EDUCATION IN INTERACTIVE MEDIA : A SURVEY ON THE POTENTIALS OF COMPUTERS FOR VISUAL LITERACY

A THESIS SUBMITTED TO
THE DEPARTMENT OF GRAPHIC DESIGN
AND
THE INSTITUTE OF FINE ARTS
OF BİLKENT UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF FINE ARTS

By
Hakan Güleryüz
June, 1996

EDUCATION IN INTERACTIVE MEDIA:
A SURVEY ON THE POTENTIALS OF COMPUTERS
FOR VISUAL LITERACY

A THESIS SUBMITTED TO
THE DEPARTMENT OF GRAPHIC DESIGN
AND
THE INSTITUTE OF FINE ARTS
OF BİLKENT UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF FINE ARTS

By

Hakan Güleryüz

June, 1996

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Prof. Dr. Bülent Özgüç (Principal Advisor)

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Assoc. Prof. Erdağ Aksel

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Fine Arts.

Prof. Dr. Mustafa Pultar

Approved by the Institute of Fine Arts

Prof. Dr. Bülent Özgüç, Director of the Institute of Fine Arts

ABSTRACT

EDUCATION IN INTERACTIVE MEDIA: A SURVEY ON THE POTENTIALS OF COMPUTERS FOR BASIC DESIGN EDUCATION

Hakan Güleryüz

M.F.A. in Graphical Arts

Supervisor: Prof. Dr. Bülent Özgüç

June, 1996

This study aims at investigating the potentials of multimedia and computers in design education. For this purpose, a general survey on the historical development of computers for their use in education and possibilites related to the use of technology in education is conducted. Based on this survey, the depictions related to the incorporation of technology with design education in particular, are compiled for the purpose of producing an exemplary multimedia application. The application uses the actual student projects of FA101 Basic Design course provided in the Graphic Design Department curriculum of Bilkent University, Faculty of Art, Design and Architecture.

Keywords: Design Education, Educational Technology, Multimedia, Interactivity.

ÖZET

BİLGİSAYAR VE EĞİTİM:
BİLGİSAYAR VE ÇOKLUORTAMIN TEMEL TASARIM EĞİTİMİNDE KULLANIM OLANAKLARI

Hakan Güleryüz

Grafik Tasarım Bölümü

Yüksek Lisans

Tez Yöneticisi: Prof. Dr. Bülent Özgüç

Haziran, 1996

Bu çalışmanın amacı, bilgisayarın ve etkileşimli sayısal ortamların tasarım eğitiminde kullanım olanaklarını araştırmaktır. Bu amaca yönelik olarak, genel anlamda, bilgisayarların eğitimde kullanımı ve eğitim teknolojisinin tarihsel süreci incelenmiştir. Bu doğrultuda elde edilen sonuçların tasarım eğitimindeki potensiyelleri değerlendirilmiş ve ek olarak örnek bir uygulama ortaya çıkarılmıştır.

Anahtar Sözcükler: Tasarım eğitimi, Egitim teknolojisi, Çoklu ortam, etkileşimli ortam.

ACKNOWLEDGEMENTS

Foremost, I would like to thank Prof. Dr. Bülent Özgüc for his invaluable help, support and tutorship and confidence in me, since the beginning of his advisorship.

Moreover, it gives me great pleasure to acknowledge friendship and support I received from Başak Şenova, Özlem Özkal, Önder Gürkan, Orhan Anafarta, and Tunçkan Yalnız.

Last but not least, I would like to dedicate this thesis to Marlon.

TABLE OF CONTENTS

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

LIST OF FIGURES

CHAPTER I

1. INTRODUCTION

1.1 Statement of Purpose

The technological improvements in electronic media and the changes in the field of art education have followed totally different tracks. There are several reasons for the segregation of these fields in different areas.

Art instructors generally do not have any relationship with computers in their education, conversely, the engineers or software developers are not aware of what is going on the art side. Moreover, art teachers are relatively slow in getting acquainted with the potentials of the computer (White and Hubbard, 1988).

This situation requires great attention since the computer technology that has become a part of our contemporary life, has gained a tremendous developmental acceleration. Within this respect, networks provide a great medium to exchange educational information and a further interactivity in addition to multimedia. The emerging possibilities via the hyperbolic increase of the relevant material on the internet reveals the questioning that concerns an investigation of such potential for art and design education.

Consequently, the purpose of this thesis is to attempt towards an investigation on the current applications, projects involving interactive education both on the internet and multimedia. Therein, these resources are projected to an application related to such an interactive education of design. As a result, an exemplary application for the course of Basic Design FA101, provided in the Graphic Design department of Bilkent University Faculty of Art, Design and Architecture will be presented.

The first chapter, which is on computers and education, tries to relate technology with computers in a broad sense. Its main theme is based on a brief history of computers in education where a historical and progressive perspective of the place of technology and computers in education is the concern of the study. Initially, the terms related to education with computers are defined, while reaching the conclusion that computer aided instruction is a suitable term to represent education with computers. Afterwards, several stages (from linear to generative programming) of the development of programs that effect education with computers are discussed. Two significant educational projects are presented to exemplify the attitude of government or other institutions for supporting educational projects. Thereafter, the age of personal computers are considered by seizing the impact of computer aided instruction through simulations. Likewise, games which are available for home computers are taken as a part of the study of this section. Additionally, there is an introductory part for the current situation which is heavily influenced by the market for software with the wide use of personal computers and their relative technological improvements.

Having emphasized the role of technology, the next chapter is focused on the possibility of using digital technology in education. Thereby, an evaluation of the terms related to both technology and education will be taken into consideration. Initially, an overview of the role of computers in education is presented. The chapter continues by introducing different technologies that are potentially used in education. These technologies include a range of equipment from CD technology to internet, presented in their developmental perspective. Each technology is discussed in the context of their role in education, as well as some exemplary cases related to education.

The following chapter "Possibilities and Technology for Education" points out the possibilities of the features of technology presented in the previous chapter, in relation to basic design education. The main theme of this chapter is to seek problems and possibilities of merging the current and future computer aided instruction technology, specifically that of design education. In accordance with this, the first section, "Design and the Problem of New Technology," investigates the problems and possibilities of using these new technologies in design education. In order to find potentials of these new technologies for basic design education, the next section, "Basic Design Education: A Brief Overview," discusses the subjects of basic design education in this context. The last section, "Potentials for Basic Design Education," presents the evaluation of the results of potential uses of computers in basic design education.

Then, an overview of the conducted exemplary application for the course of Basic Design FA101, the FA101 interactive application is presented in the last chapter. A brief user guide is provided after a general description of the application. Thereafter, some possible improvements and a guide to possible further work are discussed, so as to point out the current status of the completed project.

1.2 Interactivity and Education: Definition of terms

Current issues of interactivity in computer media requires some general background knowledge on both technology related to computers and the software available for different systems. A general definition of what a computer is, as an introduction to interactivity (and what it stands for in the computer related media) can be considered as a guide to the understanding of further material.

The Cyberspace Lexicon defines the word "interactive" in any environment as follows: "Description of any computer-based system in which the user's input directly affects its behaviour, and its resulting output is directly communicated to the user" (Cotton and Oliver, 1994: 112). Alternatively, the interaction is the process of control and feedback, between the user and computer or the hypermedia system. The hypermedia system is an environment in which there are certain processes that are based on this interaction. This is, therefore, a strict differentiation from the known media of print material and TV, where no such interaction occurs (Goodman, 1987).

There are various levels of interaction that can take place. Until recently, interaction was largely 'reactive:' The user would do something and the computer would react, or vice versa. With increasingly 'smart' systems, however, the computer can become 'proactive,' for example by learning about the user. In virtual systems, interaction can take place in a virtual world where both the user and computer are represented graphically and sculpturally, as an immersive interaction (Schwartz and Schwartz, 1992).

The measure of interactivity could be proposed as the user's sense of participation in a program. Apart from the sense of participation, other measures of interactivity can be found: Laurel defines three useful parameters for assessing interactivity: frequency (how often interaction can take place), range (how many choices are available), and significance (does the interaction really affect matters?) (Laurel, 1991).

Interactive and interaction are terms that fill the gap between the educational material and the computer program. Thus, they are the vital elements in order to define technology as educational or instructive, in order to differentiate between the print material, and the new technologies for education.

The space where the interaction takes place, in the medium of technology or computers, is called the interface (Cotton and Oliver, 1994). This term is generally used as an abbreviation to the human/computer interface. It can be defined as the hardware or software through which the user interacts with a computer or hypermedia system.

There is a certain progress in the evolution of the user interfaces of the computers. The earliest interaction with a computer was the hardware interface which required the user to rewire the computer to make it perform a specific program. Subsequently, there was the batch processing type of an interface performed by using programs prepared as punch-cards and processed in batches. After that follows the still used interface of command-line, where the interaction takes place through typing several commands and data (e.g. the 'C-prompt' of DOS).

The current generation of the interface is the graphical user interface, often abbreviated as GUI (Machintosh's MacOS and Microsoft Windows). Here a new type of hardware used in interaction, which is called the "pointing device", takes the main role (Truckenbrod, 1988: 5). This is the functional replacement of hands and eyes, where the command-line interface was the functional replacement of words. Therefore, it can be depicted that GUI is more about bodily behaviour than the previous interfaces, and can be seen as an extension of the body reaching the digital screen, as a remote touch. The trend for the future of interfaces lies in this notion of bodily extensions, and as for technology, the future promises immersive interfaces exploiting virtual reality and simulator technologies.

There are different 'modes' in the process of interaction with computers. These modes can be differentiated in terms of the physical appearance of the particular interface. For instance, the use of a menu is a specific mode of interaction. Another way of differentiation might be based on the nature of the information being handled. In relation to the mode of interaction, there is the 'modality' of the interaction which Mayes defines as a reference either to the particular sensory system the user is engaging: audio, vision, touch; "or to the essentially spatial or verbal nature of the information" (Mayes, 1994: 2). In this sense, the term 'medium' can be any of these or none, and it may be used to refer to the nature of the communication technology (i.e. print is a medium).

There is a certain confusion in the usage of the terms 'multimedia' and 'hypermedia.' They are often used interchangeably. Hypermedia refers to hypertext-like systems, "characterized by their data access structures and differing from hypertext only in their use of other media, usually graphics or video" (Mayes, 1994: 3). Whereas, the basic idea behind hypertext is that

> "a reader is presented with a segment of text, of graphics as needed and then can branch immediately to any other segment as needed...[convenient way] is to think of it as a collection of electronic index cards,

> each containing encoded information and references" (Vockell and Brown, 1988: 136).

Multimedia is not essentially defined by the notion of data structures present in the idea of hypermedia, rather it is signified by the nature of a mixed media communication. It refers to a mixed mode of communication where images, text, icons, graphs, sound, music and video are bundled together with interactivity within the theme of the product.

The use of multimedia, undoubtedly, enriches and stimulates the educational process. The potentials of multimedia assert that it should enable a dialogue and interface design with a more powerful storage of tools for communication. The combination of different media in high-resolution displays with colour, full-motion video with speech, carries a vividness that makes multimedia a joyful place for the process of learning.

Apart from the notions of interactivity and multimedia, there is another theme that correlates this structure of technology with learning. It is the artificial intelligence or intelligent tutoring systems that are proposed to be of major importance to computer aided education (Visalberghi, 1988).

Intelligence can be incorporated in the interactivity of the medium or it can be thought as a property, a feature of the user interface. In both cases, there are considerable problems in defining intelligence related to systems interfaces. The notion of intelligence is very problematic to define within itself, and to find out what is intelligence in any tutoring system is even more complicated (Visalberghi, 1988).

The intelligent tutoring system is based on a definition of intelligence that is quite oversimplified. This definition is quoted in Cyberspace Lexicon as follows: "The capability of a system to modify its performance as a result of feedback," whereas the definition of intelligent is even more simplistic: "A term applied to devices (such as printers or computer terminals) that have a built-in capacity to process data." (Cotton and Oliver, 1994: 112) The reason for such a simple requirement which is put on for the intelligence of machines might rely on the fact that the aura of computers and related devices for being intelligent is so strong that intelligence becomes an inherent property. Naturally, this situation justifies the problematic and therefore flexible definition of intelligence itself.

It is obvious that many applications easily fall into this category of intelligence related to technology, hence, this definition is very similar to the definition of interactivity. Therefore, the question of whether interactivity can be accepted as intelligence appears. This would simply mean that the TV remote control unit could fall into this category, however, there is a lacking element of feedback here. Therein the response to feedback is considered as the vital element for intelligent tutoring systems. Thus it corresponds to the capacity of learning for an application.

In any case, it is stated that "the subject of artificial intelligence remains the most promising source of new ideas for educational software." (Dunn, 1987: 110) This argument is mostly supported by the world of computer science, where the strongest criticism comes with the implication of the importance of artificial intelligence in enabling future developments to be more productive.

2 COMPUTERS AND EDUCATION: HISTORICAL PERSPECTIVES

2.1 Computer Aided Instruction and related terms

The emergence of the computers in the field of education is in correlation with the computer manufacturing companies becoming more interested in the individual as a customer rather than the industry giants. Before the development of such a relationship, there was a large amount of work conducted to introduce the computer to the education field. The content and potential abilities present in these attempts are defined by several attributes that include the relative technology, software know-how that has accumulated and the costs of using computer as a tool for education.

The history of computers in education starts in early 1950's. Within this context, the work of producing quality software for education had become reasonably cheaper. The effect of cost on the application of computers to any educational area was crucial. Zinn (1988: 190) remarks that "a simple programmed workbook will do what the computer can do at one-tenth the cost!" Although the cost comparison shows similar results even in some of today's CAI (Computer Assisted Instruction) applications, today, the content proves that what we have now is quite distant from the programmed workbook.

The term CAI (Computer Assisted Instruction) was originated in late 1950's with the use of computers in education. In fact there are two other different terms called CAL (Computer Assisted Learning) and CMI (Computer Managed Instruction) related to using computers in education. These two terms, CAI and CMI, have a slight difference and rank in meaning and they represent different levels of responsibilities for the computer in teaching. The Computer Assisted Learning is often used as a general term for both CAI and CMI. Willis et. al. give brief descriptions of both terms to show their difference in function. In CAI, computer takes some responsibility for actually teaching the student, where as in CMI, computer manages instruction:

> "as part of a particular course or program of study, the computer may keep records, make lesson assignments, administer tests, and compute grade or progress reports, but it does not actually do any of the teaching." (Willis et. al., 1983: 159)

There is a certain group of CMI applications which Willis et. al. (1983) differentiates as Diagnostic/Prescriptive applications. In this sub-group of CMI applications, the computer is used to administer and score tests, to evaluate diagnostic tests and evaluations may generate a report or prescription for future learning experiences.

After marking these inherent differences among the terms related to computers in education, it would be more convenient to refer to all such applications of education as CAI, computer assisted instruction. The only reason for this is that CAI is the most widely used term, and not many people make the differentiation between CAI and CMI.

