The Development and Evaluation of
a Sound-Slide Production on
the History of Computer Art

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Abstract

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The purpose of this thesis-equivalent is to provide instructional material, in the form of a sound-slide production, on computer art to serve senior high school art students. A second goal is to show that information gain on computer art leads to a more positive attitude towards that subject. The production presents the history of computer art, describes the associated equipment, and illustrates the work and techniques of individuals producing computer graphics and computer art. The subjects consisted of 76 senior high school art students coming from four different schools. Two of these groups were given the pretest, treatment, and posttest; while the other two groups received the treatment and posttest. The evaluation of the production found that the sound-slide production succeeded in increasing the information level regarding computer art of these students. It was concluded that the sound-slide production is an effective method of teaching computer art to senior high school art students. Some students with a significant gain in factual knowledge clearly exhibited a positive attitude change, while others showed no positive change in attitude.

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CHAPTER ONE

Introduction

Our society has become a predominantly technological society with computers pervading our lives. Computer artists reflect this cultural phenomenon in their work. Throughout history man has always left a trace of his culture by his expression in art forms. The fact that many artists are working with engineers and scientists today in the hope of exploiting the latest technical processes to be used in their work indicates the extent to which contemporary society is influenced by modern technology. Arnold Hauser in describing the change of art styles writes, "...the rapid development not only accelerates the change of fashion, but also the shifting emphasis in the criteria of aesthetic taste... The continual and increasingly rapid replacement of old articles in everyday use by new ones... readjusts the speed at which philosophical and artistic revaluations occur..." (Toffler quoting Hauser in Future Shock, p.173).

The development of computer art reflects the impact technology has had on contemporary society. There was a need to make available to interested persons in general and to art students in particular, instructional material on computer art. Because most publications strongly emphasize the technical aspects of computer art, and most art students do not have a background in computer technology, such information has been geared to the computer scientist and little is available for the art student. Hence there is an educational need for an introductory module presenting the important aspects of computer art.

Art education is divided into 2 major schools of thought. Herbert Read (Education Through Art) and Viktor Lowenfeld (Creative and Mental Growth) believed the main goal of art education was to facilitate the creative development of the child. They believed man has to express himself creatively in order to maintain a sane society. When such expression is suppressed, destruction follows. The ideas expressed by Read and Lowenfeld are defined by Elliott Eisner (Educating Artistic Vision) as the Contextualist school of thought.

> "Contextualist justifications argue the role of art education by first determining the needs of the child, the community, or the nation. Art Education is seen as a means of meeting those needs, whether they be needs directly related to art or not" (Eisner, 1972, p.8.)

Kenneth M. Lansing (1974) and Fred R. Schwartz (1970) believe the most important goal of art education is to produce artists and consumers of art. These ideas are represented in the Essentialist school of thought as defined by Eisner.

> "Essentialist justifications argue the place of art in the schools by analysing the specific and unique character of art itself, and by pointing out that it has unique contributions to make and should not be subverted to other ends" (Eisner, 1972, p.8.)

Both theories are interesting and valid in a teaching situation but which orientation one adheres to would depend on the needs of the students. If the group being considered is made up of elementary school children, it would be more important to encourage each child to express himself creatively rather than focus attention on the art product, a contextualist viewpoint. On the other hand, an adult art class would concentrate more on achieving an aesthetically powerful work of art and how to arrive at that goal - an essentialist viewpoint.

The underlying philosophy of the instructional material developed for this experiment has an essentialist orientation. For the field of computer art to arrive at its potential, the worlds of art and technology must produce artists who will use computer technology and as a result produce satisfying works of art. It is hoped that by making instructional material available to art students, some will be inspired to experiment in this field.

The Problem

The purpose of this thesis-equivalent is to prepare and evaluate a sound-slide production on the topic of computer art aimed at senior high school art students. The production was made first to fulfill the need for instructional material on computer art, and second, to determine if an increased level of awareness would bring about a more positive attitude on the part of the students.

The following questions were therefore raised in this study:

1. There is a need for instructional material to increase art students' information about computer art. Does this production succeed in increasing the level of awareness of the students of computer art?

2. Does such a presentation lead to a more positive attitude towards computer art?

CHAPTER TWO

Review of Literature

Computer Art

Relatively little literature about computer art has been published. Most of the material available was written in the 1960's and early 1970's. These publications emphasize the potential of the computer as an art tool as opposed to its achievements. The authors often looked to the future for artistic achievement in computer art. More recent literature on the subject is often highly technical and difficult for an individual lacking a computer technology background to understand. The recent articles on computer graphics emphasize the techniques, advanced hardware, and use of colour in scientific applications. The literature reviewed in this chapter is largely material that was written for the individual who was interested in the artistic aspects of computer art rather than the technological.

To many, the union of art and computer technology seems at first an unlikely proposition. Other technologies -- photography, film, and video -- have in the past extended the range of the visual arts. Computer art has just recently begun to do so. Even though most artists who have been working with computers are not able to do their own programming, artists from around the world are now using the computer either to generate finished drawings and prints or to generate designs for works finished by hand.

Lloyd Sumner was educated in art before he became involved in computer art in 1964. His book, Computer Art and Human Response (1968) illustrates his experiments with creative design by computer.

Many of Sumner's works attempt to express the elements of exactness in our modern world, justifying the precision of the computer as an appropriate medium. He uses the computer as a tool to produce drawings "...too delicate, too aesthetic, too intricate for my hand alone" (Sumner, 1968, p.21).

Jasia Reichardt collected a volume of essays, Cybernetics, Art, and Ideas (1971) which included articles by computer artists who wrote about their work. Irving John Good in Science in the Flesh, (Reichardt, 1971) writes that the computer as an art tool is limited because artists lack the knowledge necessary to understand the equipment and to program computers in order to explore what can be achieved through their use. (This article was published in the mid-sixties. Artists now have available to them equipment which is easier to use and are collaborating with programmers or using programs that have been written specifically for this type of use.)

Much of the art produced by the computer in the 1950's and 1960's was considered to be experimental and looking to the future for great artistic achievements. In his article, The Digital Computer as a Creative Medium, A. Michael Noll writes "...computers are a new medium. They do not have the characteristics of paints, brushes, and canvas. Nor are the statements that grow out of the artistic engagement with them likely to be similar to the statements of, for example, oil paintings" (Reichardt, 1971, p.143).

Similarly, Jasia Reichardt points out the exhibit "Cybernetic Serendipity" staged in London in 1968 -- "deals with possibilities rather than achievements, and in this sense it is primarily optimistic. There are no heroic claims to be made because computers have so far neither revolutionized music, nor art, nor poetry, in the same way that they have revolutionized science" (1968, p.5).

In the 1960's Noll's challenge (Reichardt, 1971) was to explore now computers could be used as a creative medium and what kinds of artistic potentials can be achieved through the use of computers. When A. Michael Noll produced computer graphics in the 1960's, he did not consider himself an artist. He viewed himself as someone who was doing preliminary exploration in order to acquaint artists with these new possibilities.

Artist and Computer (1976) edited by Ruth Leavitt is a collection of statements by a number of artists about their work. They answer such questions as how they became involved in computer art, what their art background is, and if they do their own programming. Most of the artists whose articles are included in this volume have had an art background. These artists are using the computer in a variety of ways to produce different kinds of art. For example, Manuel Barbadillo uses the computer to generate aesthetic designs which he does with a line-printer and produces the final version by hand. Karen Huff studies textile structures through diagrams drawn by the computer.

In Art and the Future (1973) Douglas Davis discusses computer technology being used as a tool to produce art from an historical perspective.

Melvin Prueitt's Computer Graphics, 118 Computer-Generated Designs (1975) is a collection of computer graphics using his program, PICTURE, which can produce a picture with hidden lines removed creating the illusion of three dimensions.

