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A COMPUTER - MEDIATED MODEL FOR VISUAL PREFERENCE
RESEARCH AND IMPLICATIONS FOR INSTRUCTION
IN ART CRITICISM

DISSERTATION
Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

by
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* * * * *

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Donald Arnstine, in his essay, "Needed Research and the Role of Definitions in Art Education," observes that much recent research in art education is not research in art education at all. He claims that much of that research, heavily influenced by Viktor Lowenfeld, rather constitutes research on personality, on mental health, on emotional adjustment and on art therapy. Such research does not provide answers to the questions Arnstine perceives as central to art education. How do we make a student a better artist or a more discriminating appreciator of art? How do we alter a student's attitudes toward art? How do we improve the student's aesthetic standards? The proper direction, according to Arnstine, for art education research is the investigation into "the conditions that enable learners to acquire new attitudes and knowledge about art and aesthetic experience." He also favors research into "the kinds of experience the qualities of which children and youth are capable of apprehending aesthetically."

If art teachers had some idea about the kinds of experience that different youth find immediately valuable in perception, it would be of enormous help to them in devising means of connecting what is both familiar to students and relevant to art to the kinds of art experiences that teachers hold valuable.
In Arnstine's essay, the question presented as central to art education is: "From what kinds of situations do learners currently experience aesthetic qualities?" This question implies within it further questions related to the nature of the stimulus which promotes aesthetic experiences as well as ones related to the individual learner's preferences. The question takes one into the study of the student's taste and calls for the development of taste or preference assessment strategies.

Art, for Arnstine, "refers to any human artifact that has been deliberately made to elicit an experience the emotional impact of which is based, at least, on the perception of the formal relationships of its constituent elements." His definition implies attention to both the nature of the stimulus (deliberately made and formal relationships of its constituent elements) and to the individual's response (emotion and perception). In order to answer his question regarding the kinds of situations in which learners currently experience aesthetic qualities, a researcher must attend equally to dimensions and properties (elements) of the stimulus as to assessment strategies of the individual's response. In fact, it is claimed here that strategies for stimulus property identification, description and independent manipulation are prerequisite to the learner response assessment. One needs to be clear about what property or combination of properties an individual is responding to in the stimulus before that response can be evaluated. Arnstine is presenting the field of art education with a very complex problem as its central area of research. This problem, though a relatively new one for art education, has a history of over one hundred years in aesthetics.
Since 1876 considerable attention has been paid to the systematic study of aesthetics using experimental methods. The work which Gustav Fechner began in that year led early writers to refer to a "science of aesthetics." This new study of aesthetics was to proceed by observation and induction, rather than by deduction from metaphysics, the method used by many philosophers writing on aesthetics. The subsequent work within this experimental tradition has limited itself to those features of art and aesthetic experience which can be described with objective accuracy such as stimulus properties and dimensions, and reports of aesthetic judgment on the part of tested subjects.

In this research literature, visual preference is generally held to mean "the extent to which an individual expresses his relative like or dislike for a given visual stimulus." Aesthetic judgment is distinguished from aesthetic preference and is commonly held to mean "an individual's appraisal of the aesthetic merit of a stimulus according to an external standard of value which is being employed." The appraisal of aesthetic preference is seen to be different from the expression of aesthetic preference in that an individual may find a case where he prefers a given stimulus but judges another to be "better" according to a given standard.

Much of this experimental research has been criticized by philosophers of aesthetics as reductionistic. The need for objective accuracy in the description of variables and the various controls required for the experimental research environment are seen by some to exclude the concerns of greatest importance to artists and critics. Those concerns center on the subtle and complex ways in which a work of art affects a sensitive observer.
Complexity is a major problem which the experimental researcher faces. This complexity manifests itself in both areas of stimulus and response in research design. In regard to the stimulus in visual preference testing, the researcher needs to: (1) identify stimulus properties, (2) describe them using some system of classification, (3) analyze their relationships according to that system, and (4) have control over the properties to afford independent manipulation. The complexity of this task has led some researchers to simplify the visual stimulus which is presented to subjects. In these cases control is achieved by limiting the number of properties of the stimulus. An example of such simplification is found when subjects are tested for their preference of simple polygons or patches of color. Other researchers have addressed the problem of complexity by limiting the number of stimuli presented. Since the task of stimulus property identification and description of more complex pictures or objects is a formidable task, the number of stimuli is limited in order to achieve control. Another method of control had been to test for only one variable at a time. In such cases subjects are shown stimuli that are identical in all respects except one; a single property such as color may be manipulated. Each one of these solutions to the problem of complexity regarding stimulus control have been subject to the reductionist criticism. In a review of twenty recent empirical studies which dealt with preference for visual arts stimuli, George W. Hardiman and Theodore Zernich concluded that:

