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RE-INVESTIGATING THE USE OF COMPUTERS ON BASIC DESIGN EDUCATION

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Abstract

The rising debate on the use of computers in practice and education of design appears to be guiding the future of design in both architecture and urban planning. While advances in CAD and visualization enable paperless design activities and virtual design studios to take hold of architectural practice in developed countries, there are still many steps to be taken in developing countries. This paper attempts to compare the views of students, academicians and professionals in Turkey with regard to use of computers in respect to some main prejudgments about computers' impact on the time needed for a design process, on design creativity, on easing the design process, and on understanding the big picture. The study conducted three follow-up experiments to examine three questions: (1) do students, design educators and design professional share the same view when evaluating the benefits of computers in general?, (2) when completing an actual design task in a basic design class, where technique is more efficient and aid creativity more for students, computers or traditional techniques?, and (3) when students compare two techniques, of which they favor, computers or traditional techniques?. The findings of this study pointed to superiority of computers over manual techniques. The results obtained are assumed to have contributions in discussions concerning the future of design education in general, and basic design in particular. Future research may replicate this study using more participants from different grades and using various design problems.

Keywords: design education, empirical research, computers in design education

1. INTRODUCTION

Over the last two decades, there have been numerous studies pointing out to how changes in society and construction industry have considerable impacts upon spatial organization. This necessitates re-investigation of the related disciplines and particularly how architects, planners or designers are trained, since the problem with our built environments has close relations with how design education is structured today. It is acknowledged that design education needs to address to changes in the industry. In addition to traditionally accepted framework of design education, among those issues to be emphasized for development of professional competencies lie the importance of team-working skills, collaboration, dispute-resolving skills, self- and peer assessment skills for lifelong learning, and finally the ability to adapt to technological changes (Pilling, 2000), i.e., computer-based design and presentation skills. Of these issues, computer-based design and its implications on basic design education is what this paper attempts to focus on.

With the rise of computerization in both training and practice of design, the question of how computers are used or, in words of Suchman (1987), how they are 'consumed' by designers, remains an issue to be further investigated. The ever-changing pace of rapid developments in advanced technologies appears to have a compelling force upon the framework of professional practice and, in turn, the design education.

This paper tends to address to several pre-judgments that are concerned with the use of computers in design education and practice. These pre-judgments are concerned mainly with the perceived benefits of computerization, including how they ease the process of designing, but more than that, with how creativity is influenced and how the actual process of design may be fully covered. Whether the perceived benefits of computerization do aid in increasing creativity or taking control over the entire designing process emerges as an issue to be further questioned. Particularly in basic design education, the prevailing idea is to invoke creativity and personal skills while dealing with basic design problems, not via use of computers, but rather via the traditionally accepted manual methods. With the thought that computers cover a considerable portion of what designers do by spending enormous amounts of time, and thus, that development of the main technical drawing skills may be overshadowed, computers are kept distant in the first year. But what if creativity is positively affected? What if development of basic design skills is further reinforced? In order to catch up with the changes in professional practice, the future of design education shall render such questions as inevitable for a possible restructuring to take place.

Use of Computers in Design Practice

Since the day computers have begun to aid the design processes, there conspicuously has been a considerable progress in the way how they were used by designers, architects and planners. From the day computers were used merely to automate routine manual tasks, such as word processing, spreadsheet databases and drafting, to the time of intense computerization where paperless designs and virtual design studios (VDS) have become prevailing, the developing world has been leading in efficient use of CAD systems.

In architectural practice, the time has come even for those projects, such as the Disney Concert Hall project as one of the largest commissions of Frank Gehry's office, where it would have been impossible to describe the shape of stonewalls with traditional two-dimensional drafting techniques. The architectural office of Frank O. Gehry & Associates is perhaps one of the most important examples of the current period of architectural computerization (Andia, 2002). Under such circumstances, the technologies related with CAD systems have become so advanced that today it is even possible to benefit from virtual reality (VR) technologies for conceptual design, where the designer is enabled to perform design activities in an intuitive manner (Warwick, 2006, p.79) by way of using not 2D, but 3D input devices for 3D graphics.