The British Journal Leonardo is a science and art journal which has published articles on computer art. Some of these articles are written by computer artists where they discuss their particular method and art style.

In Computer Art: Pictures Composed of Binary Elements on a Square Grid, Michael Thompson (Leo. 10, 1977) describes his procedures for generating pictures most of which consist of black and white squares on a square grid.

Ruth and Jay Leavitt (Pictures based on Computer Drawings made by Deforming an Initial Design, Leonardo, 9, 1976) were interested in making nonfigurative pictures that convey a feeling of motion. Ruth Leavitt's pictures are based on selected computer drawings that were made by the deformation of initial designs. The computer program allows the artist to vary the design by making changes to the program.

Colette and Charles Bangert (Experiences in Making Drawings by Computer and by Hand, Leo. 7, 1974) discuss their reasons for using a computer and plotter for producing art. Colette Bangert's hand drawings provide a base and modifications for the programs she and her husband write. The computer-generated drawings contribute to the artist's subsequent hand drawings.

In an article by J. Sykora and Jaroslav Blazek (Computer-aided Multi-Element Geometrical Abstract Paintings, Leo. 3, 1970) Sykora describes paintings he had been making since 1961 The composition of these paintings consisted of repeated use of one or more basic elements -- square or rectangular -- and of specific internal geometric patterns. The mathematical complexities of arranging the elements led to the use of a computer. Jarsolav Blazek, a mathematician, wrote the computer programs for Sykora.

Reiner Schneeberger gave a course in the programming of computer graphics at the University of Munich (Computer Graphics and Art, 1, No. 4, 1976). The students participating in the course possessed no technical skills but were familiar with the theoretical aspects of computer graphics and the computer arts. After the first lecture period students were able to produce aesthetically appealing computer graphics.

As illustrated in this review of literature on computer art, the information available is limited. There is a need for a unit specifically designed for high school art students.

Attitude Change

In his discussion on attitude change, Insko (1967) points out that the acquisition of new information about some aspect of reality, a modification of social factors, and a shift in anxiety-producing internal problems are all factors which may produce attitude change. Despite the fact that an attitude may change as a result of more than one influence, it is possible to identify a few determinants that are more important than the others. Knowledge is one of them. It is the basis of the main influence and is instrumental in producing an attitude change (Insko, 1967).

Differences in the amount of information a subject is required to receive at any one time and the complexity of that information will influence an individual's capacity to receive and process information. A subject is limited in the amount of information he can absorb and process at one time (Wyer, 1974). Thus, it follows that these factors which influence information processing, can also affect the degree of attitude change when the information is geared for that purpose.

There is evidence demonstrating that both children and adults acquire attitudes, emotional responses and complex patterns of behavior through exposure to pictorially presented models (Bandura, 1971). Symbolic modeling provided in television, films, and other audio-visual displays is an influential source of social learning at all age levels.

An experiment by William J. McGuire (1960) sought to prove that a persuasive message will produce changes in attitude towards an explicit target issue and also toward logically related issues which were unmentioned in the message. The message, about school regulations, consisted of rational appeals presenting arguments based on factual evidence. One hundred and twenty high school seniors and college freshmen were used in the experiment. Their attitudes were measured by a questionnaire administered before subjects were given the messages, immediately after, and one week later. Immediately after the presentation of the message there was a change in attitude toward the target issue and also on logically related issues.

Krech, Crutchfield, and Ballachy (1962) point out that whether new information will change an attitude depends upon the nature of the communication situation (that is, group versus solitary listening), the characteristics of the communicator, the medium of the communication, and the form and content of the message.

Elliott W. Eisner (1972) performed an experiment with art students in which he compared students' scores on the Eisner Art Information Inventory with those they received on the Eisner Art Attitude Inventory. He found there was a change in attitude toward the visual arts with the increase of level of information.

To summarize, the literature reviewed here indicates that information gain, although not the only factory influencing attitude change, is an important contributing factor.

CHAPTER THREE

Design and Production of the Program

Audience

The production was designed for senior high school art students to be used in art history classes. The production can be used for any group or individual interested in the history and evolution of computer art.

Educational Objectives

The main objective of the sound-slide production was to provide instructional material on the history and nature of computer art and as a result inform art students about a much neglected area in the field of art.

A secondary objective was to change students' attitudes in a positive direction toward computer art as a result of seeing the sound-slide production.

After seeing the production, the viewer should be familiar with the history of computer art, the major artists who have made contributions to the field, and the techniques employed to produce their work. The viewer should also have a more positive attitude towards computer art than before seeing the production.

Rationale for Media Selection

Although much research has been devoted to the issue of media selection for instruction, there seems to be insufficient evidence to point out the superiority of one medium as opposed to another to perform a specific set of instructional functions. In experimental comparisons of different treatments such as film versus print, or live teachers versus film, the overwhelmingly common result is that no significant differences were found among the groups (P. Saettler, 1968). Jamison, Suppes, and Wells (1974) reviewed the literature on instructional media and technology and concluded that no significant differences exist between media used for instruction. Oettinger and Zapal (1971) state that learning as usually measured is largely independent of the "details of means". Olson (1974,p.6) points out "The impact of technologies both ancient and modern on children's learning is either negligible or unknown". Leifer (1976) and Schramm (1977) conclude that learning is affected more by content than the medium by which the content is transmitted.

According to Salomon (1974) the typical experiment in which the effectiveness of one medium is compared with that of another is actually a study comparing different technologies. The use of media in education involves several factors: the symbol system (that is media's way of structuring and presenting information), the content, the learner, and the educational objective (Salomon 1974). These factors interact with each other in complex ways. Salomon concludes that no medium (or medium attribute) is best for all learners. Research on instructional media should focus on the symbol systems that they use which develop in interaction with their technologies. The question yet to be answeres is "... what media characteristics facilitate instruction on what kinds of tasks and for what types of learners?" (Salomon, 1974, p. 384).

A considerable number of studies have attempted to evaluate the relationship between instructional media used and attitude formation and change. These experiments have shown that mediated instruction (i.e. a medium used in addition to books, teacher, and blackboard) does produce the desired attitude or attitude change in learners (Simonson, 1980). Hoever, a theory on media produced attitude change has not yet been formulated.

Because this production is being produced generally for grade 13 art students, the variety of students' cognitive characteristics and aptitudes were considered by using several media attributes. The sound-slide presentation combines verbal content, music, and slides. More specifically, audio tape synchronized with 35 mm slides were chosen as the media for this production for the following reasons:

1) Because computer art is a visual subject two types of media, both visual and verbal, are essential for real understanding. The possibilities are sound motion pictures, sound filmstrip, slide-tape, and videotape.

2) The most suitable verbal medium would be audio-tape as print would make it impossible for students to read and watch a screen.

3) Slides and audiotapes have the capacity for easy updating by changing, adding, or eliminating individual slides and parts of the tape.

4) Due to the rapid changes and increasing number of computer artists, the above-mentioned capacity for easy modification makes it possible to make changes in the presentation as they occur in the field.

5) Slides and audio-tapes are inexpensive, easy to present, and they lend themselves to repeated viewing by either groups or individuals.

6) Slides are much less expensive than motion pictures and color videotape, and have the definite advantage in that the rate of presentation can be completely controlled. The material may be stopped, reversed or advanced rapidly to bypass unwanted information.

7) A slide-tape presentation lends itself to being easily portable and being copied. As well, it can be put on film loop cassettes and presented without human attendance.

8) Equipment for a slide-tape presentation (slide projector, tape recorder) is relatively inexpensive.

9) The use of slides rather than videotape enables a low cost use of good quality color and accessibility of equipment for presentation.