... a great deal more work dealing with the isolation of the various dimensions of visual arts stimuli must be undertaken. Until the salient properties of visual arts stimuli can be manipulated for experimental purposes, there will be little meaningful explanation of preference behaviour.
Hans and Shulamith Kreitler raise a criticism of preference research in the area of the subject's response. The complexity of response interpretation is raised as an issue in the following:

In studies on preference the experimenter usually poses too general a question, so that the subject is bound to rephrase it more specifically for himself. But since too little is known about the question the subject poses himself, it is often difficult to understand the answer he gives the experimenter.13

These critics see the limited control of stimulus properties and subject response to be a major problem, if not the major problem facing research in preference. The problem exists due to the complexity of the task of isolating and controlling the large number of variables involved in both areas.

**Statement of the Problem**

A major problem facing experimental research in visual preference is created by a limited ability for control of stimulus properties and subject responses. Generalizability over subjects is impaired by this limited control. Control is limited in part by the complexity of the task of stimulus property description, classification and manipulation. It is limited as well by the complexity of continued task-clarification for subjects during testing. Much research in visual preference uses a judgment-task strategy and the subjects' proper understanding of that task is essential to the reliability of the study.

The study at hand assumes as its major problem the development of a functional model for stimulus property description, classification
and manipulation and subject response analysis. While the model potentially has applications to several areas of research requiring picture description, it will be examined in light of the requirements of picture description for visual preference research and preference-based instruction in art criticism.

Chapter II, Methodology, details the procedures followed in the generation of this functional model. It begins with a discussion of the kind of thinking required for model building and theory construction.
NOTES TO CHAPTER I


5. Ibid.

6. Ibid., p. 15.


11. The reader is referred to Chapter III, A Review of Related Literature, where specific studies are cited in support of this point and those which immediately follow.

In her paper "Ways of Inquiring," Elizabeth Steiner searches for "the real helps for the human mind in its endeavor to produce science without defect. . . ." Specifically, she is searching for the ways of inquiring which produce theory. The paper examines traditional conceptions of induction and deduction and introduces a third way of inquiring, retroduction or abduction. Steiner cites Pierce as the source of the term, "retroduction." Pierce uses the terms "abduction" and "retroduction" interchangeably. Pierce argues it is through retroduction that theory arose.

. . . neither deduction nor induction contributes the smallest positive item to the final conclusion of inquiry. They render the indefinite definite; deduction explicates; induction evaluates: that is all. Over the chasm that yawns between the ultimate goal of science and such ideas of Man's environment as, coming over him during his primeval wanderings in the forest, while yet his very notion of error was of the vaguest, he managed to communicate to some fellow, we are building a cantilever bridge of induction held together by scientific struts and ties. Yet every plank of its advance is first laid by retroduction alone . . . and neither deduction nor induction contributes a single new concept to the structure.

Pierce recognized three main stages of inquiry and retroduction comprised the first of these three. It often is the result of a "surprising phenomenon, some experience which either disappoints an expectation, or breaks in upon some habit of expectation. . . ."
The inquiry begins with pondering these phenomena in all their aspects, in the search of some point of view whence the wonder shall be resolved. At length a conjecture arises that furnishes the surprising fact as necessary consequent upon the circumstances of its occurrence together with the truth of the credible conjecture as premises. . . . The whole series of mental performances between the notice of the wonderful phenomenon and the acceptance of the hypothesis . . . I reckon as composing the First Stage of Inquiry. Its characteristic formula of reasoning I term retroduction. . . .