There have been different approaches to CAI since the date the term CAI appeared. Nievertgelt et. al. (1986) define some stages of the emergence of CAI. In the beginning there was a movement based on programmed instruction (PI) which can be said to initiate the use of computers in education: "The psychological theories behind programmed instruction combined with the speed and accuracy of the computer as a delivery device raised high hopes that a labor-saving technology of education had been found."

(Nievertgelt et. al., 1986: 3). After this first stage there appears a disillusionment as it is now realized that what has been done is not very far from Skinner's criticism mentioned above:

> "The rigid control implicit in the teaching strategies of early CAI was followed by disillusionment at the unimaginative use of computers for "electronic page turning," best expressed by Arthur Luehrman's provocative question: "Should the computer teach the student or vice-versa?" The Logo project at MIT pioneered the idea of a computer laboratory for children, in which attractive devices led the child to learn by exploring." (Nievertgelt et. al., 1986: 4)

The Logo project, which first appeared with the work of Seymour Papert, whose book Mindstorms - Children Computers and Powerful Ideas has "prompted teachers to think about how Logo can open up new ways of teaching and learning." Logo aimed at introducing programming concepts to young children with a rather intuitive approach (Goldstein and Ainley, 1987: 1).

Logo is classified in the problem-solving category of (O'Shea and Self (1988: 68). In their analysis of the historical development of computers in education, they classify the works executed under a theme where the trend from rigid computer-oriented approaches towards more sensitive learner oriented ones, is crucial. This approach is fruitful for understanding the inherent difficulties in the field of computers and education, as each range of developments try to cover the lack of the previous ones.

2.2 Sequential Programming

The initial strategies on CAI were based on sequential programming. This type of programming was referred to as 'linear programming' although, in computer science, it refers to a different, specialized type of programming. In these linear programs, a systematic representation of the learning material is presented to the applicant. Teaching here is "simply the arrangement of contingencies of reinforcement" (O'Shea and Self, 1988: 68). For Skinner, the basic underlying principle of instruction with linear programming, is as follows: "If the occurrence of an operand is followed by the presentation of a reinforcing stimulus, the strength is increased" (Skinner, 1988: 69). This is also called the Law of Effect of Thorndike in pedagogy. Teaching continues with successive approximations to the desired behaviour.

The actual practice of teaching begins with a distinct material pre-determined by the teacher called a "frame." The student responds with either filling a blank or giving a "yes/no" answer. Then the program moves on to the next frame, and each frame moves towards a deeper level of the learning material.

The problem is the lack of feedback which could be generated from the answer of the student. There is no individualisation for the student, other than the pace at which the student can go from one frame to the other. The resulting program is very easy to implement, but does not serve much for capturing the individual behaviours of the students. There is also a meta-limitation on the kinds of answers that the students give because of the limitations of comparison techniques in linear programming. The resulting program is "often a program written for the lowest common denominator rather than for average or above average students. With the exception of allowing students to learn." (Willis, 1983: 159)

2.3 Branching Programs

A further development in generating teaching programs is to use branches, which causes the changing of the responses of the program on a comparison basis. Crowder explains the additional element of feedback introduced as follows: "the essential problem is that of controlling a communication process by the use of feedback. The student's response serves primarily as a means of determining whether the communication process has been effective and at the same time allows appropriate corrective action to be taken." (O'Shea and Self, 1988: 73)

In terms of their educational value, the main difference between branching programs and linear programs relies on this feedback mechanism. The frames, the units of teaching material, are larger as the author does not have to try to ensure that the student responds correctly. The answer of the student can now be more free, it does not have to be either 'yes' or 'no,' and the student can now receive a comment for the response, thus either the current step is repeated or the next step is introduced.

2.4 Author languages

The implication of the adaptive teaching program was the emergence of a class of programs called 'author languages.' Steinberg explains the function of an authoring environment as follows:

> "Authors need appropriate tools to design good instruction. For example, because there may be many correct answers to one question, all of the answers need to be judged and accepted as correct answers to one question, all of the answers need to be judged and accepted as correct by the computer lesson. An author language consists of computer commands that enable the author to transmit this information to the computer without writing long or complicated programs." (Steinberg, 1991: 72)

Indeed, the name 'author language' implies the fact that authors could produce educational software without actually doing any computer programming. The actual state of author languages do not quite match with this notion. O'Shea and Self explain their potentials as follows: "At their worst, such languages were extremely primitive, providing only routines to input, output and compare text, and to move between frames by means of a GO [Branching statement in LOGO language]. Only dogma, however, stood in the way of extensions which soon became standard features of author languages." (O'Shea and Self, 1988: 73)

The most premature version of such author languages is the TUTOR application. This is a simple guidance for the user to write his or her own branching programs. CALCHEM is an example of a tutoring application written with TUTOR. It is based on text dialogues with the student and the inherent mechanism reflects the idea of an 'understanding teacher.' The mechanism is based on the detection of some keywords in the input text. (O'Shea and Self, 1988: 77)

There are certain requirements for a good authoring language. The most vital one of these is the ability to generate decisions on the basis of the student's performance history. This information is not incorporated in the fixed teaching material. The next frame is programmed and how the student has performed has very little to do with the determination of it. Another inconvenience is the specification of the learning material. In these programmed learning applications, all of the content is determined by the writer, and the content of each learning frame is fixed. This gives no control on the level of difficulty for individual students. The only option for the writer to overcome this difficulty is to make more learning frames and to generate more branching decisions, but this, after some point, makes the program incomprehensible and hard to manage by the authoring user.

2.5 Generative Programs

There are some similarities between the linear programs and the branching programs which are opposed to the former. They both emphasize the systematic representation of the learning material. Hence, they both treat the student as *tabula rasa*. These initial efforts on introducing computers in the education field has generated some negative perception of the CAI. It was viewed just as the programmed learning:

> "Both [linear and branching programs] are concerned with the efficiency of instruction rather than the quality of learning, seeing learning as the acquisition of 'knowledge' rather than 'experience' and ignoring the emotional and spiritual dimensions. Both tend to encourage the student to do what he is expected to do and not to offer his own interpretations. The outcome has been that the combined approach, programmed learning, has been taken by many to be that of all computer-assisted learning." (O'Shea and Self, 1988: 77)

The next generation of computer assisted programs started to use the so-called generative computer assisted learning mechanism which provides a new means of generating the learning material. The origin of the generative computer assisted learning was based on reducing the author's task of preparing the learning material. In generative computer assisted learning, the learning material is generated from a computer program rather than the fixed input of the author.

The simplest example would be the problem of teaching addition. In this case, the computer generates certain problems, hence, the answer or the solution is inherent to the computing mechanism. Thereby, numerous problems can be generated on some difficulty basis, and the solutions to the problems can be presented to the student if there is a wrong answer.

The advantage of generative computer assisted learning can be stated as follows:

> "There can be an unlimited resource of teaching material. The store occupied by teaching material is reduced. They can provide as many problems as the student needs to achieve some level of competence. They may be able to control the level of difficulty of problems so that the student is presented with problems appropriate to the needs at any time." (O'Shea and Self, 1988: 81)

The response to the system is now more complex compared to linear or branching programs. Likewise, the student can now ask questions about some step of the solution to the problem and get a consistent answer.

Nevertheless, there are some limitations on the type of material that generative computer assisted learning can be used. At first, the material should be of some 'standard format' so that the problem can be solved by the computer. This format restricts the material to algebraic or computational type of fields of education. Therefore, each intermediate step in the solution can be identified. Secondly, the material should be such that it should be easy to determine a difficulty model, so that the questions can be classified in an order of difficulty. It is obvious that generative computer assisted learning is not convenient to teach politics or poetry.

In spite of the fact that branching programs and generative systems provide more than the linear programs, they are still derived from informal theories of learning. This lack of academic rigour in computer assisted learning had caused some researchers to define precise theories of learning "which predicted the effects of alternative teaching actions, and then to develop programs which used such theories to choose between alternatives. These so-called mathematical models of learning have developed a distinctive style in which learning is represented probabilistically or statistically, and which deal mainly with stereotyped learning situations." (O'Shea and Self, 1988: 83)

Within this respect, the problem is to state a learning model for each type of learning material. One example for the teaching of vocabulary was presented by Laubsch and Chiang in 1974 in their work "Application of Mathematical Models of Learning in the Decision Structure of Adaptive Computer-assisted Instruction Systems" (qtd. in O'Shea and Self, 1988: 83) The first step is to define a set of teaching actions. Then some teaching objectives are determined. For vocabulary learning, this objective might be to maximize the number of words learned by the student after a number of sessions. The next step is to define a cost of each teaching action. Resulting from these steps, a mathematical model for the learning process is constructed. For the vocabulary learning, the model consists of some states that each word can take while being presented to the student, such as 'permanently learned,' 'learned but forgettable,' and 'unlearned' for the Laubsch and Chiang model.

Although the initial steps of the generation of the mathematical model can be applicable for some cases, the last step, the generation of the model may not be applicable. Furthermore, the determination of the effectiveness of the learning model is another problem in itself. Moreover, it also requires a through understanding of the learning process. For the particular cases where this can be determined, it produces effective teaching strategies, but generally the abstraction of the any learning process to a proposed mathematical model is very problematic.

2.6 Projects for Computer Assisted Instruction

The first distinct attempts to utilize CAI systems to practical usage were the TICCIT and the PLATO projects. Near the end of 1960's there were many small applications of CAI which survived their trial period, but still an effective and operational system was required to show its implications and use. In 1971 the National Science Foundation of America (NSF) decided to solve this problem by investing ten million dollars in five years, in two demonstrations of computer-assisted learning. These two projects define two different approaches in computer-assisted learning.

2.6.1 The TICCIT Project

The Time-shared Interactive Computer Controlled Information Television (TICCIT) project required the MITRE corporation that had been developing cable television systems, to design and develop hardware and software for a computer-assisted learning delivery system. The MITRE Corporation hired educational psychologists to develop an instructional design for the system and to produce TICCIT courseware. (Steinberg, 1991: 64) Another contract had been made with the Institute for Computer Uses in Education at Brigham Young University to develop course material.

The TICCIT project aimed at "demonstrating that computer-assisted learning can provide better instruction at less cost than traditional instruction in community colleges." (O'Shea and Self, 1988: 86) The project was not intended to replace the classroom teaching, however, it was considered as the main source of delivery of instruction.

This decision was made in order to take into account the approach that the mainline is designed from the first for mass dissemination. The belief beneath under this decision is that "neither lower cost, higher performance systems, nor improved theories of instructional psychology would get computer-assisted learning in schools, but that the real problem is making of a 'market'" (O'Shea and Self, 1988: 87). This implied a factory like production of the course material.

The teaching material is produced by a team of experts: an instructional psychologist, a subject-matter expert, an instructional design technician and so on. Thereby, the division of the work for preparing the course content, relies on the belief that the effectiveness of a particular learning strategy is independent of the subject-matter. The course content is completely separated from the computer programming and teaching strategy:

> "The particular model of instruction implemented on TICCIT is, naturally, based on 'instructional theorems having sound empirical footings where possible and theoretical integrity elsewhere.' In practice, most learning is considered to involve concept learning and rule using, and most teaching sessions are organised on the basis of presenting a general statement, examples of the generality applied to specific instances, and practice problems. A range of examples and problems are provided, and the learner is allowed to choose between them at different difficulty levels." (O'Shea and Self, 1988: 87)

The idea of a general learner profile is reflected in the project's user interface. The student terminal has a keyboard and a colour television terminal. The communication of the student is established with the keyboard or with a lightpen. There is also an audio system to provide audio messages. A minicomputer serves each such 128 terminals. The specific nature of the system was designed to serve the reliability of the system. (Merill and Marvin, 1986)

The TICCIT project was implemented in two colleges to teach courses in pre-calculus mathematics and English composition. The mathematics program included reviewing basic arithmetic and teaching intermediate algebra, logarithms, systems of linear equations, permutations and progressions, whereas the English composition section included teaching grammar, diction, sentence structure and paragraph development. As a matter of fact, there were some definite problems in both the progress of the development of the project and the preparations of the course material:

> "…one of the college project directors wrote that the initial presentation to the college faculty was a 'total disaster': the emphasis on economies to be achieved and the assumption of a 'position of hard sell laced with tactless humour' turned faculty away. In addition, the development of course material, particularly in English composition, caused problems: 'differing factions became embroiled in interminable debates among both content and methodology.' Since it was also said that 'the effort required for software development was grossly underestimated,' it is not surprising that the actual demonstrations began later than planned." (O'Shea and Self, 1988: 92)

Nevertheless, after the completion and the actual usage phases of the project, it was seen that the system has served the students who completed the classes in TICCIT, to attain higher post-test scores than the ones who did not use the system. The number of students who could not complete the courses showed some negative effect of the system that it favoured high ability students to the detriment of students of low ability:

> "…programs that allow each student to proceed at his or her own pace risked losing students unable to manage their own instruction. This has been attributed the low completion rates to an insufficient degree of instructor involvement in managing student progress. It would seem that learner control and self-pacing, if it increases motivation at all, does not do so enough." (O'Shea and Self, 1988: 92)

Evidently, the students did not appreciate the features of the TICCIT system much. Nevertheless there was one thing that all the students liked, and it was the PRACTICE button present in all the frames: "the practice problem appeared to be the cornerstone of the TICCIT system."

(Meril and Marvin, 1986: 40) Another positive element was the courseware which managed the preparations of the related course material: "[TICCIT] was proud of the uniform style of its courseware, which was based on a theory of instruction and generated according to a systematic process." (Nievertgelt, 1986: 7)

The general response to the TICCIT system was mild. It caused a certain shift in the role of the teacher as a "tutor-advisor/diagnostician and problem solver for individual students." (O'Shea and Self, 1988: 93) After several terms, the instructors began to think that they were not doing their work with the TICCIT system, and they were uncertain that TICCIT accomplished their task. After the evaluation period the TICCIT program was said to show the potentials of computer-assisted instruction, but there was not a widespread adaptation of the TICCIT project by other educational institutions:

> Two more recent applications of TICCIT have been in special education (for example, in New York TICCIT is used in the first project to attempt large-scale delivery of computer-based instruction to homes to teach homebound handicapped children), and in military training (for example, to train Viking air crews in procedural skills before using costly simulators). (O'Shea and Self, 1988: 93)

2.6.2 The PLATO Project

The second NSF founded project was the PLATO (Programmed Logic for Automatic Teaching Operation) project which was developed by the Computer-based Education Research Laboratory at the University of Illinois. This was a well-known example of a two way computer aided learning system.

It has been developed since 1961 under the direction of Don Bitzer and marketed by Control Data Corporation. The system has elegant graphics and an author language to help teachers construct good quality teaching materials. (Hooper, 1983: 104)

The project first started in 1960 with PLATO I, a one terminal system, then expanded to PLATO IV with 950 terminals located at 140 sites, which had 8000 hours of instructional material contributed by over 3000 authors (Hooper, 1983).