Considering the low budget of many schools for obtaining equipment for introducing instructional technology, slide projectors and tape recorders are inexpensive as compared to 8 or 16 mm projectors, closedcircuit television, video tape recorder, computer equipment, etc., - as well as the cost and lack of availability of teachers trained in instructional technology.

Presentation

A sound-slide production on the history of computer art was developed. It is a topic that has been largely neglected and ignored by art educators and art historians. The sound-slide presentation was produced from an "essentialist" orientation. The presentation begins with a review of the equipment available for producing computer graphics and the technological development from the late 1950's to the present time. Sample equipment shown ranges from oscilloscopes, to mechanical plotters, and interactive display screens - to sophisticated high quality colour display screens. Illustrations of graphics of various kinds produced by selected artists using each of these tools are shown.

The audio portion, synchronized to the slides, describes in simple terms the functioning and basic operations of the equipment, the expertise required by the user, and the flexibility of these tools. Basic technical terms such as hardware, software, and computer languages are explained.

When the slides of the graphics are shown, the audio-tape describes wherever possible, with refe·ence to the actual graphic and artist involved, the following:

a) The artistic and technical background of the artist.
b) The purpose of creating the work.
c) The technique or techniques used.
d) Opinions of the artists and others regarding computer

graphics as an art.

Evaluation Design

For the purpose of this study, a four-group pretest-posttest design was used. The reason for using a design with a pretest is to ensure the homogeneity of knowledge of students in the experiment. Because this aspect of art history is seldomly dealt with in art curriculae, art grades would not provide the investigator with any information regarding students' knowledge of computer art. The pretest serves to obtain information on the entry level of each student.

The use of a pretest may introduce design difficulties. To control for a "testing effect", that is, "gain on the posttest due to experience on the pretest" (Tuckman 1972, p. 108) some of the subjects were not given the pretest.

It was originally decided that a two-group design would be used. Because intact classes were used sampling was not random and the number of students in each class was too small. Therefore, four classes were used to provide a larger sample for the experiment. The evaluation design selected can be diagrammed as follows:

G1	O1A1	x	Y1Z1
G2	O2A2	x	Y2Z2
G3		x	Y3Z3
G4		x	Y4Z4

A pure control group was not used because the subject matter of the presentation is highly specialized and was not part of the course material. There was therefore, no reason to suspect that any learning about computer art would occur without viewing the presentation. In this design (G) refers to the group (x) the treatment which is the sound-slide presentation, O1 and O2 refer to the pretest of the factual test, and Y1, Y2, Y3 and Y4 refer to the posttest of the factual test. A1 and A2 refer to the pretest of the attitude questionnaire. Z1, Z2, Z3 and Z4 refer to the posttest of the attitude questionnaire. With two experimental groups lacking the pretest, it was possible to test the effects of testing (i.e. the pretest).

In the original design, G1 and G2 were to be given pretests a day before the treatment and the posttests were given. Due to experimental conditions, this was not possible and G1 and G2 were given pretest, treatment and posttests all at one sitting. G3 and G4 received treatment and were given the posttest immediately after. Threats to external validity due to maturation and history was controlled by administering the posttests to the four groups immediately after treatment.

CHAPTER FOUR

Evaluation of the Sound-Slide Production

This chapter presents the formulation of the hypotheses and the definition of the variables as well as the description of the procedures necessary to carry out the experimental design.

The following questions were considered:

1. Is the sound-slide production an effective method for teaching senior high school art students the history of computer art?
2. After viewing the production, will students' attitudes about computer art change in a positive direction?

Definition of Variables

Sound-slide presentation: a series of slides and audiotape which have been synchronized.

Effective method: a method which results in previously stated objectives of the slide-tape presentation.

Attitude: a feeling towards or against certain things.

Hypotheses

Hypothesis 1: A sound-slide production on the history of computer art achieves the pre-stated objectives and as a result, students will be able to demonstrate the discrimination and recall of facts and concepts.

Hypothesis 2: After viewing the sound-slide production on computer art, students' attitudes about computer art will change in a positive direction.

Rationale for Hypotheses

Hypothesis 1: The literature on computer art is technically oriented. There is a need for instructional material developed with the art student in mind. For reasons discussed in Chapter Three, Media Selection, the investigator believes a sound-slide production would successfully convey information about computer art.

Hypothesis 2: The justification for Hypothesis 2 is found in the work of Eisner (1972) and McGuire (1960) who concluded from their research that a correlation does exist between information gain and attitude change.

Subjects

The investigator received authorization from the Toronto Separate Board of Education to carry out the experiment in the schools under their jurisdiction but permission had to be obtained from the individual principals. This presented some difficulty, as, of 12 schools contacted, only 3 were able to consent to the experiment. This problem was due partly to the fact that not all schools have a grade 13 art class. An additional class was obtained for the experiment through the Board of North York.

The subjects for this study consisted of a total of 76 students drawn from four different English-speaking high schools in Toronto, Ontario. The groups of grade 13 art students were as follows:

9 students from Neil McNeil H.S., Toronto Separate School Board; 16 students from St. Joseph's High School, Toronto Separate School Board; 22 students from Senator College School, Toronto Separate School Board; 29 students from Runnymede High School, York Board of Education. At each of the schools mentioned above, an intact class was used for the experimental treatment and measurements during class time. From direct observation it was noted that the students were of lower-middle working class backgrounds, of conservative outlook, and about one-third were Italian-Canadian. All the students were taking art as an elective and were about equal in number of males and females.

Measuring Instruments

The pretest and posttest were identical and consisted of two tests: a factual test on computer art measuring level of information and an attitude questionnaire measuring attitude change. The pretest and posttest were given to students according to the experimental design. When given the pretest, group 1 and group 2 were asked to answer the attitude questionnaire first, followed by the factual test on computer art. When the posttest was administered, the four groups were instructed to answer the two tests in the same order as the pretests, followed by the evaluation questionnaire. The factual test and the attitude questionnaire took a combination of 20 minutes, while the evaluation test took an additional five to seven minutes.

The factual test consisted of 16 multiple choice and true and false questions. One question was subdivided into four questions providing a total score range from 0 - 19.

The attitude test consisted of five statements and a five-point Likert scale ranging from "strongly agree" to "strongly disagree". Each respondent was asked to check one of the five positions for each statement. A high score on the scale meant a favourable attitude. Statements numbered 1, 2, and 5 were given a score of five for strongly agree down to a score of one for strongly disagree. Statements numbered 3 and 4 were given a score of five for strongly disagree down to one for strongly agree. This method of scoring provided a total score range from 5 - 25.

The third measuring device was an evaluation questionnaire developed to determine students' attitudes toward specific aspects of the presentation. Students were asked to rate the various aspects on a five point scale ranging from excellent to poor. The test was given to the four participating groups after viewing the sound-slide production and completing the posttest. The evaluation questionnaire was scored similarly to the attitude questionnaire. The responses were scored according to favourability, with a range of five to one. A response of "excellent" received a score of five, while a response of "poor" was given a score of one.

Content Validity

The content validity of the factual test and the attitude questionnaire was verified by matching each item to the objectives being measures. The computer art test was found to be an adequate measuring instrument for that topic. As well, the attitude questionnaire was found to be an adequate measure of attitude toward computer art.

Test Reliability

The reliability of the computer art test and the attitude questionnaire was tested using the Kuder-Richardson formula 20 (Ferguson, 1966) to determine the internal consistency of the test material of both tests. The KR-20 formula found a reliability of .53 for the factual computer art test. This low KR-20 coefficient for the factual test can be explained by the different kinds of information the test dealt with. The attitude questionnaire obtained a KR-20 coefficient of .58.

CHAPTER FIVE

Results

Data Analysis

One goal of this evaluation was to determine whether the production succeeded in raising the level of information regarding computer art in senior high school art students.

A second goal of the evaluation was to determine if an increase in level of information resulted in a positive attitude change.

