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Comparison of traditional and digital visualization technologies in architectural design education

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Abstract

Today, like in all other science fields, information technologies are intensively used in architectural design education. However, in that education, conventional tools are still used. Digital technologies are used as supplementary tools. Current hybrid education system is considered as a transition period to digital technologies today. In this article, conventional and digital technology based systems which are used in architectural design and visualizing education are analyzed and compared. It is aimed to compare weak and strong sides of both technologies. The case study was held by Gazi University students in the period of four semesters. In conclusion, it was found that the transition from traditional to digital technologies in architectural design education is compulsory; however this transition will take some time.

Keywords: Architectural design, architectural education, education methods, design tools and technologies, visual design, computer aided design, information technologies

1. Introduction

In traditional architectural design process, two-three dimensional drawings and models which gradually become more concrete are used. With the use of computers in design process, although traditional expression tools are not left, digital technologies are used as additional tools in visualization of design. For this reason, a hybrid training process with a combination of traditional and digital technologies is experienced.

In this paper, “traditional” and “digital” techniques used in visualization of architecture design were compared within the scope of “Production Time”, “Spatial Need-Hardware”, “Precession-Quality”, “Photorealistic Results” “Ease of Revision”, and “Ability to Produce New Alternatives ”,“ Ease of Archiving, Compatibility for Distance Education ”and“ Satisfaction of Lecturers and Students.

We carried out a field study with the students enrolled in Gazi University Faculty of Architecture which lasted for four successive academic years. During the field study, traditional and digital visualization techniques were used and the same student group was monitored. At the end of four-semester study, a measurement and questionnaire study was conducted and an evaluation table was formed. Products produced in traditional and digital media were compared in measurement and questionnaire study.

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2. Visualization techniques in architectural design

Architectural training and applications are based on visualization of design. Expression techniques used in architectural design can be categorized in two main groups as traditional and digital techniques;

1) Traditional expression techniques: Architectural design training process refers to the visualization of ideas formed in the mind using concrete tools like paper, pen or model.

1.1.) Two-dimensional drawings on paper: Drawing refers to the description of a building or any architectural element using lines and color . Two-dimensional technical drawings which contain plan, cross-section and profiles is one of these expression techniques (Figure 1).

1.2) Three-dimensional drawings on paper; Perspectives:"Perspective is the method of describing the environment and an object in a picture plane as seen by human eye" The material of the structure is hand drawings, which are approximated to real spatial perception reflecting dimensions (Figure 1).

1.3) Three-dimensional Presentations; Models: Model is the minimized version of an architectural product, which is designed or is going to be constructed according to certain scales (Figure 1).

2) Digital expression techniques: Today, architectural designs created in digital media are used due to easy and long-term storage, photo-reality, speed, precession and design alternatives. Unlike traditional methods, hardware such as software, computers, printers and scanners are required in these techniques. Architectural software used in digital media are pixel, vector and object based software.

2.1. Vector based software in digital media: Vector based software are the ones which produce drawings in the form of mesh with line element and wireframe (Figure 2).

2.1.1. Two-dimensional drawings. Orthographic drawings (plan, section, façade)

2.1.2. Three-dimensional models: modeling, animation and photorealistic images

2.2. Object based software in digital media: Object based drawing, modeling, animation and photorealistic images: In this software, basic geometric forms are present in the software in the form of object libraries and architectural form is produced by being selected by the designer. In this software, animations where photorealistic animations can be produced (Figure 2).

Figure 1. Traditional visualization techniques

Figure 2. Digital visualization techniques

3. Case study

The aim of this paper was to analyze traditional and digital expression techniques used in the process of visualization of architectural design from various aspects and to compare the superior and weak aspects of these techniques. A field study was conducted with a group of students selected from Gazi University Faculty of Architecture. The field study lasted for four successive semesters. Within the scope of this study, an evaluation study was perfumed with 72 students starting from first grade to third grade, for four successive semesters. In this process, design visuals were evaluated in terms of "Production Time", "Spatial Need-Hardware", "Sensitivity-Quality", "Photorealistic Results" "Ease of Revision", and "Ability to Produce New Alternatives", "Ease or Archiving"," Compatibility for Distance Education "and" Satisfaction of Lecturers and Students.

