture. In the 19th century, the Industrial Revolution, which began with the invention of the automatic shuttle, brought the concept of mass production to architecture and a rapid organization and production process ensued. Thus the concept of fast, cheap production also affected designers. As a result of this, a strong connection was observed to exist between the logic of mass production and the formation of more rational forms. Since they originate from Euclidean geometry, bricks, which like various panel elements form the basic building units of architecture, correspond to the logic of mass production. In such an environment, where all design materials rely on Euclidean geometry, it is a natural result that structures will also mostly appear with the same geometry [6].

At the end of the 1980s, as a result of the increasingly flexible processes, optimized in terms of quality and cost, a new concept came into being. Using flexible processes, this new concept, named "mass customization" by Joseph Pine, is defined as the ability to produce and provide customers with products or services having unique designs in large quantities and at low cost [7]. Mass customization generally aims to provide the customer with whatever he/she wants, whenever, wherever and in whatever form he/she requires. Taking this aim into consideration, mass customization provides for a new set-up which requires a management, communication, organization and supply chain different from traditional concepts.

Mass Customisation concept was first conceived by Stan Davis in "Future Perfect" [8]. It was then further developed by Joseph Pine in his book "Mass Customization - The New Frontier in Business Competition" [9]. Pine (1992) described four types of mass customization:

Collaborative Customization: (also considered co-creation) firms talk to individual customers to determine the precise product offering that best serves the customer's needs. This information is then used to specify and manufacture a product that suits that specific customer.

Adaptive Customization: Firms produce a standardized product, but this product is customizable in the hands of the end-user (the customers alter the product themselves).

Transparent Customization: firms provide individual customers with unique products, without explicitly telling them that the products are customized. In this case there is a need to accurately assess customer needs.

Cosmetic Customization: Firms produce a standardized physical product, but market it to different customers in unique ways.

Also Pine (1992) suggested a business model, "the 8.5-figure-path", a process going from invention to mass production to continuous improvement to mass customization and back to invention [9]. As an example of mass customization applications, that of the customized denims produced by Levis may be given. In order to carry out mass customization in their products, Levis have introduced a scanner into their shops which exactly reads customers' body measurements. This application raises the cost of the product a little in relation to the normal price, but meets the customers' requirements exactly. Another example of mass customization applications is the pager produced by Motorola's Paging Products Group. The features of this pager can be determined by the customers. Motorola, creating combinations of frequency, tone, colour, programme, clips and other components according to the customers' wishes, has designed and produced over 29 million products. A separate price for pagers produced in this way is not requested. As a similar application example, the bicycles produced by Panasonic in Japan may be given. Over 11 million combinations of this bicycle, manufactured to suit individual measurements, are in existence.

Mass customization applications are essentially made up of combinations of products manufactured by mass production but suited to customer demands [7, 10]. In most mass customization applications the features belonging to the designed elements are converted into production data by entering them into CAD/CAM systems. While CAD systems allow for the application of the design variations coming from the customers and for their prompt inclusion in the production chain, CAM systems on the one hand bring machine use to the highest level and on the other allow for a wide variety of goods to be processed. The achievement of the standardization of products and processes at the same time as flexibility is the most important feature of mass customization ventures. Because of this, the modularity of products, processes and the supply chain is enabled. Modularity requires the standardization of the product. While modular components are being developed, especially the interfaces between the parts come to the fore. The relationship between different modules varies, however, when the products, processes and distribution differentiate. For this reason, in the organization of the infrastructure of communication and data, there was a need for interfaces and so digital technology arrived [11].

As a result of the inclusion of the mass production paradigm, already widely used in many industries, in construction activities as well, the view that in future architecture will be based on the assembly of local combinations of mass products is gradually gaining wide currency. In the field of architecture, the design and production of spaces that can be mass-produced but whose features can also be altered by the user are appearing on the agenda of the architectural environment [7, 10].

Digital Resources of Today's Architecture: When examples of current architecture are examined, it can be seen that alongside forms based on Euclidean geometry, previously unencountered, unconventional forms appear and that in the conceptual sense architectural approaches seated on quite different phenomena exist. In this context, Charles Jencks, talking about his work *The Architecture of the Jumping Universe*, explains this change, which is just beginning to be noticed, in this way:

It's an idea that the universe evolves in a way that is not just Darwinian. Darwin said through natural selection things go gradually. But in fact if you look at evolution on a bigger scale, cosmic evolution and you look at culture evolution you see it jumps, it goes through phase changes. It means that things are more unpredictable than Darwin thought and they move around a lot more". The evolution of the universe can itself be taken as an example. "Basically my argument in 'The Architecture of the Jumping Universe' is that we're now in a new paradigm circle. It's a new epic, although I think we're only at the beginning of it." [12, 13].