The aims of the PLATO IV project as listed below carry some vital information about the nature of the project:

> To demonstrate the technical feasibility of a truly novel computer-based education network; To prove that the system is manageable, economically viable, and capable of serving a variety of institutions at any educational level; To develop curricular materials for the new medium; To develop acceptance by instructor-users and students of a new medium designed for increasing the effectiveness and productivity of the instructional process. (O'Shea and Self, 1988: 93)

The main theme of the project was to reach a level where the PLATO system is omnipresent, so that at the end every school in America will have at least one terminal. The next generation PLATO V system was supposed to be at least 1 million terminal system so that it conforms with the comments such as "a national or international educational network could begin to introduce a new dimension of learning for world citizenship." (qtd. in O'Shea and Self, 1988: 94)

There were some basic differences at the theoretical level between the PLATO project and the TICCIT project. The underlying technology for the PLATO project was very large networks of terminals whereas the TICCIT project used mass produced components and mini-computer based systems. The PLATO project was designed as a structure to support computer assisted learning. For this reason, there were no organized production team for the course material as in the TICCIT project. Teachers could use the system as they wished and the material produced was of variable quality. The previously mentioned TUTOR language was used to assist the teachers in preparation of the course material:

> "... TUTOR programs consist of a series of statements, each of which has a command and a so-called tag (corresponding to the input of a LOGO procedure). There are over 160 commands for display (e.g. arrow, at), control (e.g. next, go to), calculations and judging (e.g. answer, wrong). The judging commands attempt to process the students answer, allowing for misspelled words or words out of order." (O'Shea and Self, 1988: 94)

The terminals of PLATO consisted of a keyboard and a plasma display panel. The display panels were transparent, allowing to superimpose color slides at the back of the panel. An additional touch panel allowed easy interaction by touching the screen. This allowed the interaction of children who found it hard to type. The terminal also allowed the input of other devices such as audio, slide selectors, music synthesizers, film projectors, and laboratory apparatus.

The PLATO system did not aim at imposing a pedagogical structure on the learning material, its only purpose was to construct a huge network of computer assisted instruction mechanism. The architecture consisted of hundreds of graphic terminals working simultaneously. Initially each PLATO IV system was intended to drive 4000 terminals. On the other hand, due to the huge amount of lessons and more amount of graphics than initially foreseen, this dropped down to 1000 terminals (Hooper, 1983: 108).

In the evaluation period, it became obvious that the preparation of course material was more difficult than expected. So, a demonstration was available a year later than planned, in 1978. The evaluation of the project after the five year period did not show much impressive results:

> "Even so, by the end of the five-year project, the evaluators had managed to accumulate an impressive volume of data, which 'taken together and in perspective, provide no compelling statistical evidence that PLATO had either a positive or negative effect on student achievement.' It was also deduced that 'the PLATO system had no significant impact on student attrition,' i.e. on drop-out rates." (O'Shea and Self, 1988: 96)

After this negative impact of the evaluation results, the evaluators turned towards questionnaires to find more subjective results. The results showed that the PLATO system was generally popular with student users:

> "...70 percent or more of students continued to use PLATO outside their class period, and similar large percentages reported that they would use PLATO for another course if given the opportunity. ... 19 percent felt that 'computers are not good for instruction because they are always breaking down,' 27 percent agreed that 'computers are too impersonal for student instruction,' and 83 percent 'would not want to have whole course thought on PLATO' ... For example, 88 percent of [teachers] definitely or

> probably intended to use PLATO again." (O'Shea and Self, 1988: 97)

This showed a high contrast between the evaluation results of the system and the general interest to the system. It was considered that the result lead to the fact that the teachers perceived that they retained control over how PLATO was used. Moreover, the system was not a threat to their current procedures. In contrast with this, the teachers did not find the TUTOR language favorable. Only 10 percent of the teachers thought that it was easy to use TUTOR, others thought that it was extremely difficult to get what they want with it. Thus the pedagogical neutrality of the PLATO project turned out to be an illusion, as the programming constraints produced severe other time and space constraints. The cost, on the other hand, was another issue which resulted in about $1.17 per hour in 1972 prices. The results showed that this price had to be reduced by a factor of 3 so as to compete with the traditional methods of teaching (Hooper, 1983).

One general implication of the evaluation of both the PLATO and TICCIT project was that such big systems were not cost effective to be used in education. It was later realized that the emergence of the microcomputers in the field would show to be a much more promising potential for computer assisted instruction.

These two government sponsored projects can be thought as the second wave in CAI systems, following the programmed instruction period. Nievergelt summarizes this second wave as follows:

> "During the 1970's a second wave of CAI systems, spear-headed by the Plato project at the University of Illinois, tried to overcome the limitations of the first-generation systems based on PI. Improved

> hardware that permitted graphic animation and a great variety of teaching strategies, including simulation and modeling, were its outstanding features. Despite significant government and commercial commitments to large-scale CAI projects, the record of actual use has been spotty." (Nievertgelt, 1986: 4)

Aside from these two bigger projects, there were many other smaller developments in this improvement phase of the CAI systems. Another mentionable example is the Smalltalk system developed by Learning Research Group at Xerox Palo Alto Research Center. This was a system "designed to provide a powerful personal programming environment for 'children of all ages'" (Nievertgelt, 1986: 8) This programming environment included tools for painting and drawing, animation, music synthesis and retrieval of document information, and other activities. Over years, Smalltalk has become an object-oriented programming language. Alternatively, another system in use is the IBM's Field Instruction System which offers CAI to maintenance personnel away from their home base.

2.7 Age of Personal Computers

The next generation of computer assisted instruction systems take their role due to their availability in the new emerging personal computer arena. These are the microcomputers that are now widely used in schools, especially at colleges and universities. An initial example is the Drexel University in Philadelphia, Pennsylvania, where an early commitment to microcomputers for education was made. Starting in 1984, all freshmen were required to have access to an Apple Machintosh. (Slotnick and Butterfield, 1989: 22)

These new smart machines, the personal computers, allow instructional dialog with a user, with their graphic terminals used as a workstation attached to an application system. There are several new areas of interest in CAI that these new affordable personal computers have opened:

> "Self-explanatory machines can be operated by casual users (without the need for a written instruction manual) according to the "learning-by-doing" paradigm. The personal computer can serve as a medium for presentations, in competition with the flip chart and the overhead projector." (Nievertgelt, 1986: 5)

This new form of widespread computer usage introduces education not as a programmed and planned project, rather as a form of entertainment and proliferation. A new way of CAI emerges in which activities are executed for fun and by people who do not consider CAI as their major goal, however, "who simply do it because it is convenient and possible on the equipment they happen to have." (Nievertgelt, 1986: 8) The educational packages which deal with areas such as educational games for arithmetic, second or native language learning, are advertised to give children 'best education.' These software packages have simple instructions for loading the program and maintaining it on the microcomputers. In contrast to the government sponsored big courseware projects, this field of educational microcomputer software show that CAI can be transformed to the public domain:

> "These developments show that, CAI although it has not yet had a large impact, is now in the public domain - accessible to anybody who has access to an interactive system and does not fear the programming effort required to produce instructional dialogs. This state of affairs has never been true before. Up to the mid-1970's, an expensive computer was required to do CAI.

> With the proliferation of inexpensive personal computers and a corresponding increase in the number of people who know "how to teach computers," a growing number of users are experimenting in teaching computers to teach students." (Nievertgelt, 1986: 9)

2.7.1 Simulations

One of the different modes of CAI in contrast to the bigger projects is simulation. Simulation presents a model of a specific situation or process by studying the working process of the specific system. It is predicted that the student will gain insight to the system being modeled. The program is usually constructed such that the student's role involves more than being a spectator and a voluntary responsibility or interaction is required to make the simulation work. Often the student has to develop a strategy and experiment with the modeled system in order to make it work. In some cases, the user can interfere with the program that generates the simulation to gain more insight to the model. The computer's power in such a case is based on its being a "powerful and flexible device for controlling simulations." (Nievertgelt, 1986: 9)

Mathematical models are widely used in physical sciences, and often the complexities of these models are beyond the standard student. The simulations serve the student to grasp the mechanism of this model more visually than the standard class-room teaching. One added benefit emerges when the simulation can be transformed into a game in which the student has to specify inputs to reach some goal, either in competition with the program or with other students.

Several such applications had emerged by the end of 70's. As a very common example, the simulation of the cardiac output in biology can be considered. This experiment could be done in laboratory, but the simulation provides a clearer and more feasible presentation than can be performed in real life. The user of such a simulation is not required to know any programming skills beforehand. Thus, the preparation of the simulation does not fit into the content of the author languages. Therefore, when simulations appeared, they formed a different class of CAI applications. (Sewell, 1990)

Cardiac simulation has been a part of one of the projects in the United Kingdom's National Development Programme in Computer-Assisted Learning (NDP). This was a five year, two and a half million pound government sponsored program that began in 1973. Most of the fund was devoted to produce simulation programs. These were described as "pre-written programs for use of the students, in 'laboratory mode'" (Nievertgelt, 1986: 9)

> "The main aim of the programme was 'the institutionalisation of computer-assisted learning and computer-managed learning,' …, was defined as follows: 'to develop and secure the assimilation of computer-assisted and computer-managed learning on a regular institutional basis at reasonable cost.' During the five years, an assortment of twenty-nine projects were supported, involving some 700 teachers in forty-four different institutions, with a bias towards science teaching in the tertiary sector of education. In December 1977, as promised, NDP funding stopped, and projects were left to be instutionalised or die." (O'Shea and Self, 1988: 100)

The institutionalization of the projects had some negative effects on the content of the simulations that were developed at the end of the project. The main concern was not to do research and development for CAI, but it was to create projects that will be selected by NDP. This situation led to unadventurous and simple results.

As a matter of fact, the aim of the simulation plays an important role in the design process. There is a possibility that this can be overlooked in the design process of the simulations. If the simulation is to replace a real-life event, then this should be a necessity in terms of conditions. Moreover, there is the possibility of misguiding the user through simulations:

> "It must be borne in mind that most simulations available for education copy only some aspects of reality. They are limited in the information they contain and, if over-simplified, may result in a misguided impression of real world events or situations. Moreover, simulations apparently designed for use by very young children may, in fact, be counter-productive." (Sewell, 1990: 35)

Merill and Marvin list four main components of any simulation: "The presentation system, the student, the system controls, and the system manager." (1986: 52) Six major reasons to have simulations are also listed: (i) less risk; (ii) low training cost; (iii) possibility of having several users at the same time; (iv) ability to focus special aspects; (v) minimization of negative effects of time; (vi) the ability to repeat experiments. (Merill and Marvin, 1986: 54)

2.7.2 Computer Games

Computer games can be considered as yet another mode of educational software which has developed not mainly for the idea of CAI, but for commercial purposes. Computer games carry within themselves a notion of joy as their initiative element, and this makes them quite distinct among other CAI applications. Computer games were present in the computer arena from the moment there was computation and output. Obviously, there is no question about their popularity, rather their potential contributions are questionable.

The features which make a successful computer game are depicted as follows:

> 1. Audio and visual effects are used to reward success and to present the game situation.
>
> 2. The game can increase in its ability to challenge the player; it need not become boringly simple.
>
> 3. The game incorporates fantasy elements (e.g. piloting a spaceship).
>
> 4. The computer can time the player's responses and calculate scores (O'Shea and Self, 1988: 103).

These features of the successful computer game can be used to disguise a teaching material to benefit from the game as an education application. Today, most serious teaching applications include game as their crucial teaching element. Furthermore, "curricular areas which have been hard to teach due to low student interest or motivation may be significantly strengthened through the use of carefully selected and integrated educational computer game." (Merill and Marvin, 1986: 73).

The most basic reason is the added reality of the game itself which presents the system not as a tutor, but as an environment where there are things to be gained (scores, goodies etc.) and things to be avoided, in order to maximize joy. Merill and Marvin lists the motivational attributes of games for education as follows: challenge, curiosity, control, fantasy, interpersonal motivation, cooperation, competition, and recognition (Merill and Marvin, 1986: 65).

2.8 Mass Market

The game logic of teaching with computers is the main theme of the newly constructed mass market of production for computer education. The construction of a mass market with the proliferation of the computers in the personal computer era, has now enabled an increase in the number of people who know how to teach computers and generated a growing number of users who are experimenting in teaching computers to teach students. This lack of mass market had once discouraged investment in courseware and caused many people to think that computer aided instruction is just an illusion that has now shown its real face:

> "The only thing we can say with confidence about the role of the computer in education over the next few years is that it is surrounded with question marks and uncertainty. It may be that computers will change completely the whole nature of the practice of education with respect to such fundamental aspects as what we teach, how we teach it and why." (Dunn, 1987: 1)

Aside from this argument about the failure of CAI, the "do-it-yourself" uses of CAI techniques are hoped to ultimately succeed where "frontal attacks have failed," and "they will introduce into education the computer-delivered instructional dialog as a standard tool." (Nievertgelt, 1986: 4) Consequently, it is considered that the people would soon improve their skills of producing effective interface programs and instructional dialog would become standard tool.

This long-range improvement of the instructional systems is justified with the new situation of the mass market of instructional programs. Currently, the hardware needed to deliver instructional dialogs is available on many personal systems, there is an increase in the number of people who can choose to use computers for instruction.

3. POSSIBILITIES AND TECHNOLOGY FOR EDUCATION.

3.1 Overview: Computers in Education

Technology has become an accepted part of the society. There is no question about its vast presence in our daily lives. Although technology has changed the nature of many tasks of our lives from bank accounts to television, it can hardly be said that the processes of education has been much effected by it. This situation provides a contrast as the important skills required from the students in future becomes the ability to utilize technology, to access, analyse, filter and organize multidimensional information sources:

> "Our educational system has not been able to keep pace with the rapid advances of technology and information access. One impediment has been the cost of hardware and software. Fortunately, most of the technologies originally implemented in business and industry are now available at reasonable prices for education. Although still a problem, access to computers and other technologies is improving for schools." (Barron and Orwig, 1993: 2)

In relation with the inability of the educational field to come to terms with technology, there is another problem of having instructors getting acquainted with technology. Obviously, it is a mutually defined situation that the instructors are also trained in lack of the knowledge required to deal with technology. (Stafford, 1993: 115)

The resulting situation is that the children find school to be much less stimulating than the multisensory world outside school. "Integrating new technologies is not a cure-all, but early indicators attest that it can help to restructure the classrooms with effective tools for interpretive skills, information management, and open inquiry." (Barron and Orwig, 1993: 2)

Thus, a gap between the older media and instructors and the new kids of technology, is evident. These new children of the computer age are termed as 'microkids' by Frederic Golden whom Robins and Webster quote:

> "Thus Frederic Golden writes of a new wave of 'microkids' who are 'part of a revolutionary vanguard: the computer generation.' 'Where their parents fear to thread', we are told, 'the microkids plunge right in, no more worried about pushing incorrect buttons or making errors than adults are about dialing a wrong telephone number.'" (Robins and Webster, 1989: 104)

Nevertheless, although this is a change outside the classroom, it will eventually effect the nature of education itself. The change might not be in the classroom, or a definition of the classroom might become obscure, rather, it is seized that the forthcoming media for education will start a kind of revolutionary impact on the teaching and learning processes. It would not emerge as a planned project involving education but as an evolutionary corollary to the age of individualized and miniaturized computer usage.