In sense of developing a holistic understanding between business enterprises and computer technology, which is synonymous to adoption of "data networks"[i] starting from initial sketches to end at its final implementation on site, professional architects of developed countries use CAD systems in architectural practice as a compelling force for competence. The architectural and planning offices of developing countries endeavour to adapt to technological changes, although they appear to be left behind the new technological developments compared to such offices of developed countries.

Use of Computers in Design Education

Although computers are being intensily used in design practice, their use in education has been long debated. The debates even go further to consideration of a challenge in prediction of "whether VDS will isolate students from a sense of place and materiality, or if it will provide future architects the tools to reconcile communication environments and physical space" (Abdelfattah & Raouf, 2004, p.155). Yet, in developed countries, computer techniques are spread quickly among designers and academicians via conferences, magazines or meetings. However, the academicians of developing countries do not stand in equivalent grounds in their designs and education.

With respect to use of CAD systems in design education in developing countries, it seems that such software are not heavily used and taught in design education. Table 1 shows the number of CAD courses, both compulsory and elective, included in curricula at the Architecture Departments of Schools of Architecture at five major universities in Turkey; Middle East Technical University (METU), Istanbul Technical University (ITU), Karadeniz Technical University (KTU), Yildiz Technical University (YTU) and Dokuz Eylul University (DEU). CAD courses consist less than 7 percent of the total number of courses in the curriculum of design-based programs at these five leading universities. This low level of CAD courses may indicate the low level of importance given to computer techniques in design education in Turkey. Note, this table is based on the course titles, rather than course contents. Yet, there is no reason to believe a table based on course contents would give different results.

Table 1 Percentage of CAD courses in curricula of five major universities in Turkey

School	Total no. of CAD Courses		Total no. of Courses	Percentage of CAD courses in the curriculum
	Compulsory	Elective		
METU	4	9	196	6%
ITU	6	-	182	3%
KTU	16	-	215	7%
YTU	10	-	166	6%
DEU	6	-	220	3%

In sense of computerization of design studios, the highest credit courses in the curriculum of design-based programs, the picture is similar. The academicians in developing countries appear to be devoid of sufficient level of technological facilities to integrate CAD based education into design studios.

The authors are teaching in a first year design studio of City and Regional Planning Department at Dokuz Eylul University, Izmir Turkey. Having observed that computers in general, CAD systems in particular, have been rarely used by first year students in presentation of final projects in the last three years, led the authors to conduct this study to find out if this inadequate use of computers in design education stems from a conflict of views of students, professionals, and academicians towards the use of computers in design or from academicians' choice of teaching via traditional techniques because students perform better and learn more with paper and pencil than with computers.

2. METHODOLOGY

This study conducted three follow-up experiments to examine three questions: (1) do students, design educators and design professional share the same view when evaluating the benefits of computers in general?, (2) when completing an actual design task in a basic design class, where technique is more efficient and aid creativity more for students, computers or traditional techniques?, and (3) when students compare two techniques, of which they favor, computers or traditional techniques? For the first and third experiments, self-report data was collected with survey method. Interviewers asked participants what they are thinking with standardized questionnaires. For the second experiment, observational data was collected with a task based laboratory test. Interviewers asked participants to complete some tasks and they evaluated the outcomes.

Experiment 1

Procedure

Some prejudgments about the benefits of computers in design education were determined via informal interviews with academicians teaching in a design-based program. These prejudgments were classified into six thoughts about computers: (1) use of computers decreases the time needed for design, (2) use of computers decreases the time needed for a whole project (including analysis, design, presentation etc.), (3) computers could not ease the design part of a design project, (4) computers could not ease the whole design process of a design project, (5)computers could help to improve design creativity, and (6) designers who use computers focus on details and tend to miss the big-picture. Then random sample of students were selected from a list of students studying at Dokuz Eylul University, School of Architecture, City and Regional Planning Department. Random sample of academicians were selected from a list of educators teaching at Dokuz Eylul University, School of Architecture. A random of sample of design professionals were selected from a list of members of Chamber of Architects and Chamber of Urban Planners in Izmir. The selected people received a written and a verbal description about the study and were asked to participate in the study. About 95% agreed to participate. Participants were asked to fill out a survey form. The survey asked participants to rate their level of agreement with the above pre-judgments concerning the use of computers in design practice. A 7-point bipolar semantic differential scale measured the level of agreement (1 = totally disagree, 4 = neither agree nor disagree, 7 = totally agree). Participants also mention the year of education or the year they had worked as educators or professionals. Gender information was also collected.