After examining the results of the factual test it became apparent that question 3a, b, c, d had a very low rate of correct responses. As a result, this four-part question was eliminated before the test results were analysed.

The data analysis was performed on both the factual test and the attitude questionnaire. The factual test measured level of information while the attitude questionnaire measured attitude towards computer art. Once the data form the content and attitude tests were scored and coded, the t-test for correlated samples was used to compare pretest and posttest scores. See Table 3, (factual test) and Table 6, (attitude questionnaire). Where pretest scores were compared to posttest scores of different groups, and where posttest scores of two different groups were compared, the t-test for independent samples was used. See Table 4, (factual test) and Table 7, (attitude questionnaire).

Because the sample groups were small, some statistical tests were done on combined groups. G1 and G2 combined is referred to as G12, G3 and G4 combined is referred to as G34. The combined scores of O1 and O2 are referred to as O12; Y1 and Y2 is referred to as Y12;

A1 and A2 is referred to as A12, and Z1 and Z2 is referred to as Z12.

Because the t-test is given strict assumptions, some of which are not met in this experiment, the Kolmogorov-Smirnov two-sample test was also used to compare pretest and posttest scores and posttest scores of different groups, (when $N_1 = N_2$ see Table 3a; when N_1 is not equal N_2 see Table 4a). Although significance levels were slightly lower than the t-test results showed, the conclusions of the t-test were confirmed.

Table 1

Number of Students and the School of the Four Groups

Group	Number	School
G1	9	Neil McNeil H.S.
G2	16	St. Joseph's H.S.
G3	22	Runnymede H.S.
G4	29	Senator O'Connor College School

Table 2

Mean Scores of Pretest and Posttest Results of Factual Test

Group	Pretest Mean Score	Posttest Mean Score
G1	3.6	9.5
G2	.43	9.4
G12	1.56	9.48
G3		7.9
G4		7.7
G34		7.86

Note: Maximum score = 19

Table 3

T-Test for Correlated Samples Applied to Results of Factual Test

Scores Compared	T-Scores	Degrees of Freedom	Probability Level
01 and Y1	4.35	8	$p < .01$
02 and Y2	14.23	15	$p < .001$
012 and Y12	11.42	24	$p < .001$

When pretest and posttest scores were compared, the results for all three groups were significant indicating a significant information gain after treatment.

Table 3a

Kolmogorov-Smirnov Two-Sample Test

Applied to Results of Factual Test Where $N_1 = N_2$

Scores Compared	K_D	Probability
01 and Y1	6	$p < .05$
02 and Y2	16	$p < .01$

Table 4

T-Test for Independent Samples Applied to Results of Factual Test

Scores Compared	T-Scores	Degrees of Freedom	Probability Level
Y1 and Y3	1.58	29	not significant
Y1 and Y4	1.70	36	not significant
Y2 and Y3	1.92	36	not significant
Y2 and Y4	2.10	43	$p < .05$
O12 and Y34	10.93	74	$p < .001$
Y12 and Y34	7.86	74	$p < .01$

Posttest scores Y1 and Y2 (posttest scores of the pretest-posttest groups) were compared with Y3 and Y4 (posttest scores of the posttest only groups) using a t-test for independent samples. The results indicate differences at various levels of significance. These results led the investigator to believe a minor testing effect due to the pretest did exist. As a result, O12 (pretest scores of G12) and Y34 (posttest scores of G34) were compared using the same t-test. The results were significant at .001 level. Information gain did occur in all posttest groups. However, those who participated in the pretests had just slightly higher scores caused by sensitization due to the pretest.

Table 4a

Kolmogorov-Smirnov Two-Sample Test

Applied to Results of Factual Test

Where N_1 is Not Equal N_2

Scores Compared	X^2	Probability Level
Y1 and Y2	.278	not significant
Y3 and Y4	.02	not significant
Y2 and Y4	5.05	$p < .10$
Y12 and Y34	7.76	$p < .05$
O12 and Y34	32.88	$p < .001$

Table 5

Mean Scores of Pretest and Posttest on Attitude Questionnaire

Group	Pretest Mean Score	Posttest Mean Score
G1	17.7	20.7
G2	17.06	20.3
G12	17.32	20.48
G3		18.72
G4		18.03
G34		18.3

Note: Score range 5 - 25

Table 6

T-Test for Correlated Samples Applied to Results of Attitude Questionnaire

Scores Compared	T-Scores	Probability Level
A1 and Z1	3.23	$p < .02$
A2 and Z2	5.16	$p < .001$
A12 and Z12	6.17	$p < .001$

Pretest and posttest scores were compared. The difference between A1 and Z1 were lower at $p < .02$ than between A2 and Z2, and A12 and Z12 at $p < .001$.

Table 7

T-Test for Independent Samples Applied to Results of Attitude Questionnaire

Scores Compared	T-Scores	Probability Level
Z12 and Z3	2.24	$p<.05$
Z12 and Z4	3.72	$p<.001$
Z12 and Z34	3.38	$p<.01$
A1 and Z3	.81	not significant
A1 and Z4	.26	not significant
A2 and Z3	1.44	not significant
A2 and Z4	.99	not significant
A12 and Z34	1.36	not significant

Table 7 shows differences at a statistically significant level did occur between Z12 and Z3, Z12 and Z4, Z12 and Z34. Again the investigator suspects a testing effect produced by the pretest on G1 and G2 may have resulted in the higher means scores for these groups (See Table 5).

Therefore, pretest attitude scores of G1, G2, G12 were compared with posttest attitude scores of G3, G4 and G34 (the posttest only groups). The results which occurred were unexpected. None of these comparisons was statistically significant.

Analysis of the Factual Test

For purposes of analysing the factual test it was divided into three categories:

1. History of Computer Art - 5 questions, numbers 2, 6, 8, 12, 16
2. Equipment - 7 questions, numbers 1, 4, 5, 10, 11, 14, 15
3. Artists and Techniques - 3 questions, numbers 7, 9, 13

After examining the posttest scores of the four groups (Y1, Y2, Y3, Y4) it was found students answered 76% of the questions regarding the history of computer art correctly. This compared with 48% of those questions concerned with equipment, and 42% correct responses to those questions about computer artists and their work. (See Tables 8A, 8B, and 8C.)

Table 8A

Number and Percentage of Correct Responses on

Posttest to Questions on History of Conputer Art

Question # on History		No. Correct		% Correct
2		64		84.21
6		63		82.89
8		51		67.11
12		62		81.58
16		43		56.58
	mean	57	mean	74.47

NOTE: N = 76

Table 8B

Number and Percentage of Correct Responses

on Posttest to Questions on Equipment

Question # on Equipment	No. Correct	% Correct
1	28	36.84
4	35	46.05
5	55	72.37
10	31	40.79
11	30	39.47
14	35	46.05
15	43	56.58
	mean 37	mean 48.30

NOTE: N = 76

Table 8C

Number and Percentage of Correct Responses on Posttest to Questions on Artists and Their Work

Question # on Artists	No. Correct	% Correct
7	31	40.79
9	24	31.58
13	42	55.26
	mean 32	mean 42.54

NOTE: N = 76

Evaluation of Production by Students Participating in the Experiment

Tables 9 and 10 summarize the responses to the students' evaluation of the production.

The greatest number of negative responses regarded the length of production. Whereas 14.6% of the students rated the length of the production as excellent or very good, 32% rated it fair or poor. Almost 19% of the respondents rated the timing of slides and the voice-over to be fair or poor, while 46% rated them excellent or very good. Quality of colour and content were given the best evaluation receiving the greatest number of positive responses. 54% of the students rated content as excellent or very good, while only 11.8% rated it fair or poor. 63% of the students rated quality of colour as excellent or very good and 10.5% rated it fair or poor.