This view of Jencks', as he himself has stated, brings concepts such as pluralism and complexity to the fore. Now, concepts such as cultural pluralism, different ethnic groups and different economic groups are what motivate architecture. Besides, even though Alexander Koyre's view that *"Since the Ancient Greeks' invention of the cosmos, the greatest revolution has been the destruction of the cosmos"* belongs to a different context, it has the quality of supporting Jencks' view that appeared with the *Chaos Theory* he called the *Cosmic Universe* [14].

Jencks has also propounded that the concept of "complexity" in fact forms the second stage of the Post-modernist age. In his view, this idea will be the science of the 21st century and this science is completely different from the science of the last 300 years. According to this view, the centre of attention of science will be *"self organizing systems and complex structures"* [15]. This situation discussed by Jencks has the quality of defining the quests for form and shape encountered in current architecture. The fact that such forms can now be generated by algorithms in a computerized environment means that new horizons have been opened to designers in their quests for form and shape in architecture and that computers have given designers more freedom. In this way, it has become possible for other forms not belonging to Euclidean geometry to be generated in a digital environment.

In digital environment, generative computational design has been explored in computer science and linguistic research, as well as aerospace and nautical engineering. Earliest examples can be found in Chomsky's work on generative grammars, which eventually led to advanced computer languages being built. Parallels can be established with architecture by replacing Chomsky's symbols with shapes. Chomsky's generative grammars were developed from his initial work on well-formed strings of parentheses. These generative grammars are now integral to computer languages and compilers [16]. In architecture and design it would be more natural to compute with shape directly rather than symbols. This idea prompted the creation of shape grammars [17] and has been applied in architecture to produce languages of architectural form, often to re-create and

extend the style of a particular architect [18]. Recent examples of the shape grammars include, Traditional Turkish Houses [19], The Prairie Houses of F.L. Wright [20] and Alvaro Siza's Houses [21].

Computers have been used as tools for representing human-conceptualized shapes in the past few decades, replacing tracing paper and pen as the de facto drawing utensils. However, the potential of computers has been truly unlocked with the introduction of computational architectural design [22]. Examples of the new searches which have appeared in architecture in recent years can often be encountered in different parts of the world. For example, the "Hessing Car Showroom and Acoustic Barrier", designed and executed in Holland, is a structure formed by utilizing the potential of the digital environment. Designed by Kas Oosterhuis (ONL), this structure, in which elements differing from one another but which are "self-similar" are juxtaposed, interacts with nature on the Rotterdam-Utrecht motorway, over a distance of 1.5km. It can be observed that structural elements and components, essentially self-similar, are different from one another. Each of these elements have been produced individually by design in a digital environment [23].

In changing digital design environment, it is also an opportunity for new creative possibilities. Burke and Tierney (2007) noticed that, architectural theory and production, which is increasingly being equipped to deal with the complexities of contemporary networked space, developing new forms of practise and exploring new levels of complex spatial conditions and contexts within the computational and actual environments [24]. Parallel to this changing architectural conception we can see too many examples around our designed environment. ARCAM, built in Amsterdam by René van Zuuk, is another structure developed by the conception, in a digital environment, of a trapezoidal surface composed of non-Euclidean forms.

CONCLUSION

The development of information technologies, by affecting architectural theories, has opened up new areas of discussion. This situation, by changing the process and application methods of architectural design, has created tension between the *"familiar and conventional"* and the *"experimental and innovative"*. The introduction of computer-aided architectural design *(CAAD)* and the production technologies into the architectural design process has, by the evolution of the *"linear design"* process, paved the way for the transformation to a single, integrated process.