Sample

43 students (18 female and 25 male), 19 academicians (12 female and 7 male), 24 professionals (12 female and 12 male) participated in the study. The distribution of students to various grades was

about equal (12 first year students, 10 second year students, 12 third year students, 9 fourth year students). For academicians, the youngest started to teach two years ago, the oldest started to teach 36 years ago with a mean of 12.37 (8.80) years. For professionals the youngest has been working for 1 year, the oldest has been working for 27 years, with a mean of 9.83 (8.19) years.

Experiment 2

Procedure

This experiment was designed as a two stage controlled study (Figure 1). *First stage* was a *training stage*. All participants received a short lecture on how to draw an isometric perspective drawing of a 9 pixel composition (3 rows X 3 columns). Width, depth and height of each pixel were given with a schematic two dimensional drawing. For the width and depth of each pixel, there was one dimension, 2cm. For the height of each pixel there were four alternatives; 0cm, 2cm, 4cm, or 6cm. *Second stage* was a *test stage*. All participants were asked to design a 64 pixel composition on a two dimensional schematic plan. They were then asked to draw an isometric perspective drawing of this 64 pixel composition. Half of the participants took the test first manually via paper and pencil than via computer using AutoCad 2004. The remaining participants took it first via computer than manually. To control the level of training for a creative design problem, participants solve the design problem first to create a symmetrical composition, then to create an asymmetrical composition (Figure 2).