The first stage of the study was conducted in second semester of 2007-2008 academic year. Within the scope of technical drawing course, the students were provided plan, cross-section and profiles of a ready project and were requested to make two-dimensional drawings, perspective drawings and models (Figure 3). In 2008-2009 academic year, this group of students made vector based drawings of the same project in "Computer Aided Design I" course (Figure 4).In the second semester of 2008-2009 academic year, in "Computer Assisted Design II" course, the students made three-dimensional modeling of this project in vector based software (Figure 5).In computer course conducted following the first semester of 2009-2010 academic year, which was the final semester, the same group of

students were requested to model the same project using object-based software; to produce material effects, light-shadow adjustments and to obtain photorealistic images (Figure 6).

Figure 3- 4-5- 6Producing sample work by using traditional techniques and vector based software and object based software

4. Evaluation of the case study

At the end of the study, which lasted for four successive semesters, an evaluation table which compared the products produced in traditional and digital media was formed (Table 1). Since real magnitudes are required to evaluate the titles of "production process" and "Spatial-Hardware Requirement", these values were determined in unit of minute and m2 . For the evaluation of other criteria, lecturers and the students were requested to conduct a questionnaire study which can evaluate both expression techniques and each criterion. In the questionnaire, a five-degree grading scale ranging from "Very poor", "Poor", "Moderate", "Good", "Very Good" was used.

Table 1. Comparison of Visualization Techniques

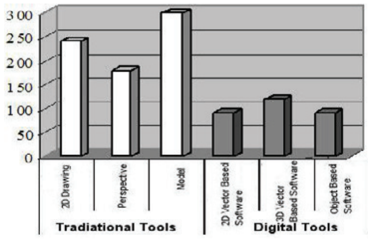
			Production Time (Minutes)	Spatial Requirements (sq/m)	Precission and Quality	Photorealistic Visualization	Revision Possibilities	Creating New Alternative Designs	Archive and Storage	Suitibility to Distance Education	Satisfaction od Lecturer and Student
Tradiational Visualization Teqhniques	2D Drawings on Paper		240	1,5	mod.	weak	weak	weak	mod.	very weak	weak
	3D Drawings : Perspective		180	1,5	mod.	mod	very weak	weak	mod.	very weak	weak
	3d Models		300	2,5	weak	mod.	very weak	weak	very weak	very weak	weak
Digital Visualization Teqhniques	Vector Based Softwares	2D Drawings	90	0,81	very well	mod.	very well	very well	very well	very well	very well
		3D Drawings and Modelling	120	0,81	very well	well	very well	very well	very well	very well	well
	Object Based Softwares		90	0,81	very well	very well	very well	very well	very well	very well	very well

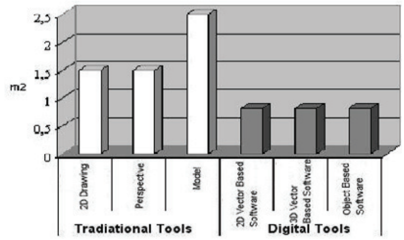
*Production Time:*It was observed that although the students behaved slowly to make more accurate and sensitive drawings in traditional methods, they were able to make drawings faster in digital methods thanks to the sensitivity and precision of the computers. In addition, the use of the objects which were formed and were recorded in object library previously (door, window, furniture etc.) in digital methods shortened the time of drawing. When traditional and digital models are compared in terms of visualization times, it was found that digital methods were more advantages as they are quicker (Figure 7).