The world is facing a period in education similar to the introduction of the printing-press five hundred years ago. The author of The Mighty Micro, Frederic Golden informs us that "teaching as it is presently carried out, has changed very little in millennia," however a new "wave of highly advanced super-miniaturized technology" would "lead to major changes and advances in the teaching process itself." (qtd. in Robins and Webster, 1989: 105)

The resulting situation brings a question as to whether institutionalized education would keep up with these major changes or the movement would be mixed up with the different branches of evolving mass market technology of entertainment such as the 'Buy yourself the best education' logic of consumer freedom. It is also questionable, whether this replacement or the movement from the classroom education to the market valued and consumer oriented one is beneficial in terms of its potential to adequately represent a certain way or strategy of educating the masses. In that respect, a freedom can be considered, on the other hand, there is also a certain lack of control in terms of having educated people who are free in their choice of the material they want to learn.

The Mighty Micro quoted in Robins and Webster reflects the situation as existence of a big step to be taken from the manner of teaching with books and classroom teaching to the new generation of children who have amplified their own brain power with the computer:

> "The truth according to Evans, that 'the world is about to move on from the era when knowledge comes locked up in devices known as books.' In brave new world of instantaneous access to information resources we are likely, for the first time, to see the development of a 'true Science of Education, and with it a real understanding of the nature of learning.' Will we remain 'wedded to the haphazard ignorance of the past,' or will we put our faith in a new generation of children 'who have amplified their own brain power with that of the computer'?" (qtd. in Robins and Webster, 1989: 106)

Though it is an exaggerated view for the function of the personal computer, it gives some clues about the importance of personal computers in education. The technology for education prior to computers, remains quite inefficient and irrelevant when compared to the potentials of the computerized environments of the new technologies for education. This argument may be questionable if it is taken in the sense of present materials of education in the computer media, still, the key point here is the potentials of use of this new technology.

3.2 Compact Discs

After considering the interruption of the use of the government sponsored computers in highly planned and developed projects by the next generation of personal computer market, the biggest breakthrough in terms of the mobility of educational software was the mass consumption of CD-ROMs. One of the key issues in educational computer environments is the storage of vast amount of image and text. In order to make these available for the personal computer market, CD-ROMs serve as an indispensable medium. The fact that its medium is a read-only environment makes the huge amounts of information encoded on its surface permanent. Hence, the read-only nature of CD-ROMs, makes the medium more reliable, and transforms the product into one which has collection value much like music records. (Barron and Orwig, 1993: 2) A recent advance in CD-ROM technology allows for a one time writing on the surface of CD-ROMs. These writable CD-ROMs are also available to the users with a relatively cheap price.

The compact disk replaces the previous technology of manual searching in order to find a reference. Manual searches have required and ensured the use of print encyclopedias, card catalogs and students searched through descriptors in huge index books. The society is very much information rich, and the challenge lies in being able to find and retrieve the desired data as quickly and accurately as possible. Thus the impact of CD-ROMs provided something that no previous technology could well accomplish. Therefore, the information is now mobile in very large chunks for the use of any person who owns a personal computer and a CD-ROM player.

There are potentials of CD-ROMS other than its being a compact form of data storage. The random access nature of CD-ROMs makes them irresistible and indispensable for all types of search activities. Nonetheless, the first applications of CD-ROMs was to transfer encyclopedias to CD-ROM environments. The first such readily available encyclopedia was the Grolier's Multimedia Encyclopedia. Thereupon, other popular digital encyclopedias such as the Compton's Multimedia Encyclopedia and the Information Finder by World Books, appeared. (Vockell and Brown, 1992: 117)

Some other application areas for the CD-ROM can be listed as follows: reference sources, databases, multimedia products, interactive books, games, music, online public access catalogs, computer software, clip art and graphics. Also various other specific forms of CD-ROMs other than the ones that require a personal computer and a CD player, are available.

The CD-ROM technology has established a strong place in the educational systems due to its high storage capacity and low cost. Their storage capacity and the relative technology for speed acquisition to its contents remains capable of establishing the CD-ROM technology a firm place in the future. Although today it might seem that the needs of the newly published multimedia products will surpass in storage need, the corresponding technology for data compression helps the medium to be stable and long-lasting. (Slotnick and Butterfield, 1989: 22)

3.2.1 CD Interactive and other CD formats

One special version of the CD-ROM disk is the CD-I (CD interactive). This is a specification by Philips for an interactive audio, video, and computer system based on compact disk as the storage medium. The CD-I players contain a built-in computer and the output will display on a standard television set (Barron and Orwig, 1993: 24). They are activated by a remote hand-held controller that allows the user to manipulate the information and games content with a graphical user interface, interactively. They first originated in 1990, and in 1993 their standard was enhanced by full-motion video. (Cotton and Oliver, 1994: 38)

Based on the compact disk technology, there are several other standards which have developed. The CDTV exemplifies the multimedia delivery system by Commodore that combines digital audio, graphics, and video on a compact disk, and uses the television set as display. Other systems include: VIS (video information system), DVI (digital video interactive), CD+G (compact disk plus graphics), Photo CD (Photographic compact disk), and CD+MIDI. All these standards use special devices in order to play, and with the emergence of the computerized CD technology, they have become obsolete. (Barron and Orwig, 1993: 24-25)

3.2.3 Videodiscs

In terms of playing video and audio, an alternative technology to the CD-ROM disks, is the interactive videodisc. This technology has been in use with military and industrial settings since 1970's and it has emerged as a potential medium for education. Several reasonably priced application examples of this medium have appeared, such as commercial movies, documentaries. Educational ones include examples such as the Interactive Mathematics by Miami-Dade College that teaches basic mathematics competencies with an Apple IIe, and the STV Rain Forest by National Geographic that contains several linear segments of video and still images. (Barron and Orwig, 1993: 41)

The potential of videodiscs for education arises from their interactive nature. Three levels of interaction are defined for the videodisc based on the type of connections made available to its hardware. The first level is the Level I interaction, in which there is no connection with a computer, and the disc player is used by itself. The disc access is controlled through either the control panel on the player, a remote control unit or a barcode reader. The Level II interaction has a configuration without a computer where the videodisc itself contains a computer program that provides increased flexibility. The Level III interaction is made with a connection with a computer and the control of the videodisc is achieved with a computer program. (Vockell and Brown, 1988: 118)

The application range of videodiscs include areas such as instructional games, multimedia libraries, visual databases, simulations. An example of an instructional game on videodisc is the Frame Up by Imedia International. This is a real-time strategy game. The videodisc is used with a Machintosh or IBM computer as if they contained a surveillance system, with many cameras to help the hero escape from a store full of suspicious characters. Another example is the Animal Pathfinder by Scholastic, which is designed for science education and information. It also includes some fantasy games as activities. These games require a blend of analysis and thinking skills, while urging the students to discover the information about animals. (Barron and Orwig, 1993: 42)

The advantages of videodiscs over CD-ROMs are mainly based on their quality and fast acquisition of videos on discs. The frames and segments are randomly accessible. Their obvious advantage on films is the interactivity with a smaller cost. The main disadvantage is the relative high cost of software and hardware. The cost of players range from $700 to $1000 (Barron and Orwig, 1993). Furthermore, they lack a standard for their interface. The technology for videodiscs are overridden by the advances in CD-ROM technology.

3.3 Audio Technology

Today, it can be stated that the technology for audio is totally transferred to the digital arena and especially to the domain of computers. Up to this stage, the computer sounds had been limited to beeps and metallic-sounding voices. The hardware and software to manage sound digitally were very expensive or unavailable. With the emergence and wide use of personal computers, this technology has developed to today's level where perfect quality sound is easily managed inside the personal computer.

With availability of large storage capacities and the reduction of hardware for implementation, educational applications using digitized audio are rapidly appearing in education. There are several categories of educational applications related to digital audio. At first, there are custom computer programs for the recording and playback of one's own audio for a computer lesson. Therefore, programs seem to become more realistical, hence, they can be used to enhance instruction for poor readers and students with poor vision. Moreover, it is under computer control and due to the nature of digital audio, it can be accessed instantly.

It should be emphasized that, the second-language learning field of education may lose much of its meaning without digital audio. The audio feedback required in this field of education, consists of making the user listen to a word spoken aloud, which means to say the word into the computer microphone and then give the chance to compare their pronunciation with the correct one in audio. Additionally, this procedure has a big potential for the cure of people with speech impairments. (Romiszoswki, 1986: 363)

A vital field in digital audio for the purpose of education is the text-to-speech synthesis. In this method, the language is defined as fixed set of sounds, and computer algorithms are user to pronounce text in spoken output. (Barron and Orwig, 1993: 61)

The main advantage of text-to-speech conversion is its nature of being generative so that very little storage area is required for the use of speech. There is no vocabulary definition as it works on a basis of synthesizing sound from the text. By this way it becomes ideal for talking word processor type applications. The main drawback of text-to-speech synthesis is its inability of producing realistic pronunciations. The sound is mostly unnatural and mechanical even in its most advanced state. The reason is that the method does not differentiate between the pronunciations of words with same lettering, such the world 'live' as in 'live performance' and 'I live in Ankara.' This differentiation requires the understanding of the language itself. The same requirement affects the inverse process of speech recognition which has not yet developed enough to find application areas related to education.

3.4 Hypermedia and Multimedia

In conjunction with these different media, there lies the hypermedia application. Hypermedia allows exploration of material in associative and non-linear ways. It has the capability of linking ideas and similar topics together. Therein, this way, it creates a case and subject sensitive tree of data and information gathered around a main theme.

The classification of data tends to create its own space, similar to the filing cabinets. The visual elements help the hypermedia application to establish a spatial relationship between the information and ideas presented in the application. The main function of this spatial arrangement of information and ideas, is the construction of an area in which users or visitors can choose among the topics or data that he/she would acquire. Therefore, hypermedia applications enable students to make their own choices and follow their own paths. Consequently, one student might explore all the information on one topic, while another student concentrates on other areas.

The concept of hypermedia has existed for many years, yet, the technical advances in computers and software have only recently made it a reality for educators. Today there are several hypermedia development programs. These development programs include mainly, Hypercard (Claris) and Linkway (IBM) and as well as Tutor-Tech (Techware), HyperStudio (Roger Wagner Publishing), Toolbook (Asymetrix), and Spinnaker Plus (Spinnaker Software) (Vockell and Brown, 1988: 140). Such applications enable students and teachers to create their own hypermedia applications.

There is a certain confusion between the terms hypermedia and multimedia. In fact, both of them can refer to the same application, as an application can both at the same time be a hypermedia application and a multimedia application. These terms refer to the different properties of the application.

In hypermedia, the key issue is the hotspot or the hypermedia link to another hypermedia element. Examples would be, the word 'jazz' which establishes a connection to another hypermedia document about jazz, in the text segment 'I like jazz'; or in a hypermedia document about animals, it can be a graphical icon of a cat which establishes a connection to a another graphical document about cats. This 'alive' linking element of the hypermedia constructs a space of information. It is much like the door between two rooms in an exhibition: an exhibition of information on a specific topic.

The multimedia application, on the other hand, is the use of different media, such as video, audio, images, animations merged together under one theme. The Cyberspace Lexicon defines multimedia as "A term which applies to works of art that incorporate the use of mixed materials (media), but more generally is used as shorthand for interactive multimedia."(1994: 136) Whereas the interactive multimedia (IMM) is defined as "The generic term for programmes and applications that include a variety of media (such as text, images, video and animation), the presentation of which is controlled interactively by the user." (Cotton and Oliver, 1994: 136)

Obviously, there is a certain common denominator of meaning and usage for the terms 'interactive,' 'multimedia' and 'hypermedia.' If they are taken in a historical perspective, these terms carry some hierarchy in terms of their wide usage. The term 'hypermedia' is the oldest one. Today, the most common usage is shortly the term 'multimedia,' for any mixture of these different specifications of applications.

Hypermedia applications can be classified in several different categories of educational application areas. The original purpose of the hypermedia applications was to manage a mixed media database. Consequently, the basic usage of hypermedia applications is the creation of teacher's own database managers, such as an inventory of equipment or videodisc images. Another basic usage of hypermedia applications is to create slideshow presentations. Apart from the ease of use of hypermedia applications when creating slideshows, the dynamic input of the audience, special transition effects and the ability to make last minute changes are advantages that make the hypermedia applications very convenient for creating presentations. A further advantage can be the ability to create handouts of presentations instantly by using a printer attached to the computer.

The creation of an authoring system with a hypermedia application is very straightforward. They provide an easy to use interface for the novice user. Furthermore, the low cost of hypermedia systems make them superior to classic authoring systems. For example, to create a multiple-choice question with hypermedia, an hotspot is placed over each possible answer. When the student clicks on an incorrect answer, he or she will activate the button, which may then provide feedback about the incorrect answer and give the student another chance to answer the question. If the student clicks on the correct answer, the button will instruct the program to go on to the next question. Moreover, it is very easy to incorporate images, text, and sound to such an interface with hypermedia applications. Therefore, the hypermedia applications can be thought as multimedia authoring systems as well.

3.5 Networks

One recently available technology for education is the Local Area Networks (LANs). The term Local Area Network (LAN) refers to a set of computers at a single site that are connected in such a way that allows them to work together and share software. (Vockell and Brown, 1992: 115) This type of networking between individual computers allows the teacher to review student's work from a single location. The added availability of distant communication between the students and the teachers provides the fluidity of ideas and information. Consequently, the structure allows messages to be sent or posted, thus, groups of students can read them, or the messages can be sent to an individual student's monitor. Furthermore, students can use the programs on the LAN, such as the electronic encyclopedias, from any computer connected to it. (Vockell and Brown, 1992: 116)

Local Area Networks (LAN) are systems of computers, printers, and other peripherals that are linked together through a set of cables. Software is stored on one central computer, called a "file-server," and appropriate files are sent to the workstations of clients as students need them. Printers can be shared by workstations, making it possible to use dot matrix printers for draft-quality printouts and a single laser printer for high-quality printouts.

Increasingly, students use computers more widely in their school activities. Therefore, tracking students, computers and necessary software becomes a major responsibility for teachers. LAN helps this tracking activity immensely.

LAN provides a possibility for all software to be centralized, hence, a single license for a specified number of users can be purchased for each piece of software. Besides, it provides security of the hardware inventory as it can automatically detect the connection of each piece of equipment. A drawback is the initial investment for the equipment. However, once it is designed properly and well-utilized, it costs less than operating a group of individual computers. (Minoli, 1994).

There are different types of connectivity configurations based on how the computers are attached to each other. Within this context, there are also other configurations which can be classified according to the criteria that a file-server exists or not. A file-server is a larger computer designed to serve others which are called 'workstations.' The peer-to-peer connection exemplifies one of these configurations, in which the computers are either attached to each other in a ring structure of a line/bus structure. For peer-to-peer connection, there is no need to have a server, as all computers have the same priority, and they are structured sequentially. The other type is the star or tree structured networks, for which a server supplies common storage space for all workstations or clients (Martin, 1988: 41).