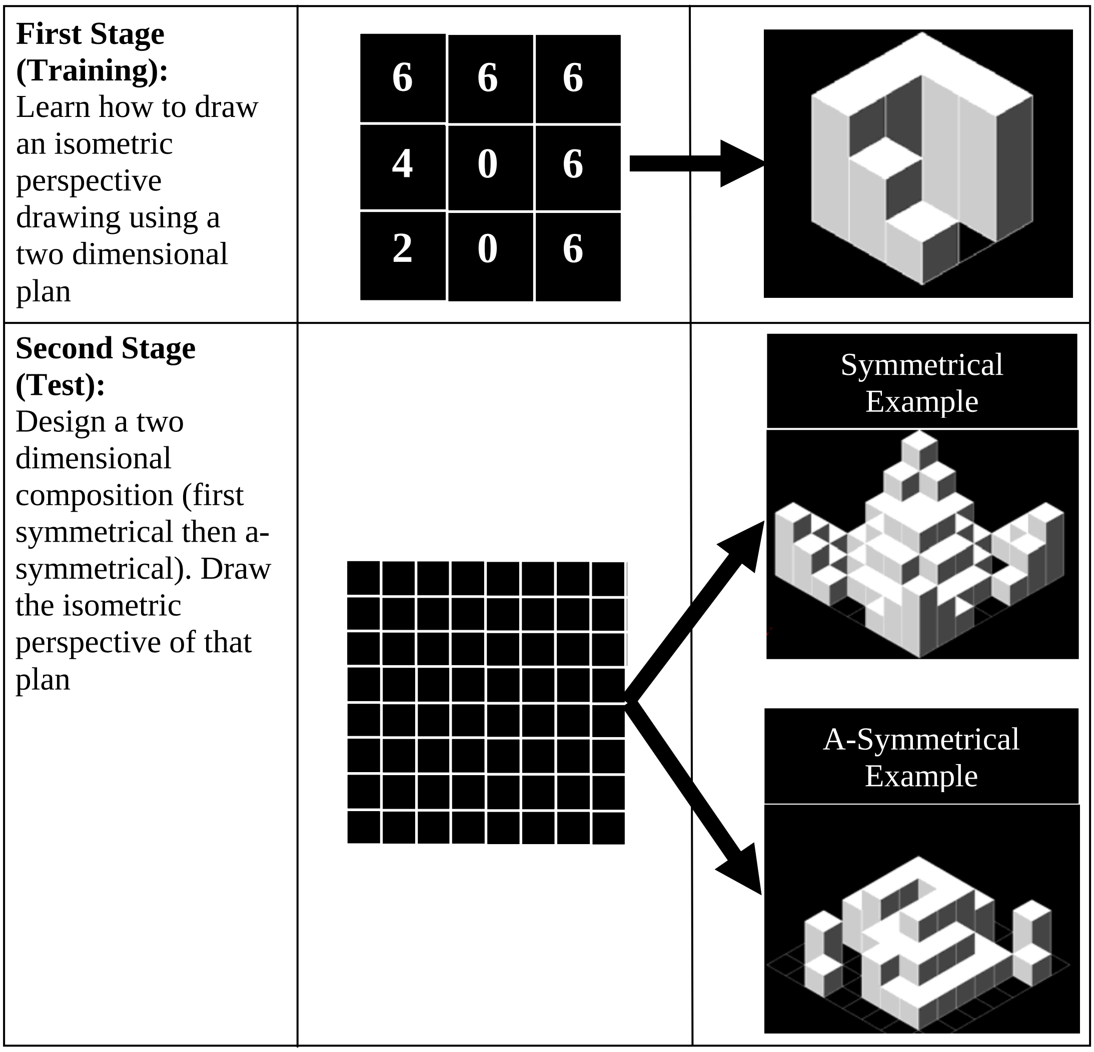

Figure 2 Two stage experiment design

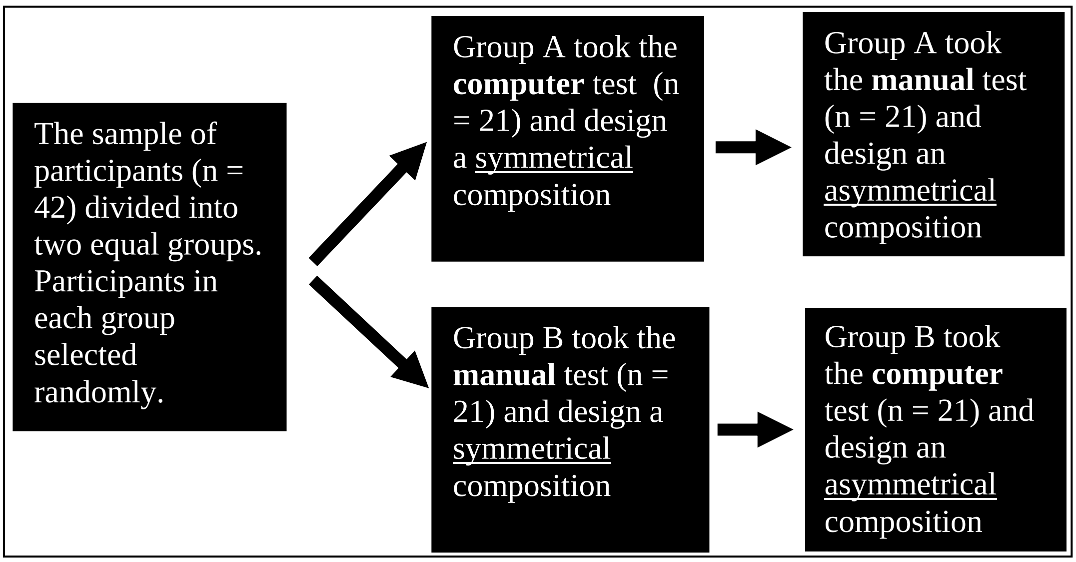

Figure 1 The order of computer and manual tests, and the order of symmetrıcal and asymmetrical compositions

The whole experiment took about 3 hours (1.5 hours for computer test and 1.5 hours for manual test). For computer test, the first stage (training) took about 45 minutes and for manual test it took about 30 minutes.

