EMBEDDING DIGITAL MEDIA IN ARCHITECTURE

LEMAN FIGEN GÜL[1]

ABSTRACT

During the last decade, the practice of architecture has changed dramatically. This change has occurred partly because of a pressure to improve efficiency by stakeholders, and the commercial availability of design software and its reliant hardware technologies. These changes will continue and transform our everyday life and surroundings into a new architecture and digital culture. In this paper I discuss three different uses of the advance digital technologies to create built environment where the boundaries of virtual and physical are blurred. The first one is the employment of the digital technologies in the built environment which are ubiquity providing visual or auditory information; the second one is the use of visual environments for extending and augmenting the built environments providing interactivity; third one is the use of artificial intelligence in built environments including performative design, generative design, parametric design and algorithmic design. The paper concludes with a summary on the characteristics of the types of new place designs.

Keywords: Place making, Digital Technologies, Media Facades, Ambient Technologies.

1. INTRODUCTION

Architecture is always dependent on the technology and the representational techniques of its time. As William Mitchell noted that 'architects draw what they can build and build what they can draw'. Recently the developments in and the extensive use of digital design technologies have brought about fundamental changes in the way the architects design and represent. Design researchers and practitioners have shown an increasing interest in predicting and examining the effect of these technologies in transforming our everyday life and surroundings, notably in William J. Mitchell's epic trilogy: City of Bits[2], e-topia[3] and Me++[4].

[1] Assoc.Prof. Dr., TOBB University of Economics and Technology, Department of Architecture, ANKARA
[2] Mitchell, WS (1995). City of Bits. Cambridge: The MIT Press.
[3] Mitchell, WS (1999). e-topia. Cambridge: The MIT Press.
[4] Mitchell, WS (2003). Me++. Cambridge: The MIT Press.

Being parallel to this transformation, an essential part of our existence, built environments have been occupied by digital technologies in several ways. These include the use of ambient technologies in buildings, animated surfaces and media facades, projectors, lighted surfaces etc.
The use of digital technologies in design process seems to have raised an issue concerned with the consideration of the digital model as the "design" in virtual environments. According to Achten and Joosen (2003), the digital model could be considered as the "design" "[...] rather than a representation of the design (technically speaking it is still a representation); in other words, to take a "designerly" stance towards the digital model". This new approach towards the digital model, in other words 'the conceptual design of spaces within virtual reality', makes possible the experience of being "inside" a 3D digital model space through external devices (Dorta and Perez 2006a). In addition, with the advent of digital technologies and the potentials of CNC (computer numerically controlled) construction, designers can develop a provocative and innovative architectural and spatial vocabulary. By using 3D scanning and rapid prototyping techniques, the designers are able to go back and forth between digital and manual mode, thus taking advantage of each one (Dorta and Perez 2006b) to create complex structures. The emerging digital technologies as new place making elements illuminate interesting opportunities for innovative designs and ideas in built environments. From the use of commercial drafting packages to the advanced use of digital technologies, they come to play a major role in architectural production.
The aim of the paper is to discuss how these digital technologies facilitate design activity and enhance our experiences with architectural space and everyday objects. Whether they enhance the quality of the spaces in which we live. In this paper, we discuss three different uses of the advance digital technologies to create built environment where the boundaries of virtual and physical are blurred: The first one is the employment of the digital technologies in the built environment which are ubiquity providing visual or auditory information; the second one is the use of visual environments for extending and augmenting the built environments providing interactivity; third one is the use of artificial intelligence in built environments including performative design, generative design, parametric design and algorithmic design.

2. VISUAL AND AUDITORY INFORMATION DISPLAYS

The first type of the employment of the digital technologies in built environments is the use of the audio and visual information as an ambient display. The increasing ubiquity of computers and related devices (such as sensors and trackers) and their diffusion into our environment requires reconsidering of the complex interplay between technology and the human. One early view was expressed by Mark Weiser, who observed "that the most profound technologies are those that disappear" (Weiser, 1991), arguing for a vision of an unobtrusive computer technology called "calm technology " (Streitz et.al. 2005).