The type of network structure to choose depends on the connection requirements of the system that will be implemented. For an application which requires the software to be unified for all workstations, a server would be required. On the other hand, if the data connectivity of the computers is required, then a peer-to-peer structure would be convenient. Nevertheless, there is one advantage of using a server for all client machines. A malfunction in one connection does not affect the whole network as it would be in the case for a peer-to-peer connection.

Connectivity, centralized management of learners, control of software for piracy, and ease of updating or adding software are the main advantages of LANs, and of networks in general. On the other hand, the case of a file-server failure, cable damage and the requirement of daily system management, high initial costs are the main disadvantages.

3.6 Telecommunications and Internet

A major breakthrough has been accomplished by the networking of these local area networks using telephone lines and special telecommunication technologies such as satellite transmission. The new technology of worldwide connection of all suitable networks has been named as the now ever famous internet. This revolution in communications technology can be fitted in wider notions of communication era, globalization, McLuhan's global village and information age. Today, television programs no longer must be watched only when they are broadcast, they can be taped for later viewing. Telephone messages no longer require direct contact with the other person, instead, answering machines have become a way of life. A search for scholarly information does not require a trip to the library, as the electronic databases can provide access to all kinds of information at any time of the day. (Winders, 1988)

Apart from the possibility of accessing remote computers through this network, the main and initial feature of internet is the availability of e-mail, electronic mail or paperless mail. In simple terms, e-mail messages are created by one person on a computer monitor, stored in a computer and read by one or more other persons from other computer monitors. There are different possibilities for addressing an e-mail as it can be addressed to an individual, a group, or the members of an entire organization.

For a local system of e-mail, some certain requirements on the structure of the network exists. E-mail can be useful only when a group of people have their desktop computers linked together through a larger server, a local area network, or by modems through a bulletin board system or other distant computer network. As to maximum effectiveness, the computers that provide access to e-mail must be convenient. For instance, if a teacher has to wait in line for a computer, he or she will use e-mail less frequently. Furthermore, there should be a productive reason for the group members to communicate with each other. If these conditions are met, then the group can use e-mail to replace the standard paper process. (Barron and Orwig, 1993)

In many cases, electronic mail is more useful than traditional paper communications. For example, electronic mail can be distributed instantly and it can go through two or three rounds of discussion. At the same time, a solution can be found, before paper transmission could have been duplicated and delivered to its destination.

A well-known execution of this kind of network is the National Geographic Kids Network that enables student to use a computer "to record data and then share their findings via modem with research team mates throughout the United States, Canada, and other countries. (Vockell and Brown, 1988)

The bulletin board systems (BBS) of telecommunications is another handy way of sharing information and ideas. In a broad sense, it is a system that lets people read each other's messages and post new ones. This system is very much like its traditional counterpart. A good example is the Usenet system of newsgroups which is in effect the world's largest distributed BBS. (Levine and Young, 1994)

Generally, the BBS is about a specific topic and the announcements made, circulate around this theme. The popularity of electronic BBS systems generates from their capability to do many of the same things that traditional bulletin boards did and plus their capacity to serve a more widely distributed group of people. (LaQuey and Ryer, 1993)

When individuals use computers with modems to post public messages, others can read and react to those messages from almost any location that has a telephone line and a computer with a modem. Likewise, BBS on the internet is similar to the electronic bulletin boards that you can dial into using a modem. Most of these BBSs on the internet, offer menu services as well as others:

> "Some provide conferencing capabilities, while others provide "read-only" information, similar to regular bulletin boards at a library where information is tacked up for everyone to read and taken down when it's no longer relevant." (LaQuey and Ryer, 1993: 82)

There are basically two types of widely used BBS structures known as the Freenets and Campus-Wide Information Systems (CWIS). Freenets are community-based bulletin board systems with email, information services, interactive communications, and conferencing. Freenets are funded and operated by individuals and volunteers. The US BBSs are part of the National Public Telecommunication

Network. This is an organization based in Cleveland, Ohio, "devoted to making computer telecommunication and networking services as freely available as public libraries." (LaQuey and Ryer, 1993: 82)

The campus-wide information systems (CWIS) are appearing with a fast pace at universities and other types of institutions all over the world. Campus wide information systems are usually menu based and they provide campus specific information such as event calendars, phone and email directories, newsletters, guides, and other local information.

Although the initial usage of the BBSs were conducted mainly by the hobbyist who exchanged tips and techniques on a particular technical topic, today, they contain all kinds of topics including headings such as the discussion of feminist discourse and the problems of racist liberalism. Therefore, the potential use of BBSs for the teachers to exchange their ideas is quite high. (Levine and Young, 1994)

Several companies have specialized in school applications of telecommunications and have created curricular packages that implement a focus on a global education curriculum through national and international telecommunications. (Barron and Orwig, 1993) They are a couple of telephone companies whose interest is in this field. Examples are AT&T's Learning Network and GTE's World Classroom:

> "AT&T's Learning Network is designed to use telecommunications to link seven to nine classrooms together into a "learning circle." Depending upon the focus of the learning circle, the classrooms can be from different schools in the same city, or they can be located in a variety of states or nations…" (Barron and Orwig, 1993: 167)

GTE Education Services offer WORLD CLASSROOM, a telecommunications package with curriculum applications in science, social studies and language arts. (Vockell and Brown, 1992) This program has at least 30 conferences in such areas of interest. The conferences are electronic bulletin boards that allow students and teachers to share ideas internationally. (Barron and Orwig, 1993: 167)

The advances in telecommunications technology have introduced new terms in the field of education: distance education and collaborative learning. The most basic form of distance education is teleconferencing.

Teleconferencing is a generic term for meeting at a distance using electronic means. In the past, teleconferencing has been complex, difficult to administer, and expensive when compared with other techniques. However, with recent advances in technology there is more practical teleconferencing options for schools. (Winders, 1988)

Kaye (1992) classifies teleconferencing based on its being collaborative or not. When learning is based on a transmissive or "information-processing model of education, where main learning activity is the individual reception and organization of information from books, lectures, videos or computer-based training materials," it is not a collaborative learning, otherwise it is. He, further, continues to examine some of the issues and problems in (CMC) computer-mediated communication. (Kaye, 1992: 1)

Basically three different forms of teleconferencing can be classified according to their communicational capability. Audio teleconferencing is the most mature of these techniques. The audiographic teleconferencing allows the exchange of figures, chart and still pictures with the use of facsimile and computer technologies. On the other hand, video teleconferencing provides full motion video with audio and it is useful for situations that require the use of motion to enhance the course content. Nevertheless, all forms of teleconferencing require careful cost planning as the cost of telecommunication is still an important issue. (Barron and Orwig, 1993)

It should be emphasized that there are several educational applications of teleconferencing. The most widely used application is the use of a classroom guest speaker. This allows the classroom to take a lecture from a guest instructor who is normally unable to visit. Moreover, it is a vital opportunity for homebound students due to some illness or injury. (Soby, 1992)

The current usage of these listed technologies for education can be said to be overridden to some extent by the wide usage of the internet, and the flourishing medium of World Wide Web. With the communication medium of the internet, the unification of different media in the world wide web pages allows to imitate and join many of the above technologies in one.

4. INTERACTIVE BASIC DESIGN EDUCATION

4.1 Design and the Problem of New Technology

Merging the fields of design and technology together is very problematic indeed. Up to recent years, design has considered technology as something to be followed and to be used. On the other hand, there has been no serious attempt to merge design and technology. Due to a lack of definition of the design field in mathematical terms, the improvements related to design, converge to a point where they appear as useful tools to create designs with ease and faster. Today, schools in US are struggling to get grips in design and technology (D&T). "Putting across what D&T is about has been taking me years" says Anne Jones of Bradford LEA school. (qtd. in Gardner, 1995: 35)

The challenge faced in design reflects a problem within art and design education over how to incorporate and deal with the new technology. For example Kitson (1991: 73) suggests that an increasing gap is developing between what is actually taught in design schools and "the expertise required of those pioneering and practising in the design industry." Apart from cost and expertise, there might be several reasons for this situation. A dominant one is the subconscious fear and dislike of new technology which worries the designers so much. It is a most pervasive and difficult task to fight this fear.

Consequently, the design education reflects this fear and is "generally more comfortable with craft tradition than a 'high tech' one...and we see a treat to the former from the latter which may or may not be justified" (Jones, 1994: 39). For a long time, technology has been seen as the traditional tools which has helped the designers create their product. Such tools have evolved over many years to fit their function. While issuing this function, they have taken on a bigger role and they have started to "symbolise the activity they enabled." (Wiezenbaum, 1984: 75) In accordance with this, designers have very much confidence in these tools and consider new and unfamiliar tools, such as the computers, as a threat.

Artists and designers use computers, most commonly, to do what they have always done and they measure these new tools against the old ones using their old criteria. Nevertheless, a transitional period exists, which Baker (1993: 78) points out as "we are still in a transitional phase in the development of a computer aesthetic similar to that in the development of motor car when it was still seen as 'horseless carriage'." We are only just beginning to see the computer as a new medium, and when this happens, it will lead to completely new kinds of activity.

Furthermore, such fears emphasize the fact that many artists and designers feel that the computer should only be used for boring and repetitive tasks and that it can not be used creatively. Many feel that its use has a strongly negative effect on creativity. Similarly, Chapman (1995: 66) points out that "it is true that the results of computer art and design so far have been of very mixed quality, but this is inevitable at this early stage in the use of a new medium." In fact, there is no fundamental problem with the computer's imaginative use and its creative power is undeniable.

4.2 Basic Design Education: A brief Overview

It would not be wrong to say that the subject of Basic Design is 'Visual Literacy.' The term 'Visual Literacy' has been in use since about 1970. It has arisen from the proliferation of visual communications, namely television, electrographic printing, and computer technology. Yet, as a concept, visual literacy is "applicable to all forms and media of visual expression" (Deborah, 1987: 1).

Thus, the processes of Basic Design is based on seeing. Seeing is a multidimensional process, and its main characteristic is its being simultaneous. Each function about seeing is linked to a process and to circumstances. Sight offers us method options for information retrieval, as well as options that coexist and are available and operative at the same time:

> "The results are astonishing, no matter how conditioned we may be to take them for granted. With the speed of light, visual intelligence delivers multiple bits of information, simultaneously serving as a dynamic channel for communication and a still hardly recognized aid to education. Is this the reason visually active seem to learn better?" (Dondis, 1988: 18)

Another statement of the subject of the basic education can be that it is the education of a visual intelligence. The current exposition of eyes to the visual medium assert different conditions for visual thinking, and "the camera, the cinema, television, EVR video cartridges, and video tape, and visual media, not yet in currency, modify our definition not only of education but also of intelligence itself" (Dondis, 1988: 20).

In contrast to visual literacy we have the verbal literacy, that is the ability to read and write a language where no distinction is made as to the typographic font, format, or method used for the act of verbal communication with the written word, whereas the concept of visual literacy is the ability to understand (read) a variety of visual examples, such as painting, sculpture, film and architecture, and also the ability to express oneself with at least one visual medium. Therefore, visual literacy is relevant to all visual arts and design disciplines (Deborah, 1987).

In the content of Basic Design, there are several unit structures defined that cover the visual space. Although the list is not exhaustive, Dondis (1988) lists the most basic set of these visual literacy units as the dot, line, shape, tone, color, texture, scale or proportion, dimension and motion. It is further stated that these are the visual elements from which we draw the raw material of all levels of visual intelligence and from which all varieties of visual statements and objects, environments, experiences are planned and expressed.

The current graphic technology has evolved so that it copes with these basic elements profoundly, and therefore computers are widely used in creating design. This effects the content of basic design towards technology related terms. The advent of the computer has not only revolutionized our ways of information processing, but also provided new methods for design creation:

> "As the computer is primarily a "number crunching" machine, it is particularly suitable for producing configurations of strict mathematical order. With the rapid development of many graphic programs and related peripherals in recent years, the computer is now capable of accomplishing with great efficiency most of

> the design work that is normally done with pencil, pen, and brush. Thus it opens new horizons." (Wong, 1993: 4)

Although, the computer and the new media of telecommunications presents itself as tools to the basic design field, this might as well be a naive argument, as each new coming technology changes the field itself. The new technology of computers competes with the older ones such as the printed word and image. The competition is for time, for attention, for money, for prestige, but mostly for dominance of their world-view. The new technology of computers adds to the design field a new world-view which is oriented towards communication. The competition of the technologies is implicit once we acknowledge that a design medium contains an ideological basis:

> "And it is a fierce competition, as only ideological competitions can be. It is not merely a matter of tool against tool - the alphabet attacking ideographic writing, the printing press attacking the illuminated manuscript, the photograph attacking the art of painting, television attacking the printed word. When media make war against each other, it is a case of world-view in collision." (Postman, 1993: 16)

Some elements in the nature of the design field changes due to the ideological attacks of the new technologies. However, the design process has some rigid rules that are not effected by this change. In order to understand the concerns of design and to think of these in the context of the new technologies, a discussion of the design process and the definition of the designer's place with respect to technology is important.

Design is a process. At the beginning of the design process, all things seem possible to the designer. There are only a few limitations on what might be sketched, on what might form a beginning. The beginning is a first explicit idea. This is what makes design difficult and exciting at the same time. However, at the end, there is only one final design. In the intermediate steps, the designer produces some ill-defined problems, which then are hoped to turn into well-defined ones, to produce the final product and to reach the single solution. Thus, the ideas are transformed into objects. (Taylor, 1989)

Therefore, the process lies in between the point where everything is possible and the point where there is only one solution: "The beginning is all things; the end is one thing" (T263 Course Team, 1993: 92)

Usually the design process starts with a brief. This brief can be in different modes and formats, such as a bureaucratic one and with some initial sketches. From the brief the design is produced, from which the artifact emerges. In this context, the design activity oscillates between the management and the manufacture. (T263 Course Team, 1993)

Besides these attributes, the design involves another important element, and it is the message purpose. Dondis (1988: 17) defines the message purpose of the design as "response to the character of what is being designed."

In order to achieve this purpose the design uses several dualities. These dualities serve as the vocabulary of visual literacy. Dondis (1988) lists these dualities existing in a design as follows: instability and balance, asymmetry and symmetry, irregularity and regularity, complexity and simplicity, fragmentation and unity, intricacy and economy, exaggeration and understatement, spontaneity and predictability, activeness and stasis, boldness and subtlety, accent and neutrality, transparency and opacity, variation and consistency, distortion and accuracy, depth and flatness, juxtaposition and singularity, randomness and sequentiality, sharpness and diffusion, episodicity and repetition. The list is inexhaustible, but these can be stated as the most frequent ones. They form the basic set of visual literacy and they exist in both contrast and harmony.

4.3 Potentials for Basic Design Education

Today many of the technologies presented in the technological possibilities chapter exist in many universities and design schools. These new technologies include CD-ROM drives, audio technology, and possibilities for creating hypermedia and multimedia applications. However, the number of educational applications created for design education is quite low. There are several reasons for this. A basic reason is the fear of the designers and consequently the educators to merge with these new technologies. Others may be related to the nature and content of basic design learning materials.