Steiner summarizes Pierce's distinctions between the three stages of inquiry in the following:

A "cork-screw" has led us to retroduction, deduction and induction as helps to the mind in developing science without defect or characterization of objects which permit control. Through retroduction, one devises characterizations—statements or theory about objects. Through deduction, one clarifies and completes such characterizations. Finally, through induction, one determines the objects falling within the range of the characterization. Retroduction devises, deduction explicates, and induction evaluates. 4

This chapter on methodology begins with this discussion of stages of inquiry in an effort to provide the language necessary to describe this study. As is the case with much research, the "Problematic situation" which provides the basis for this study was not discovered by a direct route. The discovery of the problem is the result of a combined interest, on the part of the author, in computer graphics and the teaching of art criticism/appreciation. The retroduction stage of this inquiry (that stage which devises the characterization of the problem in a functional model form) is the result of the pursuit of these two apparently disparate areas of interest. Arthur Koestler refers to this process as "bi-sociation" in Insight and Outlook: 
... the creative originality of this matchmaking bi-sociation is not apparent in the smooth syllogistic scheme. The scheme gives the impression that the mental achievement consisted in drawing the conclusions. In fact the achievement was to bring two premises under one roof, as it were. The conclusion is merely the offspring of the marriage, arrived at by routine actions. In other words, syllogism and deductive reasoning are not the method of creative thought, they merely serve as its formal justification after the act (and as a scheme for repeating the process by analogy after the original bi-sociation of the two fields in which the premises are representatively located). The solutions of problems are not "invented" or "deducted"—they are "found"; they "occur". 5

This interest in computer graphics soon introduced the author to the problem of pictorial data generation (described in detail in Chapter III, Review of the Literature). A body of literature on picture processing and picture description was uncovered. This literature addressed the problem of translation of picture elements into a numerical code appropriate for computer display and manipulation.

At the same time, interest in the teaching of art criticism and appreciation led the author to a body of literature involving picture description for different purposes. The work of Edmund Feldman, Elliott Eisner, and others in this area utilizes description of the work of art as the starting point for art criticism. 6 (This work is also described further in Chapter III, Review of the Literature.) The simultaneous study of the literature on picture processing and description is computer graphics and picture description in the literature on art criticism set the stage for the beginnings of this study. The characterization or reconceptualization of the problem (retroduction or bi-sociation) began in this way.
An initial, tentative hypothesis was formed:

"Can the technique of picture description currently developed for areas of computer graphics be utilized in the picture description process as it is used in the teaching of art criticism?"

Further study of the picture processing literature showed that the tentative hypothesis was too general and untestable in its present form. Picture processing in computer graphics is done for a wide variety of purposes (this is detailed in Chapter II, Review of the Literature) and the techniques of picture description vary depending on the purposes at hand. One special-purpose, picture description process did present itself as a viable strategy as the result of further searching. Namely, the picture description techniques used primarily by biological taxonomists: Numerical Taxonomy.

Numerical taxonomy is a classification system, generally computer mediated, which uses digital code to identify qualities of the phenomena to be classed. The system classifies qualities of phenomena based on their degree of visual similarity or their "Phenetic" relationships. "Phenetic" relationships are those based on the overall similarity among objects to be classified. This overall similarity is established by numerically coding and comparing many characteristics of the objects to be classified rather than a few used in the early days of modern science. Traditionally, classifications were based on a single property or characteristic and these were often selected quite arbitrarily. Robert R. Sokal refers to this fact in the following:

Metals are divided into conductors and non-conductors, other substances into those that are soluble in water and those that are not; organisms are divided into unicellular ones and multicellular ones. Some of these
Classifications are arbitrary in the sense that there is a continuum of properties—as in the case of solubility for which the line between soluble substances and insoluble ones is not distinct.\(^7\)

Classifications based on a single or on only a few properties are called "monothetic." In such a system all the objects in a class must share the character or characters under consideration. Classifications based on many characters are called "polythetic." In such systems one character or property is not required of all objects in a class. Sokal cites the fact that there are birds that lack wings and mammals that do not bear their young as examples of polythetic classification.