To summarize, the students' evaluation of the sound-slide production was favourable. Certain aspects of the production received more positive appraisal than others. The length of production seemed to be the main source of negative criticism. However, content, voice-over, timing of slides, colour quality, and overall reaction to production received substantially more positive responses than negative ones.

Table 9

Students' Evaluation of the Sound-Slide Production,

Representing Number of Students Rating Each Item

Item	Excellent	Very Good	Good	Fair	Poor
Content	12	29	26	9	0
Voice Over	11	24	27	12	2
Length of Production	4	7	40	21	3
Timing of Slides	14	21	27	13	1
Quality of Colour	23	25	20	5	3
Overall Reaction to Production	5	27	30	11	2

NOTE: N = 76, Exception: length of production N = 75, and overall reaction to production N = 75.

Table 10

Students' Evaluation of the Sound-Slide Production

Representing Percent of Students Rating Each Item

Item	Excellent	Very Good	Good	Fair	Poor
Content	15.8	38.2	34.2	11.8	0
Voice Over	14.5	31.6	35.6	15.7	2.6
Length of Production	5.3	9.3	53.3	28.0	4.0
Timing of Slides	18.4	27.6	35.5	17.1	1.3
Quality of Colour	30.3	32.9	26.3	6.5	3.9
Overall Reaction to Production	6.7	36.0	40.0	14.7	2.7

NOTE: N = 76, Exception length of production N = 75 and overall reaction to production N = 75.

CHAPTER SIX

Conclusion

The results of this experiement led to the following conclusions:

1. The sound-slide production succeeded in raising the information level of senior high school art students on the topic of Computer Art.

2. Although there was an increase in information level, this did not lead to a positive change of attitude.

Conclusion 1 agreed with Hypothesis 1. However, the results of the experiment did not support Hypothesis 2. Although some research shows that information gain does, in fact, lead to attitude change (McGuire 1960, Eisner 1972), the investigator was not able to substantiate this as demonstrated by the measuring instruments used. Future research investigating the effect of information gain on attitude change should look at other variables that may also contribute to attitude change.

From the analysis of the factual test, it is evident that certain classes of the information produced better results than others. The highest scores were on questions regarding the history of computer art. A future study would examine why this occurred.

From the students' evaluation of the production, it became evident that the sound-slide production could be improved by shortening the length of the presentation and improving the timing of the slides in certain areas.

In summary, this study has succeeded in developing an effective instruc-ional sound-slide production for senior high school art students. The investigator failed to show that information gain leads to attitude change. The amount of information will influence an individual's capacity to receive and process information (Wyer 1974). As shown by the students' evaluation of the production, many of them felt the presentation was too long. It is possible that the amount of information interfered with assimulation and processing of information which might affect attitude change. Further investigation is required in this area as most of the research available does not support one theory regarding information gain and attitude change.

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Appendix A

Slide-tape Presentation

	Slides	Time (min/sec)	Tape
1a.	Title slide		Switched on Bach - electronic music produced by Walter Carlos
1.	Computer of 1950's	00 07	The first commercial computer was marketed in 1950. The earliest computer grahics were produced mainly by mathematicians,
2.	Computer graphic produced by a mathematician	00 04	programmers, scientists and engineers. These were the individuals
3.	Computer graphic produced by a mathematician	00 03	who had the necessary technical training to enable them to generate programs
4.	Computer graphic produced by a mathematician	00 05	and had access to the equipment because of their computer related jobs.
5.	A printer	00 11	In order to generate and print a computer design one of several devices must be used in connection with the computer. One of the earliest devices used was the printer
6.	A printer	00 05	which prints a design consisting of letters or symbols according to the program instructions.
7.	A graphic produced by a printer	00 08	Certain combinations of symbols such as letters and numbers can provide graduations of grey from black to white.
8.	A computer graphic of the "Mona Lisa"	00 10	A striking example of a picture produced by the

	Slides	Time	Tape
			printer is the Mona Lisa by Phil Peterson of Control Data Corporation.
9.	An early computer graphic by Peter Milojevic	00 08	In the late 1950's and early 1960's one had to be skilled in computer programming in order to produce computer graphics.
10.	An early computer graphic by Peter Milojevic	00 08	These early graphics were therefore quite primitive and were visual representations of what interested these programmers,
11.	An early computer graphic by Peter Milojevic	00 03	namely mathematical functions, procedures and transformations.
12.	An early computer graphic with aesthetic qualities	00 14	However, some of the mathematical functions did produce aesthetic results. Engineers and computer scientists who had begun by using the computer to obtain information in the form of plotted diagrams
13.	An early computer graphic with aesthetic qualities by Lloyd Sumner	00 08	realized that some of their results had aesthetic value. However, a great deal of controversy exists on this topic.
14.	Aesthetic computer graphic in colour produced by a plotter by Lloyd Sumner	00 06	The computer performs according to instructions which are input and stored in the form of a program.
15.	Three illustrations of a pen attached to a plotter	00 07	It is how the programmer or artist varies the data that determines the aesthetic quality of the graphics.
16.	A colour graphic produced on a plotter	00 12	The plotter is an instrument that moves the pen to make a line drawing according to a program. Any colour ink may be used in

	Slides	Time	Tape
			the plotter pen and either in ball point or felt tip form.
17.	A colour graphic by Frieder Nake	00 12	The drawings are usually linear with variations in the thickness of line. The computer picture can be reproduced any number of times by rerunning the program and replotting the results.
18.	A graphic produced using a simple algorhythm	00 25	If one were to generate graphics involving circular patterns, a program defining the position of the centre and the length of the radius could be used to calculate points on the circumference of the circle. The plotter joins these points to produce a circle. This graphic was produced by joining each point on the circumference to every other point on the circumference.
19.	Random pattern of stars	00 13	To create a computer graphic other shapes can be manipulated in similar ways to produce interesting graphics with aesthetic results. Very often to alter a given design the artist uses a random number generator.
20.	Random pattern by Frieder Nake	00 20	The random choice increases variety and complexity which adds interest to the picture. Frieder Nake's graphic entitled 'Computer Graphic' was the prize-winning entry of the annual computer art contest organized by the magazine, Computers and Automation in 1966.
21.	Computer drawing by Leslie Mezei	00 06	Leslie Mezei uses randomness to transform a figure such as a girl's face.

	Slides	Time	Tape
22.	Modified computer drawing by Leslie Mezei	00 06	The programs are written in SPARTA, a programming language Mezei designed for manipulating
23.	Further modified computer drawing by Leslie Mezei	00 04	arbitrary lines such as these.
24.	A computer artist using a sketchpad	00 18	As most shapes cannot be described by formulae, drawings can be made on graph paper and the coordinates then input into the computer. This process can be done automatically with the Cathode Ray Tube which is referred to as a CRT with a light-pen attachment.
25.	Computer artist using a light-pen and a CRT	00 13	The CRT is an input and output device which produces pictures on a TV-like screen. Data can be entered by means of a keyboard or devices such as a light-pen and the results are displayed on the screen.
26.	Graphic produced on a CRT	00 07	With a light-pen one could draw on the screen simple patterns consisting of lines and curves.
27.	Graphic produced on a CRT	00 09	If the artist alters the design on the CRT with a light-pen, the computer program can act on the altered data to produce varied images.
28.	Graphic produced on a CRT	00 16	The image on the CRT can be shifted, rotated, enlarged, seen in perspective, stored, recalled, and transferred to paper by means of a plotter or printer with the intermediate stages recorded as desired.