Nevertheless, new educational applications for basic design are emerging. Personal computers with interactive color graphic capabilities are valuable tools for studying basic concepts in design and color theory. Students can explore basic design concepts by creating a wide range of combinations and permutations of an idea on the computer screen.

For example, in studying color theory, the relativity of color can be studied extensively with the color-changing capabilities of computers. "Computer graphics systems expand the scope of the educational process, stimulating new methods for creating images. These systems complement existing media but do not replace them." (Truckenbrod, 1988: 164)

An example of studying color theory will be presented to show what can be done. This example suits the merging of the fields notion of computerized education and design. It is the Interaction of Color: Interactive CD-ROM edition. This is a multimedia application based on the book by Josef Albers, Interaction of Color. The aim of the application is to open up new possibilities for color exploration and to make the process of re-examining color an exciting experience. (Albers, 1995) The book contains information about color and gives explanation of color and the conditions under which certain optical phenomena occur. The CD-ROM edition of the book contains same teaching material present in the book, but also adds some interactive studies of the material presented in the text of the book. There are several additional features such as annotating the studies as well as the text and quick access to any segment of the whole material, which are common features of a multimedia application.

Obviously, this example provides a very valuable and a new compact form for teaching the rules of light, which is a basic subject of design. Although the subject is quite convenient to transform into computerized education, the reason that other subjects of design are not transformed to electronic media for education cannot be their inconvenience or some kind of impossibility.

When design education is taken in the context of the development of auto-instructional materials (presented in the second chapter), it is obvious that the capabilities of computer applications presented in the initial stages were not convenient for design education. These first applications which depend heavily on text due to the lack of graphics systems, could be valuable only for presenting the text of learning material.

The linear programming and branching programming stages of the development of educational material in computers do not suit the needs of design education. It could well be asserted that a level of interactivity higher than just detecting if an answer to a question is right or wrong, is required. Therefore, the poor development of auto-instructional materials for design education at these initial stages, is quite understandable.

The subjects of design education are somewhat problematic for computerized education. They certainly do not suit the logics of generative programming, as generative programming requires a strict mathematical definition of the learning material. A mathematical definition of contrast between two shapes, or of the tension in a design, requires a good degree of visual intelligence similar to human cognitive system. The implementation of an algorithmic system with visual intelligence has not yet been accomplished. The field of artificial intelligence that deals with such a problem is called 'Cognitive Simulation' and regarding the work in this field Dreyfus states that:

> "Ironically, research in Cognitive Simulation is a perfect example of so-called intelligent behavior which proceeds like the unaided GPS [General Problem Solver]. Here one finds the kind of tinkering and *ad hoc* patchwork characteristic of a fascination with the surface structure - a sort of tree-climbing with one's eyes on moon. Perhaps it is just because the field provides no example of insight that some people in Cognitive Simulation have mistaken the operation of GPS for intelligent behavior." (Dreyfus, 1994: 120)

The naive attitude of AI (artificial intelligence) researchers towards the Cognitive Simulation field, and towards the definition of an intelligent behaviour has some misleading effects. The common optimistic attitude towards AI may cause others to believe that a plausible way of generating correct responses using computers for the evaluation of a design, can be accomplished. On the contrary, Dreyfus (1994), in the "Assumptions Underlying Persistent Optimism" chapter of his book What Computers Still Can't Do, perfectly demonstrates that this optimism will stay as just an optimism for the next decades. Furthermore, Postman criticizes Papert, the creator of the LOGO language for such a false optimism, and gives a fair judgment about over estimating the role of computer in education:

> "Seymour Papert, for example, wishes students to be epistemologists, to think critically, and to learn how to create knowledge. In his book *Mindstorms*, he gives the impression that his computer program known as LOGO now makes this possible. But good teachers have been doing this for centuries without the benefit of LOGO. I do not say that LOGO, when used properly by a skilled teacher, will not help, but I doubt that it can do better than pencil and paper, or speech itself, when used properly by a skilled teacher." (Postman, 1993: 120)

Consequently, an attempt to produce generative Computer Assisted Instruction systems for basic design education, has not yet found its justification. The nature and the process of design does not suit the properties of generative CAI applications.

Due to its nature, the design process cannot be reduced to algorithmic steps, as it is required for the generation of a solution for a design problem using computers. The problem is not yet defined at the initial steps of design. The designers define their own problems to produce designs. Afterwards, these problems are transformed into problems that can have realizable solutions. As the computers require such problems to generate solutions at their present state of the art, it is at this point where they can be useful.

At this stage, a discussion of the applicability of huge government sponsored projects for computerized design education could be made. Although they were very structural in nature, the results of TICCIT and PLATO projects show that students favor computer assisted instruction systems.

The content of these projects included learning material mainly for English composition and mathematics. These are fields for which an agreement for the teaching strategy can be reached by the instructors, whereas, for the design education, it might not be the case. Often, the teaching strategy changes from instructor to instructor. This is one of the problems of developing such huge projects for design education.

The evaluation of the TICCIT project showed that although the students had very low completion rates for the overall project, one positive response was the general interest in the 'PRACTICE' option. This shows that students value computer assisted instruction more as a practicing environment than a tutor. The reason might be that they do not like to be instructed by a machine. Although, this is an observation specifically for the TICCIT project, it is a valuable information for deciding about the nature of a design related application. Such an application should not aim at teaching how to design, but it should provide a joyful and simple environment to practice design.

The current tools for image processing and illustration are very complicated for the novice user. The students who take design classes in their first year are often not familiar with these applications and the computer itself. Therefore, when they try to create designs using these tools, they are often lost in the options that these tools provide. This might have a negative effect on the student as Postman explains with his notion of 'technopoly':

> "Technological immodesty is always an acute danger in Technopoly, which encourages it. Technopoly also encourages insensitivity to what skills may be lost in the acquisition of new ones. It is important to remember what can be done without computers, and it is also important to remind ourselves of what may be lost when we do use them." (Postman, 1993: 120)

The result of this argument and the evaluation of the TICCIT project shows that an application that tries to help the education of design in a computerized medium, should first rescue the students from the vast possibilities of the illustration and paint tools, and allow the students to practice designs without getting involved in the job of learning the features of a tool.

Consequently, the properties of a proper basic design education application can be reached at by considering the above depiction about merging technology and design education. The basic design education application should provide only the necessary tools when creating designs. Furthermore, its main purpose should be providing a medium for the practice of design. Moreover, for the purpose of creating an electronic communication medium, it should provide the required tools of networking and telecommunications.

Towards this end, a demonstration application is conducted for the FA101 basic design class, in the Graphic Design department of Bilkent University, Faculty of Art, Design and Architecture. The next chapter gives detailed information about this application.

CHAPTER 5

5. IMPLEMENTATION: FA101 BASIC DESIGN INTERACTIVE PROGRAM

5.1 General Description of the program

The main aim of this demonstration application is to provide an example on the basis of the arguments presented in the content of this thesis. The application platform of the program is Macromedia Director which is a powerful authoring tool for multimedia and the internet. A brief explanation of features and capabilities of this application can be found in appendix. The application is based on the projects and implementation of the FA101 Basic Design course executed in the Graphic Design department of Bilkent University, Faculty of Art, Design and Architecture.

The title sequence contains an animation that ends up with an entry point to the main program (Figure 1).

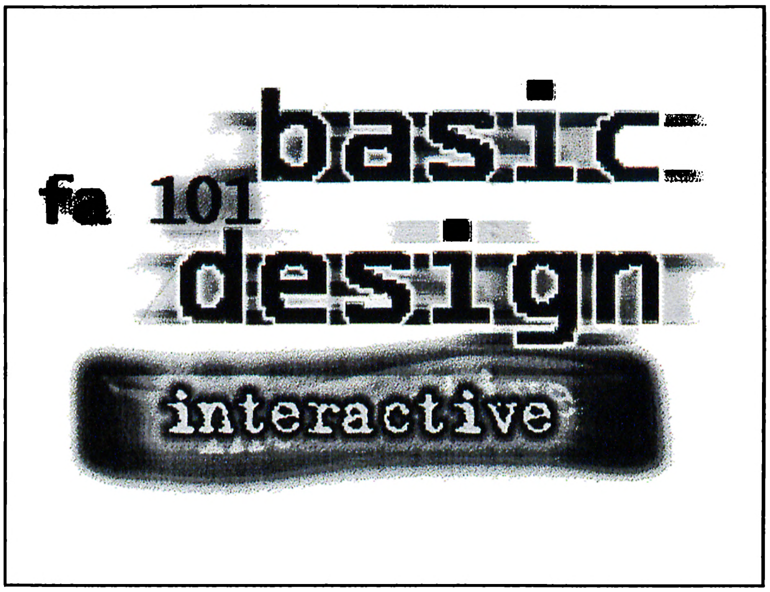

Figure 1

The system has inherent, hard-coded database of possible users and their passwords. This database is selected from the existing class of FA101 Basic Design course. The users can either login as students or instructors. Therefore, the system first asks the user to differentiate between the instructors and the students.

The first screen that the student comes up with is the project selector. The student selects a project and saves it for the viewing of the instructors. There are ten projects selected from the project set of the FA101 Basic Design class as they are suitable for the medium. Each student has an assigned current project number, and the system does not allow the student to select a project higher than the current project number. Whereas, working on a previous project is allowed with a permission of a 'redo' from one of the instructors.

The instructor can choose to look at the projects in two different forms: either by selecting a project and viewing the saved work for that project or by selecting a student and viewing the projects that particular student has saved. The instructor has two options when checking a project: giving a comment on the project in text form, and making the student either pass or continue the current project.

The system functions also as a local communication network, as the instructors can view each others comments and exchange information with each other. This feature allows the users to post comments that are related to the class in general.

The next section gives information on the usage of the application with screenshots from the working application.

5.2 A brief user guide

This section gives necessary details for the usage of the implementation of the FA101 Interactive Basic Design program.

After the title sequence, the user comes across a screen for the differentiation of the students and the instructors (Figure 2).

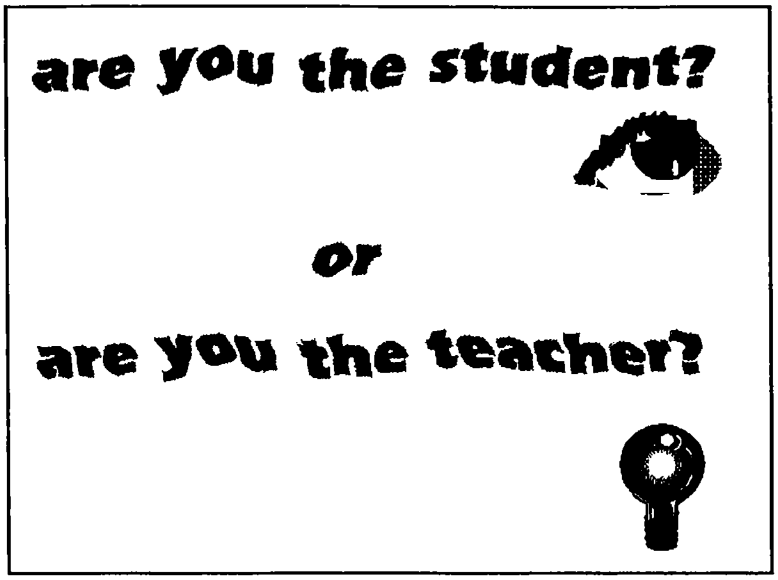

Figure 2

The user has to click either the lamp icon or the eye icon, where the lamp icon stands for the instructor and the eye icon stands for the student.

When the student icon is selected the project selector screen shows up (Figure 3).

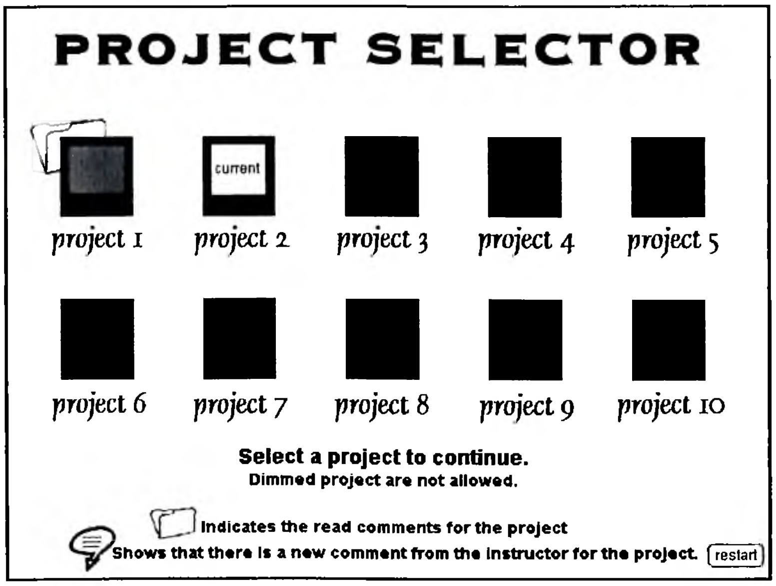

Figure 3

The project selector frame has some variable parameters. One of these is the current project number that the particular student is currently at. This current project number is implied with the current project box icon. The projects that are not allowed are dimmed, and the previously completed projects are light gray. The student can go to the previously completed projects. The frame for the first project is shown in Figure 4.

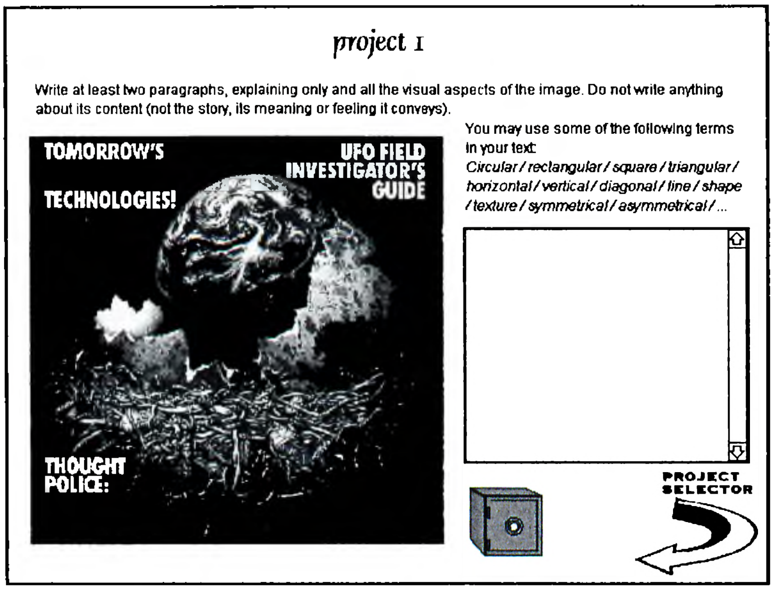

Figure 4

This is a sample project where the student is required to give the appropriate text solution. The safe icon is present in all project frames, and allows the student to post his/her project. However, the student can post the project only once. A redo permission is required for a second time posting of the project to the system.