In such cases a given "taxon," or class, is established because it contains a substantial portion of the characters employed in the classification. Assignment to the taxon is not on the basis of a single property but on the aggregate of properties, and any pair of members of the class will not necessarily share every character.\(^8\)

The development of computer techniques which tabulate and process large numbers of characters has made polythetic classification more reliable. The theoretical application of polythetic classification to the problems of identification, description and manipulation of visual stimulus properties is one of the methodological procedures used in generating a functional model.

The term model is used in several ways in different literature. Sometimes it is substituted for terms like theory, analogy, hypothesis and flow chart. It is given a rigorous definition in one context and used very loosely in another. A model can simply represent an attempt to describe phenomena and to indicate approaches to the study of those phenomena. This study presents a functional model. A
functional model is not necessarily descriptive or comprehensive. It specifies certain relationships among elements of a process in such a way that new relationships or propositions can be generated from the model itself. The proposed model is not presented as the model for all of visual preference research. It is neither comprehensive nor inclusive of all of the elements involved in such research. It is rather a model for solving problems identified with that research. It uses problem identification and analysis as its starting point. The nature of the problem suggests the procedures outlined by the model.

CRITERIA FOR EVALUATING THE MODEL

The principal criterion for evaluation of this model is its responsiveness to the criticisms leveled by authors who have reviewed visual preference research. These criticisms fall into two areas: inadequate descriptive strategies for visual stimulus properties and the task confusion of test subjects in the selection of preferred stimuli. The test of responsiveness is in the area of fidelity and utility. The model is held accountable for a significant increase in descriptive fidelity to the selected stimuli. The model's utility is examined in light of its ability to meet the principal aims of preference research and the degree to which it increases task clarification for the test subject. The use of fidelity and utility as criteria for evaluating functional models is in keeping with standard practice.
FIDELITY

The fidelity of the model is examined in relation to the significant increase of descriptive capability of the visual stimulus properties. While the model does not claim an exact, one-to-one relationship between the property described and the descriptor unit, descriptive capacity must be significantly increased. This significant increase in fidelity is demonstrated through the possibility of reconstruction of the visual stimulus from its descriptive units. The stimulus is more than the sum of the descriptive units and exact reconstruction would require more data than is required by the nature of preference research. The current practice in visual preference research makes use of only a few descriptor units and the possibility of reconstruction based on those units could not be considered.

UTILITY

The utility of the model is examined in relation to its responsiveness to the criticisms leveled at the current practice. Specifically, it must address those of reductionism, standardization of treatment and subject task clarification. The model's utility is also assessed regarding its capability for and efficient performance of subject response analysis.

LIMITATIONS OF THE STUDY

This study is limited to the design of a functional model for visual preference research. It takes a problem-solving approach to a number of specific problems encountered in current practice. The model
is tested conceptually by the application of *fidelity* and *utility* as criteria. The principal arguments offered in Chapter IV in support of the model are drawn from numerical taxonomy and computer literature. The evidence that is provided for descriptive fidelity and utility is evidence resulting from research in these fields. This evidence is offered in support of selected features of the proposed model. It is offered when there is a clear correspondence between the problem to be solved in visual preference research and the problem solved in the related field. The application of conceptual tests for the model's validity and the analogous nature of the arguments add a tentativeness to the study's findings.

The proposed model must be empirically validated as to its fidelity and utility in the area of visual preference research. The conception of the model and its empirical validation are seen as two separate studies by this author. The identification of the problems, the generation of a functional model to address those problems, and the communication of that model to colleagues, is seen to be a significant and valuable research effort in itself. Grant assistance is being sought to provide the opportunity for empirical validation of the model. The results of such an attempt at validation will comprise another study by the author.

The study is also limited in that it does not identify the appropriate taxonomic or descriptor units for visual stimuli. Rather, it is argued that the model can accommodate a large number of taxonomic units. These units can be of at least six different types and that five different taxonomic strategies are possible in their selection. This
author has chosen not to make the value decisions as to the appropriate units. These could vary depending on the nature of the stimuli and the purposes of the study. The types of taxonomic units and selection strategies are discussed in detail in Chapter IV.