Spatial-Hardware Requirements: This refers to the working area and the tools and devices the students need. In traditional methods, while spatial needs of the students for the tools and devices and drawing table they used to transfer the design on the paper is 1,5m^2 on average; it is 2,5m^2 for making models. On the other hand, in digital media, since only one computer is used, it was found that an average of 0.81m^2 area was adequate. Based on this result, it was found that digital media were more advantageous in terms of spatial needs and hardware (Figure 8).

Precession-Quality: Sensitivity and quality of drawings produced with traditional methods are considered as moderate level due to hand drawing mistakes and the models were evaluated as moderate due to the mistakes in cutting and pasting. However, visuals which were produced in digital media are advantageous as they are produced

with precise scale sensitivity. The findings of this criterion were obtained from the questionnaires conducted with lecturers and their opinions (Figure 9).





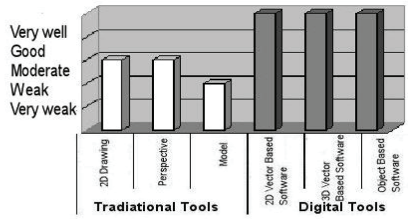
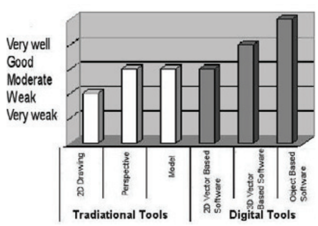


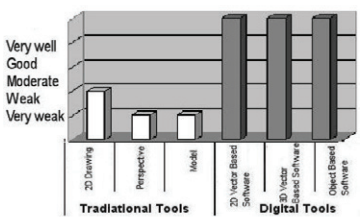
Figure 7. Production time Figure 8. Spatial-hardware requirements Figure 9. Precession-quality

Photorealistic Results: In traditional methods, since in visuals material and light-shadow effect were expressed only by scanning or painting in two-dimensional drawings they were evaluated as “poor” in terms of photorealistic results. In three-dimensional drawings and models, since auxiliary expression tools with material fabric are used, they were evaluated as “moderate” in terms of photorealistic results. On the other hand, in digital media, two-dimensional drawings produced with vector based software were evaluated as “moderate” since no material assignment were made. However, three-dimensional models, although material covering, light assignment and background (object like trees, humans, sky etc.) can be added, they were evaluated as “good” since display quality was low. On the other hand, three-dimensional models produced with object-based software were evaluated as “very good” since they produced very realistic simulations in terms of material use, light-shadow (Figure 10).

Ease of Revision: Revision refers to modification of design. In traditional methods, when partial modification will be made on two-dimensional drawing, related section of the drawing should be erased and drawn again. If a substantial modification will be made on the design, the drawing should be renewed. Since this is a time-consuming activity, ease of revision was evaluated as “poor”. In three-dimensional perspective and models, since even partial modifications require them to be reproduced, they were evaluated as “very poor” in terms of ease of revision. On the other hand, in digital methods, ease of revision was evaluated as “very good” as digital methods allowed for monitoring of the design process during drawing and modeling, flexibility and making small modifications during parametric construction without damaging the whole system (Figure 11).

Ability to Produce New Design Alternatives: This provides convenience in decision-making process to form different alternative solutions for the design problem. In traditional method, since drawing, perspective and reconstruction of models for different alternatives is time-consuming, this property was evaluated as “poor”. On the other hand, in digital methods, since all these steps can be performed in a short time and easily, ability to produce new alternatives was evaluated as “very good” (Figure 12).





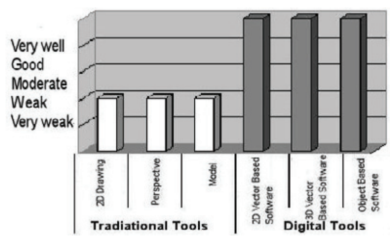


Figure 10. Photorealistic results Figure 11. Ease of revision Figure 12. Ability to produce new alternatives

Ease of Archiving and Storage: Since drawings and perspectives produced in traditional methods remain in paper plane, archiving and storage were evaluated “moderate”. As for the models, archiving was evaluated as “very poor” due to difficulty of archiving. On the other hand, since the visuals produced with digital methods are stored in small memory units, archiving was evaluated as “very good” (Figure13).