Additionally, the project selector screen has two hotspots to allow the students to read the comments posted by the instructors. The balloon icon refers to the new comments which the student have not read yet and the folder icon refers to the previously read comments. The comment reading frame is shown in Figure 5.

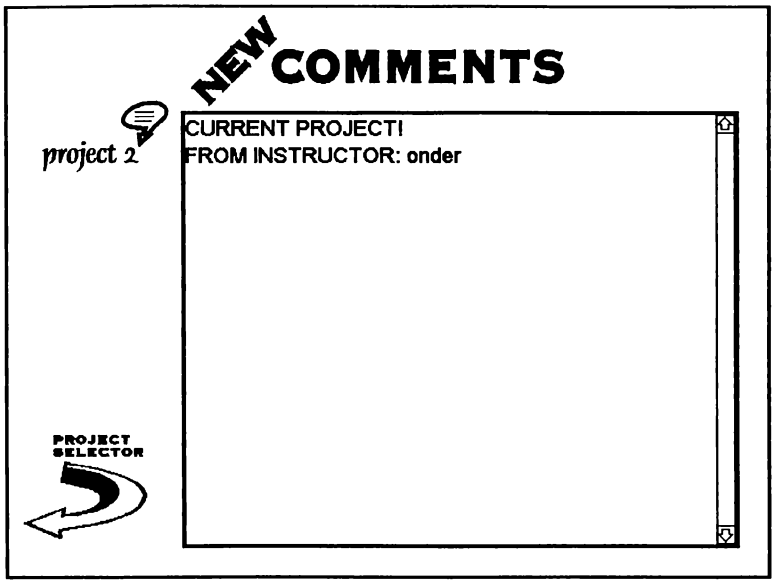

Figure 5

The frame for the previously read comments looks similar. The comment frames let the student see comments from instructors attached with the instructor name, as a list.

Furthermore, the system allows for projects that are in visual format. The following frame shows the second project where the student has to construct an orderly design using identical shapes (Figure 6).

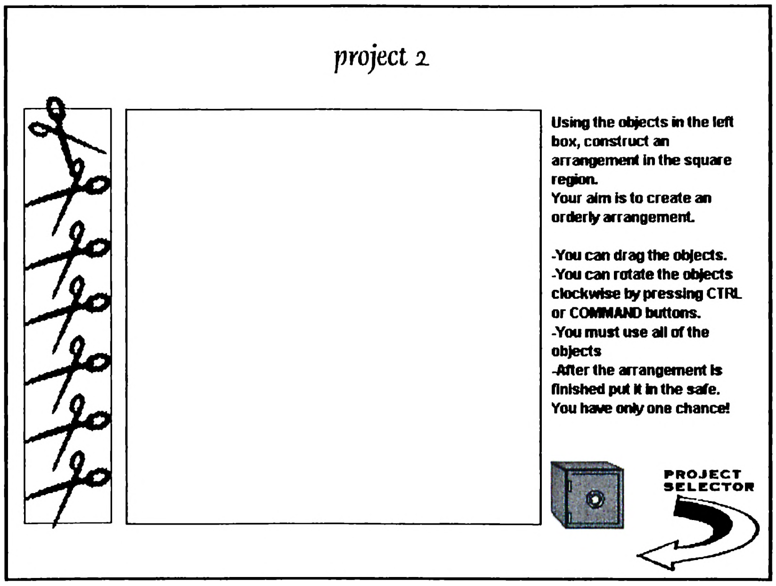

Figure 6

Visual projects allow the students to drag and drop objects to the design frame and the rotation of the objects by pressing CTRL key for windows environment and COMMAND key for Machintosh environment. As before, the project is posted by pressing the safe icon.

If the user is an instructor, after correctly entering name and password, the student or project selector frame appears (Figure 7).

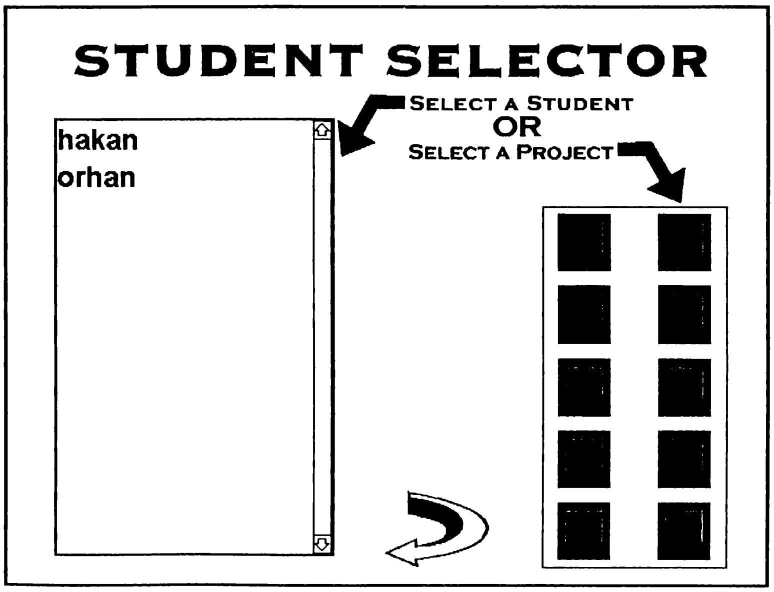

Figure 7

This frame allows the instructor to view the posted projects in two different selection criteria. One is the selection of students that completed a particular project, and the other is the selection of projects that a particular student has completed. The selector on the left side gives a list of students that have completed at least one project. The selector on the right side gives a list of all available projects. When the instructor selects a student, another frame for the selection of the submitted projects appears (Figure 8).

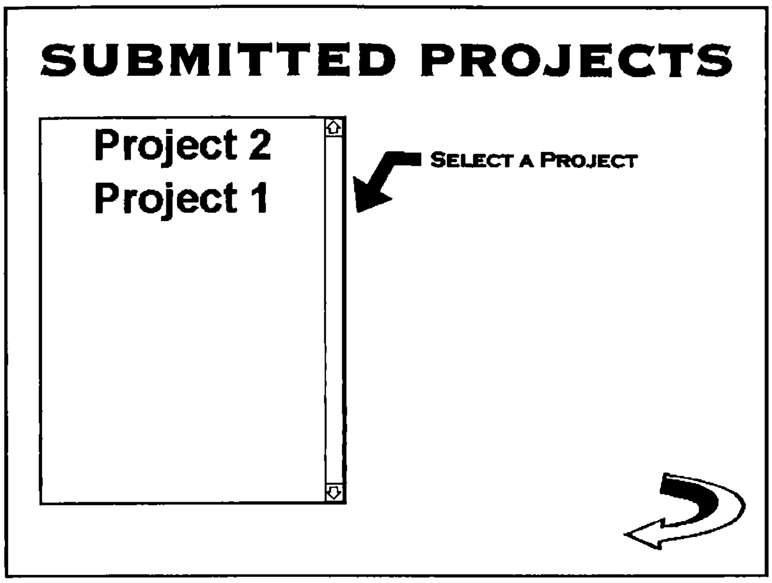

Figure 8

This frame allows the instructor to select a project that the student has submitted. The list includes only the projects with a submission. After the selection, the project frame for the instructor appears (Figure 9).

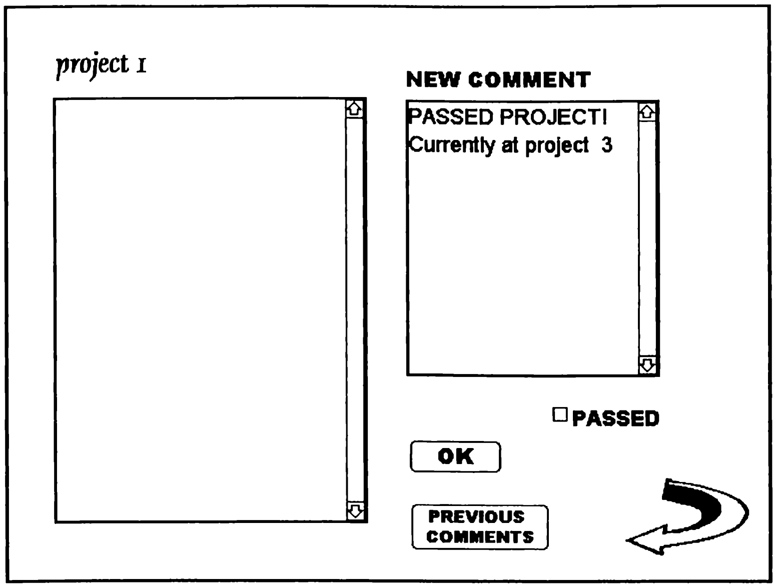

Figure 9

This is an example frame that shows a text based project displayed for the instructor's evaluation. The instructor can see what the student has typed as text in the big box, and can write the required comments on the smaller one. The 'OK' button lets the system accept the posted comment. The passed checkbox allows the instructor to either make the student pass the project of fail. The previous comments button is a link to a frame which lists all the previous comments posted for the specific project and student (Figure 10).

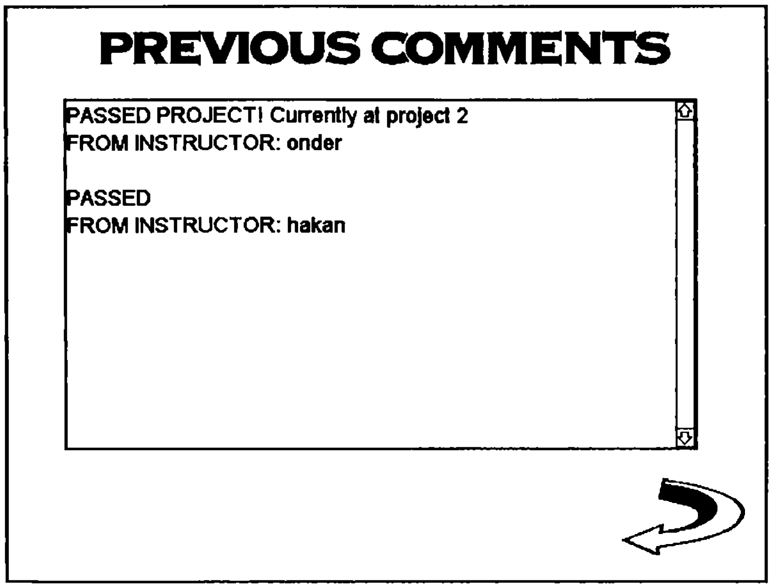

Figure 10

The projects that have some visual elements are generated again for the comments of the instructor. The instructor evaluates the design that the student have made and posts his or her comment accordingly (Figure 11).

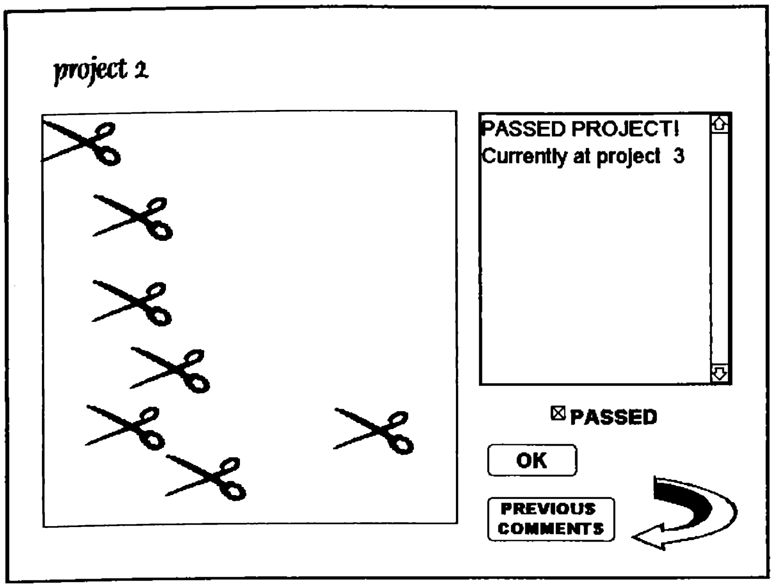

Figure 11

The instructor has the same options as in the previous case of viewing a text based project. Although the graphic objects are movable by the instructor, yet, there is no option to post a corrected design to send to the student. The next section explains possible ways of improving the application in such and related ways.

5.3 Possible further improvements: Project writer module and Expert Systems

This section investigates further improvements on the FA101 Interactive Basic Design demonstration application. These improvements include the ability to exchange visual designs in a particular format between users, ability to save designs locally, network support, the project writer module and the use of expert systems to evaluate designs.

The ability to exchange visual designs between users is quite important. The instructor should be able to post a better design attached with the comment he or she gives, or a student should be able to send the solution to a particular project to another student.

Nevertheless, this is not so easy to implement, as this would require much higher amount of data exchange, and a better database system. At the time of writing this thesis, the highest version of the Macromedia Director is version 4.0 and it does not support such database structures. The next version, Director 5.0, has a database management system called FileFlex incorporated with it. (Macromedia, 1996) This database module allows fast and easy manipulation of databases within Director.

Another requirement for the implementation of such an exchange system is the formulation of a unique format for designs. The users would want to change the designs, further than one step. Therefore, it should be an object based structure. Existing drawing formats such as postscript could be used, but it is not guaranteed that it will give better results with bitmap elements.

Apart from this local graphical exchange system, it is very desirable to have network support in a better version of the implementation. This would allow the students to make use of various information resources through internet, while doing their project. Moreover, it would allow the instructors to refer to a particular topic related to the design, as an URL (Universal Resource Locator) link, in the definition of a specific project. Furthermore, the internet email system could be used inside the implementation to exchange information.

In order to have these features, the implementation should work on a world wide web page, inside an html document.

Macromedia supports such a transformation through a feature called Afterburner (Macromedia, 1996). Afterburner allows Director designers to transform their multimedia publication directly to world wide web pages, and adds additional functionality of URL referencing inside Director. In order to display this page, the world wide web browser needs an extension called a plug-in. The corresponding plug-in for displaying Director movies inside the world wide web pages, is called the Shockwave plug-in. Nevertheless, this improvement is yet to be investigated in order to successfully incorporate it in the current application.

A further improvement would be the chance of saving designs on local machines. The students would want to save what they have produced on their discs. Unfortunately, this feature needs further investigation of Director, as normally it does not allow file saving. One possible way of implementing this is to use a feature of Director called X-objects. X-objects refers to usage of user-defined and implemented functions in Director, but this disables the transformation of the application to web pages. This problem can be solved by using next generation software that will be provided in future.

The most beneficial improvement, in terms of adaptivity, is to create a project writing module for the use of instructors. This would be a module that generates project frames in a particular format for the use of the instructor. Thereon, the application can be modified to accept these as student projects. Since, instructors are not supposed to have any programming background, it would be a convenient way of by-passing technical support people who program what the instructor needs as new projects.

Basically and at first, a definition of the format of project is required for the implementation of such a module. This format should consist of definition of what can be in a project, such as images, movable items, texts. Thus, the project information can be saved for the use of the main program.