Built environments can become the interface to communicating remotely with friend, accessing information, executing computer programs and collaborating on projects, without being confined to the computer screens. Such innovative visualisation applications have been used for the portfolio and risk managements, trading analytics, real-time auction systems, customer management, text visualisation, network analysis, environmental impact and GIS information visualisation and so on. These ambient displays that are situated in office and domestic environments provide rich opportunities for information display. Ambient information sources that are the small indications of the state of the world are everywhere. For example, the indication of the number of people are around (via ambient noise), the indication of the weather outside is like (via ambient light). We normally spent very little attention to absorb the ambient information.
To take the calm technology idea further, researchers at the Carnegie-Mellon University developed a device, Breakaway, which is a small sculpture placed on the desk of stationery office worker, interacts with its user (Jafarinaimi et al. 2005), as shown in Figure 1. It draws from performing arts and animation by using pose and gesture to remind the user that she has been sitting for too long and needs to go for a short walk. The key idea of this project is to understand how interactions over time with an ambient display can potentially change human behaviour. The preliminary results show that Breakaway shows a positive relationship between the movement of the sculpture and the user's break times. It also confirmed the clarity of the lifelike and aesthetic aspects of the display to the user.

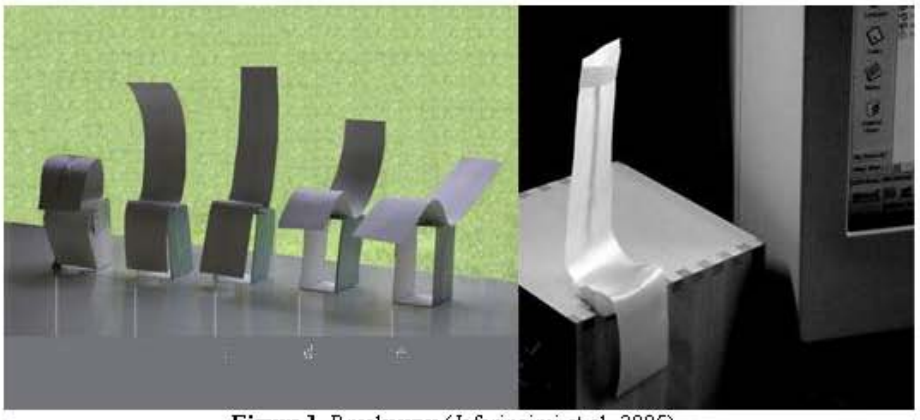

Figure 1. Breakaway (Jafarinaimi et al. 2005)

The advancement of the computer technology have enabled us to provide an architectural space with an electronically amplified memory, e.g. by using sensors that capture data about people's activity in the space and presenting an overview of this data in a visual display. This is different than smart objects which interact with the people around. Skog (2004) proposed the concept of ambient information visualization which is designed to provide subtle information presentation in public places. Skog (2004) proposed the Activity Wallpaper, an ambient visualization of activity information based on an analysis of audio data. The prototype of the

Activity Wall is set up in a cafe as shown in Figure 2. Using sensor technology, the collected audio data is analysed and then projected on a wall as patterns.
The above kind of Ambient information displays are intended to fit in a part of the surface design that does not necessarily have the usefulness property. Most of the ambient displays are designed to transmit background or context information that the user may or may not wish to attend to at any given time. Ambient Displays are designed to work primarily in the border of a user's awareness, moving to the centre of attention only when appropriate and desirable. Heiner et al. (1999) work on ambient display which is designed to give a rich medium of expression placed within an aesthetically pleasing decorative object. This display – the Information Percolator – is formed by air bubbles rising up tubes of water. By properly controlling the release of air, a set of pixels which scroll up the display is created. This allows a rendition of any (small, black and white) image to be displayed. In addition, the ambient display allows interactivity, when people walk past the device it follows their movements with a trail of bubbles. This is intended to invite people to stop and interact with the display. When standing in front of the display, the user can "paint" on the display in real time by moving back and forth in front of it, waving their arms, etc.