Suitability to Distance Education: Since formal educational system is used in traditional methods and since traditional methods do not allow for these technologies, compatibility for distance education was evacuated as “very poor”. On the other hand, as digital methods allowed for both formal education and distance education, compatibility for distance education was evaluated as “very good” (Figure 14).

Satisfaction of Lecturers and Students: Based on interviews with the students and lecturers, it was found that satisfaction of lecturers and students were evaluated as "poor" in traditional methods since they are produced in longer time and were more laboring; sensitivity could not be precisely adjusted; realistic simulations are limited; revision and producing new alternatives is difficult. On the other hand, satisfaction of lecturers and students were found to be "very good" due to the advantages of this method such as speed, time, variety and visually (Figure 15).

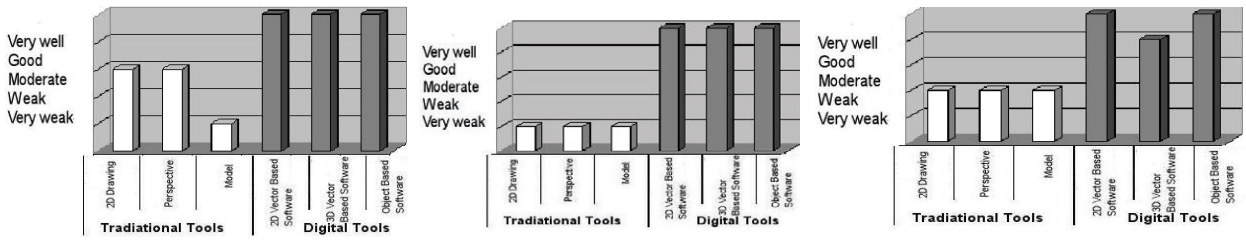


Figure 13. Ease of archiving and storage Figure 14. Suitability to distance education Figure 15. Satisfaction of lecturers and students

5. Conclusion

In architecture, digital visualization techniques are used both in training and application. However, today since digital revolution is not yet completed; educators have not yet mastered these technologies, programs fully based on digital technology are not available and necessary infrastructure for hardware and software could not yet be produced in faculties of architecture, a mixed program which combined traditional methods and digital methods is used in training. It was observed that after the completion of these deficiencies, in near future, each stage of design process from planning to production will be performed in digital media. In the field study expression techniques used in this mixed training model were analyzed and the advantages of digital expression techniques to traditional expression techniques were identified as follows:

In digital media, production and modifications of visuals are performed in a shorter time than traditional methods. When compared to traditional methods, more alternatives can be produced with less effort in digital methods. With the same model produced in a computer; two-dimensional drawings, photorealistic images, animations and walking simulations can be produced. Digital visualization techniques give more successful results in expression of inputs such as three-dimensional expression, spatial perception, scale, fabric, shadow and light, where traditional methods lag behind.In digital models, more advanced models like drawing or models are more easily produced than traditional methods and ensure interactive sharing of more information. Unlike traditional expression techniques, the most important advantage of digital models is that models produced in computer can be observed as three-dimensional and from any desired point. Digital expression techniques allow for distance education along with the collective use of computer and internet technologies.

As a result of this comparison it was found that the most advantageous visualization technique was "object based" software. On all evaluation criteria, it was found that while traditional visualization tools received the lowest values; object based software received the highest values. It was found that "vector based" software were the most commonly used type among digital technologies and that in near future they will be replaced by "object based" software.In conclusion, it was observed that in architecture training, transition to the use of information technologies is a compulsory process, however it will take time. We suggest that the education program and the courses in the program be associated, accordingly educators have digital knowledge and necessary software and hardware infrastructure be provided.

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