The use of expert systems for the pre-evaluation of the student projects, might be another way of extending the abilities of the application. This would mean an intelligence on the visual level for the application. Such an artificial intelligence for cognition is very hard to implement. Nevertheless, if such an understanding can be accomplished, it can give some comments to the student or the instructor about the specific project, before the evaluation of the instructor.

An exemplary problem is to differentiate between an orderly arrangement of visual items and a design which does not contain order. Dreyfus' (1994) work What Computers Still Can't Do gives very valuable information about the current state of artificial intelligence and expert systems and its future projections. The conclusion of the particular topic on cognitive intelligence states that the computers are still in a very premature level to recognize visual structure. Dreyfus quotes from Greenwood: "From this brief summary of the state of the art of artificial intelligence, one would conclude that little significant progress has been made since about 1960 and the prospects for the near future are not bright." (Dreyfus, 1994: 151)

CHAPTER 6

CONCLUSION

The challenge faced in design and design education stems from the problem of incorporating and dealing with the new technology. There is an increasing gap between what is actually though in design schools and the expertise required in the design industry. The reason depends on the fact that design education has not yet projected its interests to the new technologies.

As it is discussed within this thesis, the development of auto-instructional materials or computer assisted instruction applications have not merged with the design education field. Therein, basically, two reasons for this inconvenience related to both areas are depicted. Design educators carry a certain fear and dislike for the new technologies for education and they are generally more comfortable with craft tradition than a high-tech one. On the other hand, the developers of new technology are not familiar with the design field. As the attack from the new technologies to the design education implies an avalanche point where the latter is the buried victim, there is a certain urgency to fill this gap between new technologies and design education.

In order to find a way for incorporating computers in design education, the historical background of the relation between computers and education has been investigated. Thereby, this investigation shows that the students grant the computers for the possibility of practice and joy. Furthermore, the usage of computers for creating visually intelligent applications is presently impossible and seems to stay this way for the near future. After taking all these points into consideration, it can be asserted that computers are obvious means of communication and design practice tools which would provide efficiency in design education.

Moreover, in order to produce efficient design education tools, the essence of technology for education and the possibilities of technology should be considered as vital elements. Within this respect, the problem of having instructors getting acquainted with technology, is seized to point out the inability of the education field to merge with technology. In accordance with this, it is stated that the necessary information about the relevant technology for education, should be a new concern of the design educator.

Although, technology supplies the contemporary tools for the creations of designs, it also creates a boundary with the vast number of options it generates. Thus, a computer application that relates to design education should rescue the students from the vast possibilities of computer imaging and design tools.

Such an attempt has to keep away from technological immodesty, as it creates an acute danger of losing previously attained skills. In order to use computers efficiently in design education, it is important to remember what can be done without computers, and what may be lost when we use computers. Therefore, a thin borderline exists between an efficient use of the computers and a restricting one.

Apart from the use of computers for creating designs, the possibilities they have created for communication cannot be overlooked by the design education field. The telecommunication technology should be used to exchange visual information in the design education application extensively.

For the purpose of demonstrating an attempt of creating such an efficient multimedia application for design education, the FA101 Interactive Basic Design application has been developed. The above conclusions on the role and properties of such an application, have been tried to be incorporated in this application.

The aim in developing such an application was to provide the students a computerized medium for practicing the actual projects of the FA101 Basic Design course, and also to produce an electronic medium for communication, incorporated within the application. The application is yet in a premature state, as it lacks an authoring tool, and support for network. Nevertheless, it provides a good starting point for the purpose of developing a working system of computerized basic design education.

APPENDIX

1. Director and Lingo

The implementation is performed with the Macromedia Director. The latest release during the time of this thesis is version 5.0, but version 4.0 is used in the implementation. Director is a powerful authoring tool for multimedia and internet. Many of the recent multimedia publications use Director as their authoring tool.

Director uses each multimedia element, such as audio, image, MIDI music and special scripts as casts, and these casts can be put in the score windows for repeated use, after which they are named as sprites. The score line consists of consecutive frames, which can contain several sprites on top of each other, and some additional special information for different behaviour, like the sound, palette information, tempo, and the lingo script.

The power of Director depends on its scripting capabilities with Lingo. Lingo is system independent language to control every property of the cast members and their behaviour as sprites. Furthermore, it can except external functions to control additional devices with vendor support for a Lingo X-object library. It is basically a simple language, mainly composed of special functions that control and manipulate special attributes of the timing, the movement of sprites, sound, object creation, palette manipulation, text, movies. It has a Basic-like syntax of commands for flow-control.

Further information on examples of multimedia applications created with Director, and the features available in

Macromedia Director can be found on the internet web page (Macromedia Kudos, 1996).

2. The database structure for the interactive FA101 Basic Design Application

The macromedia director does not support complex database structures. Nevertheless, due to its developed features related to interactivity and the possibility of transferring the work to the internet pages through this platform, it is more suitable than other multimedia publishing tools. Furthermore, the Lingo scripting language of the Director allows one to construct a simple text based database with simple search and replace commands allowed on the text blocks (casts). An explanation of the necessary database follows.

First there should be a database of every student. This database contains information about which project is the current one for the selected students. The student and instructor names are strict. They are defined for the selected FA101 class, and they are defined at start for once. This information is contained in the movie script of the Director movie, and one needs Director to change this data. The movie scripts is reached by pressing command-shift-u together. Then the resulting lingo script appears as:

```
on init
  global students, teachers,stu_passwords,
tea_passwords, currentproj, currentcomment
  global studentselected
  set students to list("hakan", "orhan")
  set stu_passwords to list("xxx","xxx")
  set teachers to list("hakan", "onder")
  set tea_passwords to list("xxx","xxx")
  set the text of cast "name" to "name"
  set the text of cast "password" to "password"
  set the textSize of field "password" to 2
  set the text of cast "password" to ""
end
```

This is the initialization script of the movie script and the commands *set students to list("hakan", "orhan")* and set *stu_passwords to list("xxx","xxx")* define the names and passwords of the students defined in the application, where as the commands *set teachers to list("hakan", "onder")* and *set tea_passwords to list("xxx","xxx")* define the names and passwords of the teachers registered. In order to change the teacher and student set, one has to change the names and passwords in these lists.

The student database has a list of the projects. This list indicates which projects have comments attached to them and from which instructor.

The structure of this list is as follows:

```
Student:
      Current project number.

      Project1:   Comment 1* - instructor name
                  Comment 2 - instructor name
                  Comment 3 - instructor name
                  ...
                  Comment n - instructor name.

      Project2:   Comment 1 - instructor name
                  Comment 2 - instructor name
                  Comment 3 - instructor name
                  ...
                  Comment n - instructor name

      End marker
```

*Each comment should contain a comment start marker and a comment end marker.

A sample database could look like this:

```
          Hakan
               5

               3
                    [You have not done enough research]
                                                  Hakan
                    [Look more in the text for details]
                                                  Ahmet
               ^   {End marker}

               5    [Where is the order in this design?]

                                                  Hakan
               ^   {End marker}

        *    {End marker}
```

The first thing to do when entering the project selector is to match the current student name with the correct comment block in the database and then to get the number of the current project. As a duplicate of the student name can be found in the instructor names, the criteria for finding the correct start position should be that the name should either be found at the beginning of the field or after some end marker.

After finding the current project for that student, the projects which have comment, should be compiled. This is easy as a number before the end marker indicates that there is a comment for that project and this is the number of the project which have comment in it.

Another text database is the projects database which contains the information of the projects saved by the students. The structure of the database is constructed as:

```
Student1:
      Project number
            Project Data
      End Marker
      Project number
            Project Data
      End Marker
End Student Marker
Student2:
      Project number
            Project Data
      End Marker
      Project number
            Project Data
      End Marker
End Student Marker
End Marker
```

The end markers are needed to differentiate between the project data and the sections starts and ends. Therefore, the projects should not contain any of these markers. In the application the project end marker is '^', student projects end marker is '*' and the end marker is '**'. This last marker is used as Lingo does not allow to check for end of the text body of casts. An example database looks like this:

```
hakan
      2
            132 110 0 176 174 0 175 246 0 207 303 0
            169 351 0 378 356 0 237 395 0
      ^
      1
            There is a circular structure in the
            middle of the picture
      ^
*
orhan
      2
            164 137 3 271 181 1 171 235 1 330 267 1
            229 315 1 147 350 1 327 389 1
      ^
      1
            The design looks symmetrical.
      ^
*
**
```

Obviously, the project information contains either text information or numerical data. The numerical data in the example are the coordinates and the rotation values for a sample student design for the second project.

This concludes the explanation of the database structure. One remark would be that for the implementation of the project writer module extension, a new strict definition of the project data would be required so that a mechanism for differentiating between text, images and movable objects in the project data can be made.

REFERENCES

Albers, Joseph. Interaction of Color: Interactive CD-ROM edition. New Haven: Yale University Press, 1995.

Barron, E. Ann and W. Gary Orwig. New Technologies for Education. Englewood: Libraries Unlimited Inc., 1993.

Chapman, Gill. "Computer Aided Design in Industrial Design Education" Journal of Art and Design Education. 14.1 (1995):65

Cotton, Bob and Richard Oliver. The Cyberspace Lexicon: an Illustrated Dictionary of Terms from Multimedia to Virtual Reality. London: Phaidon Press Ltd., 1994.

Curtiss, Deborah. Introduction to Visual Literacy. Englewood Cliffs NJ: Prentice-Hall, 1987.

Dunn, Seamus and Valerie Morgan. The Impact of Computer on Education. Englewood Cliffs NJ: Prentice/Hall International, 1987.

Dondis, A. Donis. A Primer of Visual Literacy. Cambridge MA: MIT Press, 1988.

Dreyfus, L. Hubert. What Computers Still Can't Do. Cambridge MA: MIT Press, 1994.

Gardner, Carl. "Child's Play" Design. (Summer 1995). 35.

Goldstein, Ronnie and Janet Ainley. Making Logo Work: A Guide for Teachers. London: Basil Blackwell Ltd., 1988.

Goodman, Cynthia. Digital Visions: Computers and Art. New York: Abrams Incorporated, 1987.

Hooper, Richard. "The Computer as a Medium for Distance Education" World Yearbook of Education: Computers and Education. Ed. Jacquette Megarry. New York: London/Nichols Publishing Company, 1983. 103-109.

Jones, Anthony. "Design Education" Design., (May 1994). 38.

Kaye, Anthony. "Learning Together Apart" Collaborative Learning Through Computer Conferencing. Ed. Anthony Kaye. Berlin: Springer-Verlag, 1992, 1-25.

Kitson, Micheal "Computer Graphics in Art and Design Education: the Problem of Planning for Change" Leonardo., 24.5(1991): 73.

Laurel, Brenda. Computers as Theatre. Los Angeles CA: Addison-Wesley, 1991.

Levine, R. John and Young, Margaret. More Internet for Dummies. Chicago: IDG Books, 1994.

Macromedia. "Macromedia Director: Key Features" http://www.macromedia.com/key.html (25 Apr. 1996)

Macromedia Kudos. "Macromedia Director: Kudos" http://www.macromedia.com/kudos.html (25 Apr. 1996)

Martin, James. Data Communication Technology. New Jersey: Prentice Hall, 1988.

Mayes, J. Terry. "The 'M-Word': Multimedia Interfaces and Their Role in Interactive Learning Systems". Multimedia Interface Design in Education. Ed. Alistair D. N. Edwards and Simon Holland. Berlin: Springer-Verlag, 1994. 23-42.

Merill, F. Paul and N. Marvin Tolman. Computers in Education. Englewood Cliffs NJ: Prentice Hall, 1986.

Minoli, Daniel. 1st and 2nd and Next Generation LANs. New York: McGraw-Hill Inc., 1994.

Nievergelt, Jay and Andrea Ventura and Hans Hinterberger. Interactive Computer Programs for Education: Philosophy, Techniques and Examples. Reading MA: Addison-Wesley Publishing Company, 1986.

O'Shea, Tim and John Self. Learning and Teaching with Computers: Artificial Intelligence in Education. Sussex: The Harvester Press Limited, 1988.

Postman, Neil. Technopoly: The Surrender of Culture to Technology. New York: Alfred A. Knopf Inc., 1993.

Robins, Kevin and Frank Webster. The Technical Fix: Education, Computers and Industry. London: Macmillan, 1989.

Romiszowki, A. J. Developing Auto-Instructional Materials: From Programmed Texts to CAL and Interactive Video. London: Kogan Page Publishing, 1986.

Schwartz, F. Lillian and R. Laurens Schwartz. The Computer Artist's Handbook. New York: W. W. Norton & Company, 1992.

Sewell, F. David. New Tools for New Minds: A Cognitive Perspective on the Use of Computers with Young Children. Exeter: Harvester Wheatsheaf, 1990.

Skinner, B. Frederick. Teaching Machines. New York: Appleton-Century-Crofts, 1988.

Slotnick, L. Daniel and M. Evans Butterfield. Computers and Applications. Boston MA: D. C. Heath and Company, 1989.

Soby, Morten. "Waiting for Electropolis" Collaborative Learning Through Computer Conferencing. Ed. Anthony Kaye. Berlin: Springer-Verlag: 1992. 39-49.

Stafford, Roy. Hands On: A Teacher's Guide to Media Technology. London: BFI Publishing, 1993.

Steinberg, Esther. Computer-Assisted Instruction: A Synthesis of Theory, Practice and Technology. Englewood Cliffs NJ: Lawrence ErlBaum Associates Publishers, 1991.

Taylor, Rod. "Critical Studies in Art and Design Education" Critical Studied in Art and Design Education. Ed. David Thistlewood. London: Longman. 1989. 27-42.

Truckenbrod, Joan. Creative Computer Imaging. Englewood Cliffs NJ: Prentice Hall, 1988.

T263 Course Team. "Where are Designers Placed?" Technology for Technology Education. Ed. Robert McCormick and Charles Newey and John Sparkes. Wokingham: Addison Wesley Publishing Company, 1993. 92-105.

Visalberghi, Aldo. "Artificial Intelligence: Educational Problems and Implications" Artificial Intelligence Tools in Education. Ed. Paolo Ercoli and Robert Lewis. New York: Elsevier Science Publishing Company, 1988. 1-4.

Vockell, Edward and Walter Brown. The Computer in Social Studies Curriculum. New York: McGraw Hill, 1992.

White, Charles S. and Guy Hubbard. Computers and Education. New York: Macmillian Publishing Company, 1988.

Wiezenbaum, Joseph. Computer Power and the Decline of Human Reason. New York: Penguin, 1984.

Willis, W. Jerry and D. LaMont Johnson and N. Paul Dixon. Computers, Teaching and Learning: An Introduction to Computers in Education. Beaverton: Dilithium Press, 1983.

Winders, Ray. Information Technology in the Delivery of Distance Education and Training. London: Biddles Ltd., 1988.

Wong, Wucius. Principles of From and Design. New York: Van Nostrand Reinhold, 1993.

Zinn, K. L. "An evaluative review of uses of computers in instruction" Artificial Intelligence Tools in Education. Ed. Paolo Ercoli and Robert Lewis. New York: Elsevier Science Publishing Company, 1988. 189-203.