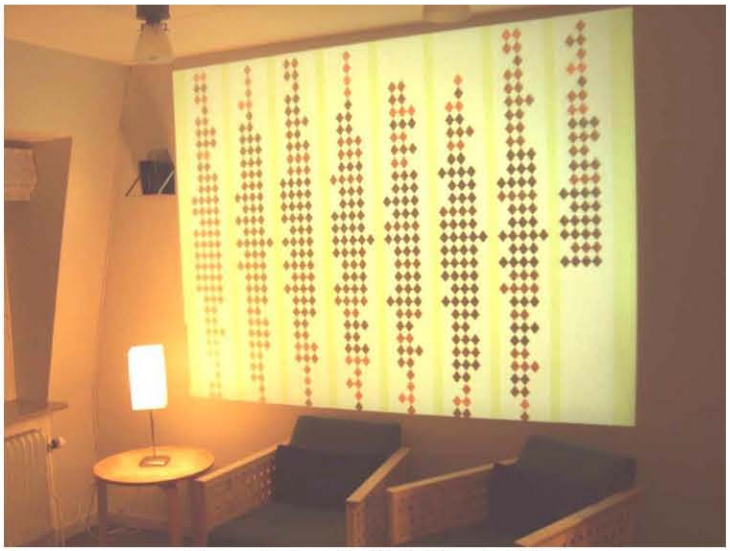

Figure 2. Activity Wall (Skog 2004)

Gu et al. 2008 reported the early attempts to apply digital media as place making elements were media façade; a technique that is very familiar to contemporary architects and artists. Examples of media façades used in architecture and art installations can be seen in Kunsthaus Graz[5], the Blinkenlights project for Haus des

[5] http://www.bix.at

Lehrers office building at Berlin Alexanderplatz[6], as well as Monuments of Switzerland art installation on giant cooling towers. Most of the media facades can be considered as art installations where computers are employed to generate patterns of light or sound. Unlike the commercial models for the smart house which uses different forms of multimedia flatscreens for climate control, light control etc. interactivity technologies have potential to further enhance the architectural space.

3. AUGMENTED REALITY IN PLACE MAKING

The second use of the digital technologies is the employment of the augmented reality technologies in built environment. The main aim of those technologies is to enhance our activities in the built environment and provide new ways of designing by articulation and test of the 3D space.

The term "Cyberspace" for artificial environments inside a computer was introduced by William Gibson in his science fiction novel "Neuromancer" (1984). Unlike Gibson's Cyberspace which was largely illusory and fantastic space, today we used the term in double sense: indicating "virtual reality" "mix-reality" and "augmented reality" that allows interaction within a computer-generated 3D space; and indicating any type of space generated by any computerized information medium. Cyberspace distinguishes itself from other networked technologies by having place characteristics. It is not just another communication tool but the "ultimate destination" where we shop, are entertained and get educated (Kalay and Marx, 2001). For architects and designers, cyberspace can be considered as an excellent tool, allowing the user to study and visualise the full implication of a 3D environments being designed. With the recent use of interactivity technologies in built environment, modifications of real architectural space have maximized. The implications are vast, as "architecture is recasting itself, becoming in part an experimental investigation of topological geometries, partly a computational orchestration of robotic material production and partly a generative, kinematic sculpting of space," as observed by Peter Zellner in "Hybrid Space" (1999, as cited in Kolarevic 2001).