Production based on mass customization, developed by means of the digital design and production techniques which prevail in current design and production processes, has created a new architecture different from that of the past. This situation offers various opportunities for architects to present their own individual interpretations. At the same time, in the construction sector, the technological advances which have brought about the switch from on-site production to production in the factory have made it possible for the design and production, in the architecture of the future, of spaces which can be mass-produced and yet whose features can be altered by their users. The *"pattern language"* idea [25] put forward by C. Alexander in the 1960s, in which the user plays an active role in design, was a kind of herald of the change we are experiencing today. Consequently, with the *"mass customization paradigm"*, an approach which will greatly influence future architecture, a radical change is being observed in the approaches of architects to the design and construction process and to their roles in this process.

ACKNOWLEDGEMENTS

The authors would like to thank Philip Smith for his assistance in editing the final manuscript.

REFERENCES

1. Kidd, P.T., 1994. *Agile Manufacturing: Forging New Frontiers*, Addison Wesley Publishing Company, England.
2. Harvey, D., 2006. The Condition of Postmodernity, Metis Publications, Istanbul.
3. Womack, J.P., D.T. Jones and D. Roos, 1990. The Machine That Changed The World, Rawson, New York.
4. Eraydin, A., 1992. *Postfordism and Changing Spatial Priorities*, METU Architecture Faculty, Ankara.
5. Tübitak, 1996. *Flexible Production/Flexible Automation Systems and Technologies*, Science-Technology Strategy and Policy Studies 96/03, Ankara.
6. Ediz, Ö., 2003. A Generative Approach in Architectural Design Based on Fractals, Institute of Science and Technology, Architectural Design Graduate Program, Unpublished PhD dissertation., I.T.U.

7. Kolarevic, B., (editor) 2003. Architecture In The Digital Age: Design and Manufacturing, London, UK: Spon Press.
8. Davis, S., 1996. Future Perfect, 10th anniversary edition, Addison-Wesley Pub Co, Harlow, England, ISBN: 020159045X.
9. Pine, II, J., 1992. *Mass Customization:* The New Frontier in Business Competition. Boston, Mass.: Harvard Business School. ISBN 0-87584-946-6.
10. Akipek, Ö. and N. İnceoğlu, 2007. Computer Aided Design and Production Technologies: Their Applications in Architecture, Megaron YTÜ Architecture Faculty Online J., 2(4): 237-252.
11. Silveira, G., D. Borenstein and F. Fogliatt, 2001. Mass Customization: Literature Review And Research Directions, International J. Production Econom., 72: 1-3.
12. Jencks, C., 1997. The Architecture of the Jumping Universe: A Polemic: How Complexity Science is Changing Architecture and Culture, Academy Editions, London.
13. Cathcart, M., 2002. *Architecture Profile: Charles Jencks*, (http://www.abc.net.au/arts/today/stories/s248345.htm). Retrieval Date: 12.13.2001.
14. Bumin, T., 1996. Modernity in Question: Descartes and Spinoza, Yapi Kredi Publishing, Istanbul.
15. Jencks, C., 1997. The Architecture of the Jumping Universe: A Polemic: How Complexity Science is Changing Architecture and Culture, Academy Editions, London.
16. Stiny, G. and J. Gips, 1972. Shape Grammars and The Generative Specification of Painting and Sculpture, Information Process., 71: 1460-465.
17. Stiny, G., 1980. Introduction to Shape Grammars, Environment and Planning B., 7: 343-351.
18. Shea, K., 2004. Directed Randomness, in Leach, Neil; Turnbull, David; Williams, Chris (eds) Digital Tectonics, Wiley-Academy.
19. Çağdaş G., 1996. A Shape Grammar: The Language of Traditional Turkish House, Environment and Planning B: Planning and Design, 23: 443-464.
20. Koning, H. and J. Eizenberg, 1981. The Language of the Prairie: Frank Lloyd Wright's Prairie Houses, Environment and Planning B., 8: 295-323.
21. Duarte, J.P., 2001. *Customizing Mass Housing:* A discursive grammar for Siza's houses at Malagueira, PhD Dissertation, Massachusetts Institute of Technol.
22. Ediz, Ö., 2009. *Improvising Architecture:* A Fractal Based Approach, eCAADe, Proceedings book, İstanbul, Turkey, pp: 593-599.
23 http://www.oosterhuis.nl/quickstart/index.php?id=122.
24. Burke, A. and T. Tierne, 2007. Network Practices: New Strategies in Architecture and Design, Princeton Architectural Press.
25. Alexander, C., 1977. A Pattern Language, Oxford University Press, London.