	Slides	Time	Tape
29.	A colour computer graphic produced on a CRT	00 13	To produce color graphics off a CRT, color filters can be used while photographing the images on display. This method was used before color CRT's became available.
30.	Computer graphic produced by Boeing Co.	00 20	In the early 1960's Wm. A. Fetter produced a series of experimental works for Boeing Company. These computer graphics produced on a plotter were representations of different views of an airport seen by a pilot about to land and
31.	Computer graphic produced by Boeing Co.	00 04	practical simulations for airplane cockpit designs.
32.	Computer graphic produced by Boeing Co.	00 07	Although these designs had scientific goals, they were aesthetically pleasing to some individuals.
33.	Computer graphic produced by Boeing Co.	00 10	The potential of producing aesthetic computer graphics began to attract individuals with purposes other than solving or expressing mathematical problems.
34.	A colour computer graphic produced on a plotter by Frieder Nake	00 25	At the same time in the early 1960's, three mathematicians, Frieder Nake, George Nees and A. Michael Noll began using computers to work on the development of aesthetic computer graphics. Their work illustrates the initial successful attempts by mathematicians to produce intentionally aesthetic and creative computer graphics.
35.	A colour computer graphic produced on a plotter by Frieder Nake	00 37	Frieder Nake's first computer graphics were produced in Germany in 1963. He used a special plotter which has

	Slides	Time	Tape
			4 pens fed by Indian ink of different colors with nibs of varying thickness. This graphic produced by Frieder Nake in 1967 entitled 'Matrix Multiplication' is an example of the visualization of the mathematical process known as matrix multiplication. Numbers were arranged on the field, a color was assigned to each number and applied with maximum line thickness.
36.	A colour computer graphic produced on a plotter by Fieder Nake	00 17	The graphic entitled 'Klee No. 2' which Nake produced in 1965 has a variety of random elements including position of symbols in the square, number of circles, position of circles and radius of circles.
37.	A computer graphic by George Nees	00 13	Many computer drawings especially from the early days of computer graphics are based on simple random assignments. A good example of this is the Maze series by George Nees.
38.	A computer graphic by George Nees	00 09	In his graphic called 'Gravel Stones', a random number generator causes the increasing swaying of the squares.
39.	A hand drawing by Piet Mondrian	00 16	In the early 1960's A. Michael Noll performed an experiment using this work by Piet Mondian entitled 'Composition with Lines' of 1917 and a computer generated picture using a plotter.
40.	A computer generated imitation of Mondrian's drawing	00 28	When both pictures were shown, 59% of the subjects preferred the computer generated graphic and only 28% were able to identify

	Slides	Time	Tape
			correctly the picture produced by Mondrian. In general these people seemed to associate randomness of the computer-generated picture with human creativity whereas the orderly bar placement of the Mondrian painting seemed to them mechanically produced.
41.	A computer graphic by Lloyd Sumner	00 21	During this period of the mid 1960's, some artists learned to write programs to produce their art. Lloyd Sumner of the University of Virginia was one of them. He produced computer graphics using the computer language ALGOL and used a plotter to generate his graphics.
42.	A computer graphic by Lloyd Sumner	00 09	Many of his works resulted from his attemps to portray natural phenomena using mathematical symbols, functions, expressions
43.	A computer graphic by Lloyd Sumner	00 03	and combinations, for example, stars
44.	A computer graphic by Lloyd Sumner	00 12	and flowers. Sumner also used the feelings expressed by the movement of the various mathematically developed graphics to express his perceptions and feelings about his surroundings.
45.	A computer graphic by Lloyd Sumner	00 07	He launched a firm called Computer Creations from which he sells computer graphics.
46.	A graphic by Kolomyjec	00 20	Wm. J. Kolomyjec has a background in both fine arts and computer science. For his computer artwork Kolomyjec generally writes his own FORTRAN programs but he

	Slides	Time	Tape
			sometimes works with a mathematician to help in writing complex problems as, for example, determining the orientation of his imagery in 'Birds' and
47.	A graphic by Kolomyjec	00 04	and 'Bird Curves'.
48.	A graphic by Kolomyjec	00 21	Kolomyjec's graphic entitled 'Organic Illusion' uses the basic idea of a large array of squares. According to program instructions circles are randomly placed within each of the 25 squares, and lines are drawn from the circumference of the circles to the extremities of the squares.
49.	Moire pattern by Kolomyjec	00 25	Kolomyjec's 'Moire' deals with the optical phenomena produced by moire patterns very much like the work of 'Op' artists Bridget Reilly and Victor Vassarely. Kolomyjec has taught computer graphics as a form of creative expression to art students at Michigan State University and has found the response enthusiastic.
50.	A graphic by Charles Csuri	00 48	As acceptance grew in the mid and late 1960's, more and more artists became involved with computer graphics. Some artists, like Lloyd Sumner, learned to program, while others collaborated with mathematicians or programmers. For most of his career Charles Csuri worked as a painter. However, he believed strongly that mathematics offers new possibilities in the realm of the arts. In

Slides		Time	Tape
			the late 1960's Csuri began working with James Schaeffer to produce aesthetic graphics. In their graphic entitled 'Sine Curve Man'
51.	A graphic by Charles Csuri	00 09	a realistic line drawing is transformed in this image by means of a mathematical function called the sine curve. In their graphic entitled 'Transformation' the face of a young girl is transformed into that of an old woman.
52.	Graphic by Aldo Giorgini	00 23	Aldo Giorgini started using the computer as a scientific tool in 1966. While using the computer for scientific purposes, he started to experiment with some of the computer drawings that were made as illustrations of the research done. Giorgini began to use the computer as an art tool shortly afterwards.
53.	Graphic by Aldo Giorgini	00 12	These graphics have all been made using drawings generated with the program FIELDS developed by Giorgini with the help of Dr. W.C. Chan.
54.	Graphic by Aldo Giorgini	00 21	Giorgini maintains that his work can be achieved without the use of a computer. The difference between doing the drawing and calculating by hand and using the computer is the amount of time required for the execution of a piece. However, he feels that using the computer affects the results.

	Slides	Time	Tape
55.	Graphic by Edward Zajec	00 14	Artists Edward Zajec and Vera Molner also turned to the computer to ease their tasks for their particular artistic styles. Edward Zajec first used the computer in 1968.
56.	Graphic by Edward Zajec	00 21	At that time he was experimenting with repetition of the same module over large areas with only slight changes in size. The monotomy of the manual task and the limited variations which he was able to produce in a given period of time made him realize the inadequacy of traditional methods in dealing with his work.
57.	Graphic by Edward Zajec	00 06	The computer greatly facilitated Zajec's work and created new artistic possibilities.
58.	Graphic by Vera Molner	00 12	Vera Molner used the computer as an art tool for similar reasons. When she makes a picture she produces a first version which usually requires modification.
59.	Graphic by Vera Molner	00 07	The dimensions, proportions, and arrangements of the shapes are altered in a stepwise manner.
60.	Graphic by Vera Molner	00 11	By comparing the successive pictures resulting from a series of modifications, Vera Molner can decide whether the trend is towards the results that she wants to achieve.
61.	Graphic by Vera Molner	00 10	She finds it fascinating to experience the transformation

Slides	Time	Tape
		of an indifferent picture into one that she finds aesthetically appealing.
62. Graphic by Vera Molner	00 18	However, like Zajec, Molner finds doing this work by hand tedious and slow and since time is limited she can only consider a few of the many possible modifications. Furthermore these choices are based on biased influences coming from one's background.
63. Graphic by Vera Molner	00 18	There are differences between Vera Molner's method and that widely used by other artists. Whereas they begin with an initial set of rules specifying the way parameters are to be varied, she tries to elaborate the rules as the work develops.
64. Graphic by Vera Molner	00 19	Another method she employs is that instead of waiting for pictures to be plotted which can take from several minutes to several hours depending on its size and complexity, Molner makes the parameter changes quickly while viewing the images on the CRT and then plots the results she prefers.
65. Graphic by Vera Molner	00 11	She will sometimes produce a painting based on her computer drawing. This graphic is an example of a painting based on a computer generated design.
66. Graphic by Zdeneck Sykora	00 13	Another artist who has used the computer because of the nature of his artistic style is Zdeneck Sykora. Sykora worked with a mathematician