Novak (1996) introduces the concept of "TransArchitecture" and "Liquid Architecture" a fluid, imaginary landscape that only exists in the digital domain. Novak suggests a type of architecture cut loose from the expectations of logic, perspective, and the laws of gravity, one that does not conform to the rational constraints of Euclidean geometries. "TransArchitecture is the architecture of hyperlinked hyperspace" which has a twofold character: within cyberspace is exists as liquid architecture that is transmitted across the global information networks; within physical space it exists as an invisible electronic double superimposed on our material world. According to this view, architecture is free of traditional and conventional forms, characterised as the "dematerialized" architecture. The focus of the concept is on the buildings that adapt and provide unique experiences for visitors, and buildings that interact with visitor, just as a virtual world can do (Novak

[6] http://www.blinkenlights.de

1991). In those responsive environments, enhancing perception and providing action become essential. Spuybroek (2004) argued that the perception depends on the action, and the action is only possible through perception.
Dutch architects in NOX group, designed H2O expo which is an aquatic experience and an interactive installation, "WaterLand"[7] , situated on the island of Neeltje Jans from 1993 to 1997. The design intention of the project is the generation of possibilities of perception of architectural space constructed through user action. The interior responds to the movement of people within the space producing constant changing of lighting, sound, and image projection. The space contains multiple distributed processors of sensors and trackers which produce interference in the continuous processing of a virtual real-time model of water on the walls and floors of the space, as shown in Figure 3. The images from which are projected into the interior changes according to the sensed changes in the environment. "There are interesting innovations here, not least in the distributed intelligence of multiple processors, but what is significant is not the qualities of the interior environment, nor even the real-time immediacy and content of the images projected, but the conceptual schema of interactivity" (Weinstock, M, 2005).

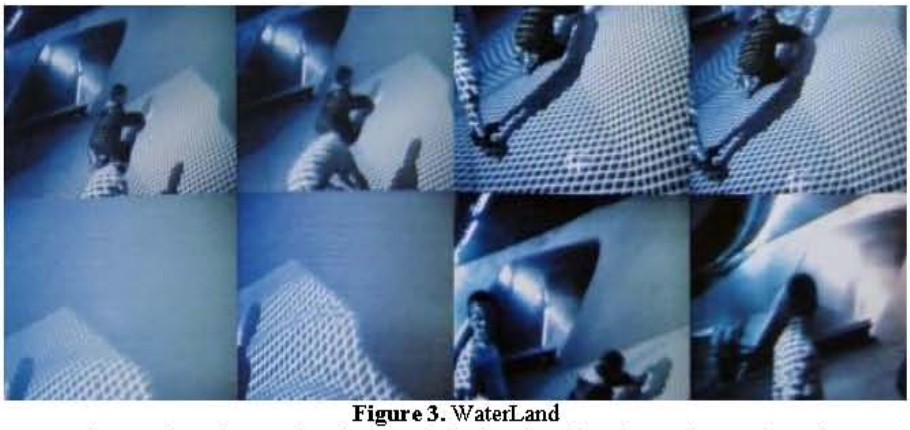

Figure 3. WaterLand
(source: http://www.vitruvius.com.br/revistas/read/arquitextos/11.125/3541)

4. EMERGENT DESIGN TECHNOLOGIES

Third, the emergent modes of computer aided design and manufacturing technologies have transformed the current processes of architectural design practise into a new understanding of the design realm by facilitating the creation of complex geometries, with greater accuracy, faster finishing and increased automation. "Digitally driven design processes characterized by dynamic, open ended and unpredictable but consistent transformations of three-dimensional structures are giving rise to new architectonic possibilities" (Kolarevic 2000).

[7] http://inaugpea.blogspot.com/2011/09/fonte-httpwww.html

The potentials of algorithmic programming, generative design and parametric design for architecture have been demonstrated through the works of some of the well known designers of our time. A unique and innovative approach to the process of delivering complex building projects (Shelden, 2002) and design artefacts have been developed such as in Gehry Partners, Greg Lynn, ONL Architects and Herzog de Meuron. CAD/CAM (Computer Aided Design / Computer Aided Manufacturing) tools and CNC (Computer Numerically Controlled) technologies started to be used in design profession. These emergent tools provide many new possibilities for the development of industrial manufacturing, creating free-form / complex design artefact and building components. In particular, CNC technologies have the capacity to significantly alter and enhance the relationship between architect and material through the means of digital fabrication (Booth, 2009).