Summary

The methodological procedures followed by this study are as follows: They are presented in a step-by-step fashion by way of summary. The study:

1) Identifies the nature of the problem in visual preference research.
2) Identifies the nature of the descriptive problem in numerical taxonomy and computer picture description literature.
3) Integrates the separate literatures in a single review.
4) Establishes correspondence between the problems as addressed by the different literatures.
5) Identifies the procedures for addressing the description problem in the outside fields.
6) Develops a functional model for applying these procedures to the stimulus description problems in visual preference research.
7) Conceptually tests the model applying fidelity and utility as principal criteria.
8) Proposes further empirical testing of the model for its validation.
NOTES TO CHAPTER II


3. Ibid., p. 367.


8. Ibid.


10. Ibid., pp. 94-95.
CHAPTER III
A REVIEW OF RELATED LITERATURE

This chapter reviews the literature which has relevance to the problem stated in Chapter I. Three different fields have literature related to the problem. These fields are visual preference research in experimental psychology; pedagogical literature in the field of art education regarding art criticism and art appreciation; and technological literature in computer science relative to computer graphics. The significance of the literatures reviewed and their relationship to the problem at hand will be established in following chapters.

I
A SURVEY OF VARIABLES AFFECTING EXPRESSIONS OF VISUAL PREFERENCE

The gestalt theory of perception is central to the discussion of variables which affect aesthetic preference. This theory characterizes perception as an active process, capable of varying in different individuals observing the same scene. The meaning the viewer ascribes to the scene may thus be said to be in part derived from the mode of perceiving. This mode of perceiving can be subject to the many variables within both the stimuli and the viewer. However, the resulting meaning
is not purely idiosyncratic but is mediated by both the form and medium of the stimuli.

For the purpose of clarification of issues within this discussion, two operational definitions of aesthetic preference are set forth. There will be the occasions when aesthetic preference will be discussed generically; in these cases it will be held to mean "the extent to which an individual expresses his relative like or dislike for a given aesthetic stimulus." On other occasions aesthetic preference will be discussed as a measured variable within an experimental research context. In these cases the term will be understood to mean the following: "Aesthetic preference, as a measured variable, is the extent to which, when a person expresses (by word or action) his relative liking or disliking of various stimuli, this relative preference for various stimuli corresponds to their aesthetic value as defined by the external standard." This external standard varies with many of the research studies to be cited. In some cases the subjects' preference choices will be compared with the choices of expert judges, in other cases with the choices of other subjects or a control group and in still other cases the preferences may be analyzed and ranked according to a given set of criteria.

While there is some confusion in the literature the distinction between "aesthetic preference" and "aesthetic judgment" will be made here. In the case of the former the subject indicates (by word or action) his relative liking or disliking of the stimuli, in the case of the latter he appraises its aesthetic merit according to the external standard of value which is being employed. Aesthetic judgment can be
understood in another sense. The above definition calls for an explicit standard of value so necessary for psychological testing. Aestheticians have used the quality of critical reasons provided in support of an aesthetic judgment as a criterion or external standard for such a judgment.

In beginning the examination of possible variables affecting aesthetic preference, one can ask a series of questions related to the origin and development of preferences. Is there any research to indicate whether preferences are innate or acquired? If they are in any way acquired, how early does this take place and what affects this kind of learning? Do preferences change as an individual matures? The variable, affecting aesthetic preference, raised by such questions could be called "age" or "maturation."

While the evidence is tentative in both areas a proper answer to the question, "Are aesthetic preferences innate or acquired?" would have to be affirmative in both cases. Since preference is dependent upon perception and to some degree an idiosyncratic "mode of perceiving," it is not at all unlikely that an individual inherits some traits, physical or chemical, which biologically affect his "mode of perceiving." It is also possible that an individual inherits certain predispositions in much the same way he inherits physical characteristics. Without becoming embroiled in the famous "nature vs. nurture" dispute, let it suffice to say that it is possible that certain elements are innate but that much evidence supports the fact that preferences are acquired.