	Slides	Time	Tape
			with whom he prepared a program.
67.	Graphic by Zdeneck Sykora	00 08	The composition of his paintings resulted from the use of a square or circle and other geometrical patterns.
68.	Graphic by Zdeneck Sykora	00 08	The large number of possible variations led to his using the computer which could accomplish some of the tedious work.
69.	Graphic by Zdeneck Sykora	00 05	He finished his work by hand painting on canvas.
70.	Computer generated picture by Kenneth C. Knowlton and Leon Harman	00 09	In the 1960's Kenneth C. Knowlton and Leon Harman produced computer generated pictures.
71.	Computer generated picture by Kenneth C. Knowlton and Leon Harman	00 10	A 35mm transparency was made from a photograph, the transparency was then scanned by a machine similar to a television camera.
72.	Computer generated picture by Kenneth C. Knowlton and Leon Harman	00 09	The electrical signals were converted into numerical representations which resulted in a picture consisting of symbols.
73.	Film strip of computer animation	00 14	The computer has been used quite extensively for producing animation films. To produce these films, an electronic microfilm recorder which consists essentially of a CRT and a camera is used.
74.	Film strip of computer animation	00 15	An image is generated and displayed on a CRT, film is exposed, and the film is advanced for the next frame. By successive variations of the image an animation sequence can be produced.

	Slides	Time	Tape
75.	Colour film strip of computer animation	00 19	In addition to a program for generating the images on the CRT, programming instructions are available for controlling the camera. Kenneth C. Knowlton developed a computer language called BEFLIX to be used for computer animation.
76.	Frames from colour animation film strip	00 10	These computer generated images are from the film 'Pixillation' by Lillian Schwartz and were made using the BEFLIX system.
77.	Graphic by Lloyd Sumner	00 19	In the fall of 1967 the National Film Board and the Junior Association of the Montreal Museum co-sponsored a computer graphics and animation exhibition at the Montreal Museum of Fine Arts. Many works were presented including those of Lloyd Sumner,
78.	Graphic by Charles Csuri	00 02	Charles Csuri,
79.	Graphic by Frieder Nake	00 02	Frieder Nake and
80.	Graphic by Peter Milojevic	00 02	Peter Milojevic.
81.	Exhibit entitled Cybernetic Serendipity	00 14	In 1968 Jasia Reichardt organized an International Exhibition of computer generated art entitled 'Cybernetic Serendipity' at the Institute for Contemporary Arts in London.
82.	Exhibit entitled Cybernetic Serendipity	00 06	This exhibition dealt with the relationship of the computer and the arts.
83.	Computer graphic produced on a printer		During the late 1960's the hardware and software had evolved to enable less and less technically sophis-

	Slides	Time	Tape
			ticated users to access computer graphics.
84.	Computer graphic by Katherine Nash	00 14	For example, Katherine Nash, Professor of Art at the University of New Mexico used a language called ART II at the same university to teach art students to make simple computer graphics.
85.	Three dimensional perspective	00 18	Since the early 1970's most computer artists have been reproducing their computer output in a variety of media. Whereas in the 1960's the majority of those individuals producing computer art were physicists, systems analysts, and programmers,
86.	Three dimensional perspective	00 11	today computer artists are sculptors, painters, and architects who use the computer primarily as a designing aid rather than to generate the artwork itself.
87.	Graphic by Manuel Barbadillo	00 10	Manuel Barbadillo began his computer art in 1968. His work is based on a series of elementary shapes
88.	Graphic by Manuel Barbadillo	00 07	or modules with which he builds his pictures by combining them so as to create a rhythmic pattern.
89.	Graphic by Manuel Barbadillo	00 08	The paintings are composed of positive modules, black on white and negative ones, white on black.
90.	Graphic by Manuel Barbadillo	00 08	He uses the computer to produce a great number of designs to study and compare and to choose from.

	Slides	Time	Tape
91.	Graphic by Manuel Barbadillo	00 16	Barbadillo uses the computer mainly as a help for execution, and therefore he is more interested in speed than in perfection of drawing, preferring to use a line printer with asterisks roughly filling the shapes. Barbadillo usually produces by hand the final version of his works.
92.	Graphic by Manuel Barbadillo	00 15	He uses the power of the computer and the speed of the printer to generate a variety of designs from which he can choose to paint.
93.	Graphic by Joseph Scala	00 30	Joseph Scala discovered the EXPLOR software system designed by Ken Knowlton for artists. Scala acquired the system for Syracuse University and proceeded to set up and offer a course in computer graphics especially for art students. Within a few weeks, art students who had never seen a computer and who had little or no mathematical training were writing programs in FORTRAN and producing graphic images.
94.	Graphic by Joseph Scala	00 15	His students came from a variety of disciplines and therefore their output varied from tapestries to animated film. Scala completed the final version of his work by painting by hand.
95.	Graphic by Ruth Leavitt	00 08	Artist Ruth Leavitt produced seriographs based on some of her computer generated designs.
96.	Graphic by Ruth Leavitt	00 07	She demonstrates the trend of increased use of form and colour during the 1970's.

	Slides	Time	Tape
97.	High resolution CRT	00 10	The development of high resolution color CRTs now allow more varied forms and richer color in computer graphics.
98.	A recent colour computer graphic produced for scientific purposes	00 11	Because initially this equipment was expensive and was designed by scientists and engineers, these color CRTs were first used for scientific purposes. More and more high level computer languages which can be easily taught are being developed to enable specialized use for producing computer graphics.
99.	Computer graphic by Melvin Prueitt	00 11	The kaleidoscopic design by Melvin Prueitt was produced by a small program he called KALIDE. It shows how a simple set of lines can be rotated and reflected around a centre point to produce a pleasing effect.
100.	Computer graphic by Melvin Prueitt	00 29	The Butterfly was produced by Melvin Prueitt by an animation program called ANIMINT. The different segments of the Butterfly are separate images which can be changed and moved. Where the images overlap, hidden portions of those that are further back are automatically removed. This picture is a single frame from a movie sequence in which a green caterpillar transforms itself into a colorful butterfly.
101.	Computer graphic by Melvin Prueitt	00 17	As high level languages become more readily available and more versatile in their application, and as the cost of hardware decreases, more

	Slides	Time	Tape
			individuals outside of computer-related fields will have the opportunity to use the computer as a tool in producing art.
102.	Colour computer graphic produced for CBS	00 12	In the past 20 years, computer art has evolved from simplistic expressions of mathematical formulae to graphics which are concerned with aesthetic expression.
103.	Computer graphic produced by artist David M	00 15	Because computer art is still evolving as an art form, we cannot look back on it as a movement. As computer technology is becoming more and more accessible to a greater number of people, the potential of computer generated art increases.
104.	Computer graphic produced by artist David M	00 30	The involvement in computer art of a growing number of artists will significantly influence further developments in the field.
105.	Computer graphic by M. Thompson and M. Schecter		<u>Switched on Bach</u> - electronic music produced by Walter Carlos
106.	Computer graphic produced by Information International Inc.		Music
107.	Graphic by artist David M		"
108.	Graphic by artist David M		"
109.	Graphic by artist David M		"

Appendix B

Table 1

Pretest Scores (O1) and Posttest Scores (Y1)

of Factual Test for G1

Subjects	Pretest	Posttest
1	0	7
2	5	11
3	3	6
4	1	5
5	7	18
6	1	12
7	3	14
8	7	13
9	6	12