All participants rated their knowledge of Autocad 2004 with a 7-point bipolar semantic differential scale (1 = first time user, 7 = frequent user).

Each student received performance scores for manual test and for computer test for two criteria; 1) *the accuracy* of the solution (number of correct pixels divided by the total number of pixels designed as 2cm, 4cm and 6cm height in the two dimensional plan and 2) the level of *creativity* (1 = not creative at all, 7 = very creative).

Sample

42 first year students (20 female and 22 male) studying in City and Regional Planning Department at Dokuz Eylul University participated in the study. Students received a course grade for their participation. Three participants were eliminated from the sample as they withdraw the test before the interviewer reported that it was over. The remaining participants (20 female, 19 male) reported that they are not familiar with AutoCad 2004 with a mean rating of 1.72 (1.56). About 76% of the participants (30 participants) reported that this exercise is their first exercise in AutoCad2004.

Experiment 3

Procedure

Participants of the second experiment were asked to fill out a survey form to compare manual technique and computer technique. First they were asked to predict the time they spent to solve the simple design problem given in the second experiment. Then they were asked to pick one technique over the other to report (1) which technique they perceived as easier to use, (2) from which technique they gained benefits in terms of creativity and (3) which technique they would prefer to use next time they encounter a similar design problem.

Sample

Same group of people who participated in the second experiment participated in the third experiment.

3. RESULTS

Experiment 1

Are there any differences between students', academicians' and design professionals' views on the use of computers in design education? Results showed that there is no difference for all prejudgments tested. Table 2 shows students', academics', professionals' and the total participants' level of agreement with six pre-judgments. Pre-judgments were represented in six rows and mean ratings of different groups were represented in four columns. The last column shows the results of One-Way ANOVA test, which analyzed the existence of differences among the means of three groups of participants; students, academicians and design professionals. One-Way ANOVA test revealed no significant difference between students, academicians, and professionals. All participants thought that (1) use of computers neither decreases nor increases the time needed for design, (2) use of computers decreases the time needed for a whole project, (3) computers could not ease or harden the design part of a design project, (4) computers could ease the whole design process, (5) computers are neither helpful nor harmful in improving design creativity, (6) designers who use computers do not always focus on details and miss the big picture (Table 2).

Table 2 The comparison of students', academicians' and professionals' views on the use of computers in design education

Pre-judgements	Students (n = 43)*	Academics(n = 19)*	Professionals (n=24)*	Total Participants (n = 86)*	Significance of Difference (One Way ANOVA Test)
Use of computers decreases the time needed for design	3.88 (2.25)	3.26 (1.91)	3.46 (2.11)	3.63 (2.13)	F (2, 83) = 0.66, p>0.05
Use of computers decreases the time needed for a whole project (including analysis, design, presentation etc.)	5.74 (1.75)	5.58 (1.26)	6.29 (0.69)	5.86 (1.43)	F (2, 83) = 1.62, p>0.05
Computers could not ease the design part of a design project	3.67 (2.02)	3.68 (1.53)	3.54 (2.04)	3.64 (1.91)	F (2, 83) = 0.04, p>0.05
Computers could not ease the whole design process of a design project	2.28 (1.82)	2.11 (0.66)	1.67 (0.92)	2.07 (1.42)	F (2, 83) = 1.45, p>0.05
Computers could help to improve design creativity	4.44 (1.68)	4.32 (1.60)	4.71 (1.57)	4.49 (1.62)	F (2, 83) = 0.34, p>0.05
Designers who use computers focus on details and tend to miss the big-picture	3.30 (1.75)	3.37 (1.77)	3.04 (1.92)	3.24 (1.79)	F (2, 83) = 0.22, p>0.05

* mean scores ranged from '1' to '7' where '1' means 'totally disagree', '4' means 'neither agree nor disagree', and '7' means 'totally agree'