One particular example of the use of high-tech building systems for the design of a house, The Prairie House, is the implementation of the responsive technologies that aim to reduce the impact of building upon the natural environment designed by the ORAMBRA (The Office for Robotic Architectural Media & The Bureau for Responsive Architecture). The house is designed to use actuated tensegrity systems, in conjunction with new cladding systems, to produce a house that is estimated to emit less than half of the carbon of a typical house in Illinois. This work is driven by an attention in using programming as a type of architectural media that may reverse new modes of very specialized operation onto standardized building assemblies.

In addition to the above mentioned use of digital technologies in the architectural design, there is a growing body of research which is biodigital architecture. Biodigital architecture focuses on using nature and genetics to meet architectural objectives and on research into the use of new digital technologies to produce architecture at the real (Estevez, 2009). Estevez (2009) classified that the application of genetics to architecture has two folds: the first research objective is to obtain living elements, building materials and useful living space for architecture. In the Genetic Architecture Laboratory (ESARQ-UIC, Barcelona), researchers are working on the genetic control of growth to develop living cells that are converted into building materials and habitable space (see the Genetic Creation Bioluminescent Plants for Urban and Domestic Use in Estevez 2007). The second research objective is to work on digital design and production seen as a genetic process. This approach includes the creation of architecture by researching strategies using digital morphogenetic, or work using genetic algorithms by experimenting with emergent forms.

5. CONCLUSION

This paper presents three different uses of the emergent digital technologies in creating built environments where the boundaries of the physical and the digital worlds are blurred:

- The use of ambient information technology in built environments where the skin of the building 'facade', building components and objects in the environment are integrated with the digital information. The building

components become the container of the user information, responding to its user;

- The use of cyberspace and augmented reality technologies in built environments where the building components interact with the users enhancing the presence and providing experiences. The spaces (virtual and physical) which we occupy become a functional networked environments providing fantasies and interaction; and
- The use of advance digital design and production technologies to create complex built environments where the skin of the building is alive (etc. biodigital architecture) or each individual components of the building is unique (etc. parametric design).

All of the above mentioned approaches of employing emerging digital technologies in architecture reveal interesting ideas, concepts and potentials for built environment designs. Those approaches provide us with new design resources, design tasks and languages which take the job of the architects beyond the creation of forms occupied by some functions. Architectural designs become a subject to consider a form of artificial life, principles of morphogenesis, genetic coding, replication and selection. We can speculate whether the use of digital technologies enhances the quality of the spaces which we live in. However there is one consequence which cannot be argued, that is the conceptual shift regarding the roles of digital technologies in design - to go beyond the traditional understanding and common practice of digital technologies as conventional CAD tools for design presentation and documentation. There is no doubt that the above mentioned three approaches of the use of emerging digital technologies in design will serve as a starting point for further research, practice and validation of digital technologies in innovating built environment designs.

REFERENCE

Achten, H. and Joosen, G. 2003,The Digital Design Process - Reflections on a Single Design Case, Digital Design, 21th eCAADe Conference Proceedings Graz, Austria.

Dong, A., Maher, M.L. and Daruwala, Y. 2006, Construction Defect Reporting Using Mobile and Digital Workbench Technologies, Proceedings of Joint International Conference on Computing and Decision Making in Civil and Building Engineering, Montréal, pp. 3597-3606.

Dorta, T. and Perez, E. 2006a, Hybrid Modelling, Revaluing Manual Action for 3D Modelling. ACADIA 2006: Synthetic Landscapes, Digital Exchange.