NOTE: Maximum score = 19

Pretest mean = 3.67

Posttest mean = 10.89

Table 2

Pretest Scores (O2) and Posttest Scores (Y2)

of Factual Test for G2

Subjects	Pretest Scores	Posttest Scores
1	0	18
2	1	11
3	0	12
4	1	12
5	0	9
6	0	8
7	0	11
8	1	9
9	2	5
10	0	12
11	0	10
12	0	12
13	0	12
14	0	8
15	2	14
16	0	5

NOTE: Maximum score = 19

Pretest mean = .437

Posttest mean = 10.5

Table 3

Posttest Scores (Y3) of Factual Test for G3

Subjects	Posttest Scores
1	8
2	7
3	8
4	5
5	15
6	7
7	14
8	8
9	5
10	8
11	5
12	4
13	11
14	11
15	9
16	9
17	9
18	10
19	11
20	11
21	10
22	6

NOTE: Maximum score = 19

Mean = 8.68

Table 4

Posttest Scores (Y4) of Factual Test for G4

Subjects	Posttest Scores
1	8
2	11
3	8
4	9
5	10
6	8
7	5
8	6
9	13
10	7
11	13
12	13
13	10
14	7
15	7
16	4
17	7
18	9
19	12
20	9
21	7
22	9
23	7
24	6
25	8
26	4
27	9
28	9
29	1

NOTE: Maximum score = 19

Mean = 8.14

Table 5

Pretest Scores (A1) and Posttest Scores (Z1)

of Attitude Questionnaire for G1

Subject	Pretest	Posttest
1	17	20
2	23	23
3	17	21
4	15	21
5	16	18
6	17	21
7	15	22
8	19	22
9	21	19

NOTE: Possible score range is 5 - 25

Pretest mean = 17.77

Posttest mean = 20.77

Table 6

Pretest Scores (A2) and Posttest Scores (22)

of Attitude Questionnaire for G2

Subject	Pretest	Posttest
1	18	20
2	14	16
3	11	20
4	21	22
5	19	20
6	17	19
7	18	21
8	17	21
9	19	20
10	21	24
11	17	21
12	19	24
13	16	18
14	17	22
15	23	23
16	6	14

NOTE: Possible score range is 5 - 25

Pretest mean = 17.06

Posttest mean = 20.31

Table 7

Posttest Scores (Z3) of Attitude Questionnaire for G3

Subject	Posttest Score
1	11
2	15
3	21
4	20
5	23
6	18
7	19
8	21
9	19
10	20
11	22
12	13
13	20
14	17
15	19
16	21
17	15
18	19
19	23
20	19
21	19
22	18

NOTE: Possible score range is 5 - 25

Mean = 18.72

Table 8

Posttest Scores (Z4) of Attitude Questionnaire for G4

Subjects	Posttest Score
1	18
2	21
3	21
4	18
5	14
6	20
7	18
8	21
9	17
10	20
11	15
12	18
13	15
14	20
15	12
16	16
17	19
18	21
19	18
20	18
21	16
22	20
23	15
24	17
25	19
26	19
27	16
28	18
29	23

NOTE: Possible score range is 5 - 25
Mean = 18.03

Table 9

Scores of Production Evaluation Questionnaire, G1

Subject	Score
1	16
2	19
3	19
4	20
5	21
6	22
7	18
8	22
9	27

NOTE: Maximum Score range is 5 - 30

Mean = 20.44

Table 10

Scores of Production Evaluation Questionnaire, G2

Subject	Score
1	18
2	21
3	22
4	21
5	23
6	17
7	15
8	21
9	21
10	20
11	21
12	21
13	18
14	29
15	21
16	14

NOTE: Maximum score range is 5 - 30

Mean = 20.19

Table 11

Scores of Production Evaluation Questionnaire, G3

Subject	Score
1	26
2	17
3	19
4	20
5	26
6	22
7	19
8	23
9	15
10	17
11	30
12	15
13	15
14	14
15	24
16	22
17	25
18	20
19	19
20	18
21	22
22	23

NOTE: Maximum score range is 5 - 30

Mean = 20.5

Table 12

Scores of Production Evaluation Questionnaire, G4

Subject	Score
1	18
2	28
3	22
4	21
5	20
6	24
7	26
8	22
9	18
10	21
11	20
12	14
13	9
14	12
15	18
16	26
17	12
18	24
19	17
20	18
21	19
22	17
23	15
24	24
25	19
26	22
27	25
28	23
29	30

NOTE: Possible score range is 5 - 30

Main = 25.65

Appendix C

Factual Test

In the following questions, please choose the answer you feel is most appropriate (X)

1. Which device would be most appropriate for producing a graph on paper with lines and curves?

   a. printer ______
   b. plotter ______
   c. cathode ray tube (CRT) ______
   d. I don't know ______

2. Computer art began with

   a. artists ______
   b. graphic designers ______
   c. computer scientists ______
   d. architects ______
   e. I don't know ______

3. Which computer device did the following artists use to generate their computer graphics?

	printer	plotter	CRT	I don't know
Lloyd Sumner	___	___	___	___
Manuel Barbadillo	___	___	___	___
Frieder Nake	___	___	___	___
Vera Molnar	___	___	___	___

4. Is a plotter ever used to produce a hard copy of an image on a CRT?

   a. yes ______
   b. no ______
   c. I don't know ______

5. Can the plotter be used to generate colour computer graphics?

   a. yes ______
   b. no ______
   c. I don't know ______

6. Artists were the first to use computers as an art tool.

   a. true ______
   b. false ______
   c. I don't know ______

7. Lloyd Sumner used the computer device known as a plotter to generate computer graphics.

   a. true ______
   b. false ______
   c. I don't know ______

8. During the past ten years the cost of computer hardware has increased.

   a. true ______
   b. false ______
   c. I don't know ______

9. In the early 1960's who produced a series of computer graphics with scientific purposes for Boeing Company?

   a. Leslie Mezei ______
   b. William Fetter ______
   c. Georg Nees ______
   d. I don't know ______

10. Colour felt pens can be used with which of the following devices to produce colour computer graphics?

   a. CRT ______
   b. printer ______
   c. plotter ______
   d. I don't know ______

11. Can a hard copy of an image on a CRT be obtained by a plotter?

    a. yes ______
    b. no ______
    c. I don't know ______

12. The majority of people now producing computer generated art or designs are

    a. artists ______
    b. scientists ______
    c. I don't know ______

13. Barbadillo uses the computer mainly for its ability

    a. to visually express mathematical functions ______
    b. to generate aesthetic designs ______
    c. for its speed in execution of graphics ______
    d. I don't know ______

14. EXPLOR and ARI are names referring to

    a. computer equipment ______
    b. computer graphics ______
    c. programs ______
    d. I don't know ______

15. A light pen is a device used with a

    a. CRT ______
    b. plotter ______
    c. printer ______
    d. I don't know ______

16. More and more artists can access the necessary computer equipment for their work because

    a. although software has become more difficult there are more courses available ______
    b. hardware costs have decreased ______
    c. I don't know ______

Attitude Questionnaire

Please put an "Y" in the appropriate column

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. Computer art is an exciting new form of art having tremendous possibilities for the future.					
2. University art students should be exposed to computer art as part of their educational program.					
3. Computer art is not creative because it is mechanically designed or produced.					
4. Computer artists do not produce works of high aesthetic quality.					
5. If the Art Gallery of Ontario was exhibiting a collection of computer art graphics you would go and see it.					

Evaluation Questionnaire

Your evaluation of this production.

Please put an "X" in the appropriate box.

	Excellent	Very Good	Good	Fair	Poor
1. Content					
2. Voice over					
3. Length of Production					
4. Timing of Slides					
5. Quality of Colour					
6. Overall Reaction to Production					

Appendix D

	Cost of Production
Film	150
Tape	25
	$175

Hours of work to develop sound-slide production	280 hrs.