Experiment 2

Do computers aid in improving students' design creativity for a simple design project such as designing a three dimensional symmetrical or asymmetrical composition? Do they increase accuracy of the final technical drawing (an isometric perspective drawing of a two dimensional composition)? Results showed that students performed higher design creativity and made less technical drawing errors when they used computers compared to the situation when they used manual technique, paper and pencil. Table 3 demonstrates the comparison of computers and manual techniques for design creativity and technical drawing accuracy based on mean ratings. Paired sample T-test compares if the means of computers and manual techniques for a single group differs from each other by computing the differences between values of the two variables, computers and manual techniques, for each case and tests whether the average differs from zero. It showed a significant difference between computer-based design solutions and manual-based design solutions for design creativity and technical drawing accuracy. For design creativity, computer technique was evaluated as significantly better than manual technique. For technical drawing accuracy of an isometric perspective drawing of a two dimensional composition, students made less errors with computer technique than manual one (Table 3).

Table 3 The comparison of computers and manual techniques for design creativity and technical drawing accuracy

	Mean (Standard Deviation)	**Paired Sample T-test**
Design Creativity*		
Computer (n = 39)	5.37 (1.44)	t = 4.30, df = 38, p < 0.01
Manual (n = 39)	4.15 (1.31)	
Technical Drawing Accuracy**		
Computer (n = 39)	85.65 % (32.22%)	t = 4.90, df = 38, p < 0.01
Manual (n = 39)	54.34 % (31.60%)	

***** mean scores ranged from ‘1’ to ‘7’ where ‘1’ means ‘very low design creativity’ and ‘7’ means ‘very high design creativity’
****** mean scores ranged from ‘0’ to ‘100’ where ‘0’ means ‘no correct pixel drawn in the isometric drawing’ and ‘7’ means ‘all pixels were correctly drawn in the isometric drawing’.

Experiment 3

Do students perceive computers as more beneficial than manual techniques? Results showed that they do. Table 4 demonstrates the comparison of computers and manual techniques on perceived time spent to solve a basic design problem. Paired sample t-test showed a significant difference on perceived time spent when using computers and manual techniques. Students thought that they spent less time when they solved the design problem via computers than they solved it via manually. They thought they solved it in about thirty minutes via computers and in about ninety minutes via paper pencil. Actually, they did spent less time via computers than manual technique. Recall, the total experiment period for both tests were the same (90 minutes), but teaching how to draw an isometric view via computers (training stage) took more time than via manual technique. This situation leaves less time for the test phase of computer technique than manual technique. Yet, among the 39 participants, three participants failed to complete the task before deadline when taking the test via computer and twenty nine participants failed to complete the task before deadline when taking the test via manual techniques. Informal observations provided further support, showing that when students were taking the test via computers, many of them completed the task before the interviewer declared the end of the test, but when they were taking the test via manual technique, no student completed the test before the deadline.

Table 4 The comparison of computers and manual techniques on perceived time spent for a simple design problem.

	Perceived time in minutes Mean (Standard Deviation)	**Paired Sample T-test**
Computer (n = 39)	33.29 (17.66)	t = 9.27, df = 40, p < 0.01
Manual (n = 39)	82.31 (36.00)	

Table 5 demonstrates the number of participants picked each technique as (1) easier to use, (2) helps to improve creativity, and (3) prefer to use it for similar design problems in the future. More students thought that computer is easier to use and helps to improve creativity more than manual techniques in tasks like the one given in this study. However, an important number of students hesitated to pick either computer or manual technique as fostering creativity. This finding deserves further investigation. Finally, when students were asked which technique they would use when they encounter a similar design problem, most of them reported that they would use computers.

Table 5 Number of participants picked each technique as easier to use, helps to improve creativity, and prefer to use in the future

	Number of participants picked computer technique	**Number of participants picked manual technique**	**Number of participants did not picked either technique (undecided)**
Easier to use	37	4	0
Helps to improve creativity	26	7	8
Prefer to use it in the future	36	4	1

4. CONCLUSION

This study showed that use of computers effect design creativity positively and reinforced basic design skills. Thus the study highlights the necessity to restructure basic design education in developing country universities.