Dorta, T. and Perez, E. 2006b, Immersive Drafted Virtual Reality, A New Approach for Ideation Within Virtual Reality. ACADIA 2006: Synthetic Landscapes, Digital Exchange.

Estevez, A. 2007, The Genetic Creation of Bioluminescent Plants for Urban and Domestic Use, Leonardo, February 2007, Vol. 40, No. 1, Pages 18-18 MIT Press.

Heiner, J.M., Hudson, S.E., Tanaka, K. 1999, The Information Percolator: Ambient Information Display in a Decorative Object, UIST '99. ACM 1-58113-075-9, Asheville, NC.

Gibson, W. 1984, Neuromancer, ISBN: 0441012035, Ace Hardcover.

Gu, N., Maher, M.L., Gül, L.F. and Williams, A. 2008, Digital Technologies as Place Making Elements in Built Environment Designs, The 5th International Conference on Innovation in Architecture, Engineering and Construction, 2008, in Antalya, Turkey, (no page numbers CD proceedings).

Igarashi T., Matsuoka S., Tanaka H. 2007, Teddy: A Sketching Interface for 3D Freeform Design, ACM SIGGRAPH 2007 Courses, San Diego, California ISBN:10.1145/1281500.1281532.

Jafarinaimi, N., Forlizzi, J., Hurst, A., Zimmerman, J. 2005, Breakaway: An Ambient Display Designed to Change Human Behavior, CHI 2005, Late Breaking Results: Short Papers, p.1945-48, April 2-7, Portland, Oregon, USA.

Kalay, Y.E. and Marx, J. 2001, Architecture and the Internet: Designing Places in Cyberspace, Proceedings of Association for Computer Aided Design in Architecture Conference (ACADIA 2001), Buffalo, pp. 230-240.

Kolarevic, B. 2000, Digital Architectures, in Proceedings of the ACADIA 2000 Conference, eds. M. Clayton and G. Vasquez. Washington, DC: Catholic University of America.

Kolarevic, B. 2001, Digital Fabrication: Manufacturing Architecture in the Information Age, p.268-277.

Maher, M.L. and Kim, M.J. 2006, Studying Designers Using a Tabletop System For 3D Design With a Focus on the Impact On Spatial Cognition, Proceedings of IEEE International Workshop on Horizontal Interactive Human-Computer Systems (Tabletop 2006), IEEE, Adelaide, Australia, pp. 105-112.

Martens, J., Parthesius, F., Atasoy, B. 2010, Design TeamMate : A Platform to Support Design Activities of Small Teams AVI '10, May 25-29, 2010, Rome, Italy.

Novak, M. 1991,Liquid Architectures in Cyberspace, Cyberspace ISBN:0-262-02327-X p.225-254, MIT Press.

Novak, M. 1996, TransArchitecture, http://www.heise.de/tp/artikel/6/6069/1.html

Peng, C. 1994, Exploring Communication in Collaborative Design: Co-operative Architectural Modelling, Design Studies,15(1): 19-44.

Porter, T. and Neale, J. 2000, Architectural Supermodels. Oxford, Architectural Press.

Skog, T. 2004, Activity Wallpaper: Ambient Visualization of Activity Information, DIS2004, August 1–4, 2004, ACM 1-58113-787-7/04/0008 p.325-28. Cambridge, Massachusetts, USA.

Spuybroek, L. 2004, NOX: Machining Architecture. Thames&Hudson, 2004, p. 18.

Streitz, N. and Nixon, P. 2005, The Disappearing Computer, Guest Editors, Communications Of The ACM, March 2005/Vol. 48, No. 3, P.33-34.

Weinstock, M. 2005, Terrain Vague: Interactive Space and the Housescape, Architectural Design, Vol 75, No 1 Jan/Feb, ISBN 0470090928.

Weiser, M. 1991, The Computer for the 21st Century. Scientific American (Sept. 1991), 94–104.

Zellner, P. 1999. Hybrid Space: New Forms in Digital Architecture, New York: Rizzoli.