When students', design educators' and design professionals' views about the benefits of computers were compared, it was found that these three groups of people shared the same view. All agreed that computers are beneficial when the whole design process is considered (analyses, design and presentation). However, their benefit was not that significant when only the design phase was considered. As for design creativity, three groups of people agreed that use of design-based software cannot foster creativity significantly. This is not a surprising result when discussions of design creativity are generally dwell on intuitions or visual experiences. Use of design-based software could alter neither intuitions nor visual experiences. Some may argue that use of computers (such as the internet) may enhance visual experiences. However, this study formulated the survey questions to evaluate the use of design-based programs, such as CAD systems. Thus examining the effect of computers in general is beyond the scope of this research. Future research may test the effect of computers, not only the design-based software, on design creativity with a detailed survey.

When first year students' performance for a simple design problem was compared between computer and manual techniques, it was found that students were able design more creative 3D compositions via computers than via paper and pencil technique. Figure 3 shows some of the best examples for each technique. These examples also support the finding of better creativity via use of computers by demonstrating that students achieved more detailed solutions for a simple design problem when they were tested via computer than when they were tested via traditional technique. This finding contradicts with the above result, mentioning that computers have no effect on creativity, which was based on personal interviews. There may be two reasons that underlie this conflicting result; (1) surveys are influenced by people's interpretations of the survey questions thus they may not reflect people's actual behavior and (2) with computer technique participants completed the task before the deadline; thus, participants had more time to spare for creativity via computer technique.

When students compare two techniques, of which they favor, computers or traditional techniques, results showed that they favor computers. Students thought that computers are more efficient in

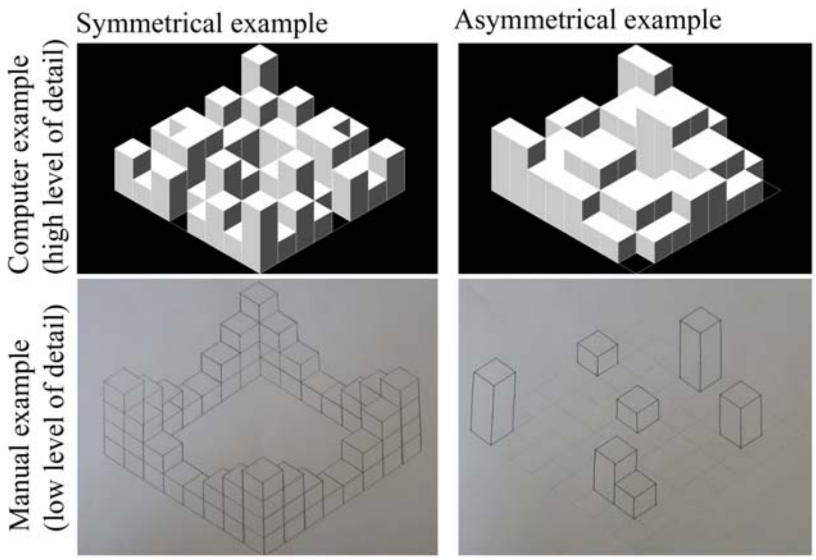

Figure 3. Some of the best examples of the computer and manual techniques.

terms of time, they are easier to use, and they help to improve creativity more than manual techniques for the task given in this study. Most of them reported that they would use computer technique when they encounter a similar design problem.

Note, this study used only one task to compare students' performance via computer and via manual techniques. Subsequent work may compare students' creativity via computer and via manual techniques for other basic design tasks, such as perspective drawing of a spatial organization. Such complementing studies may help to increase generability of the findings of this study to other basic design tasks. Moreover, this study was conducted on a group of participants from one university from a developing country. Future research may replicate this study using more participants from different universities and different grades or those from other countries.

This study clearly showed that both the students and the academicians benefit from using design-based software. Yet using such software is not common in design education in major universities in Turkey. This situation points to the necessity of reconsidering design education in general and basic design studios in particular. This does not involve any suggestion for paperless basic design studios. It rather offers the necessity to improve computer skills as a support to be developed in parallel to manual skills and creative design thinking.

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[i] Data Networks involve improving the efficiencies and qualities of the "process" of product development by aligning technological solutions via computer capabilities such as document management, printer and plotter sharing, system maintenance and better software administration.