Broudy speaks of the difficulty of identifying the origins of preference:
The attitudinal component is being formed from the first day of life, with the result that the origin of many of our likes and dislikes is a mystery to ourselves, our parents, and even to our psychoanalyst. By the time the youngster enters school, he is already equipped with a repertory of preferences, often without knowing how he came by them and whether they are beneficial or harmful.

In response to the second question as to how early preference becomes manifest, studies indicate that the three-month-old infant is able to perceive certain properties of objects, and demonstrate preference for objects having these properties. Most of these studies indicate the infant's ability to perceive color differences and to express preference for certain colors over others. In one of the cases cited, Staples studied 262 infants from 69 days old to 24 months. Using four bright colors and gray, she studied the infants' grasping and attending behaviors. Preferences for the colors over gray emerged as early as three months and preferences between the various colors by the twelfth to the fifteenth month.

In a longitudinal study checking fifty subjects from ages two to ten, Ames, Learned, Nestreux and Walker found marked central tendencies in response which changed with age in a somewhat predictable fashion. The test utilized ten standard Rorschach inkblots which were presented year after year to the same child. The researchers found that quite different perceptual responses were elicited as the child matured. They found a slight tendency to direct more attention to the major details of the stimulus, a strong trend toward more accurate identification of major details, and an increased ability to combine color and form as the child grew older. While this study tested perceptual responses and not preference choices, it is significant in that its findings show
the child attending to different properties of the stimulus as he matures. It is also assumed that this point is reinforced by the commonly held notion of developmental stages in "child art." Child makes this point as well: "As a child's cognitive functions develop, his 'artistic' productions will change in an orderly way because they depend upon and reflect his perceptions." 8

French constructed a test involving preference choices which would seem to support the perception-preference connection. The test contained thirteen pairs of drawings which he had developed. The drawings were the same in subject and organization, but differed in the amount of detail. French found that elementary school children had a distinct preference for the more simple drawings of the pairs, while their teachers preferred the more complex drawings. 9

While these studies provide supportive evidence for the fact that preference changes with age and that part of that change may correspond to cognitive development and maturation, one must ask an additional question. Are there other variables which affect this change?

The hypothesis has been set forth at times that preferences are simply a product of social learning. Broudy addresses himself to this issue:

One can say that the interpretive frame for valuing and evaluating is constituted by a set of likings and aversions, together with a set of concepts (criteria) of what likings are approved or disapproved, by some reference group. The ordinary man's likings and aversions, at any given moment, are shaped by his own experiences of pleasure and pain and by the approval rules of his normal reference group. 10

Broudy refers to the influence of the normal reference group and it would seem to follow that a change from one reference group to another would
create a corresponding change in preference, at least to some degree. This would appear to apply in the case where an individual accepts as his own certain evaluations which are currently fashionable among the elite. Another example might be found where the individual learns to value that art work which has renown or brings a high price in auction.

Research exists which supports the influence of social learning on preference. Farnsworth and Beaumont (1929) found that a painting was, on the average, rated more attractive when accompanied by a legend suggesting that it was highly regarded by experts and by the social elite. An additional study by Sherif (1935) found that students' evaluations of passages of prose were altered when these passages were falsely attributed to authors of renown. These studies demonstrate some degree of influence for social learning, but they fail to establish that the "prestige effect" or social pressure is the sole or even most important influence on preferential reactions to works of art. Child presents the argument that "... the effect may with at least equal plausibility be ascribed to the altered understanding of the stimulus, brought about by viewing it in the different context the experimenter has provided in his attempt to associate its acceptance with prestige."

As one might expect, there is evidence that training in art or what other researchers call "background in art" is a variable affecting preference. McWhinnie in a review of research summarizes these findings.

Individuals with training in art seem to prefer more complex figures; whereas, those without training prefer the simple figures. Studies by Rosen, Barrow, Beebe-Center, Davis and Eysenck have shown that perceptual choice seems to be affected by learning.
Child's findings in his study, "Personality Correlates of Esthetic Judgment," supports McWhinnie's summary and revealed some additional findings. In looking for personality variables which characterized those subjects whose choices were most consistent with the choices of a group of judges, Child found interesting results.

The positive ends of these variables, taken together, suggest a person of actively inquiring mind, seeking out experience that may be challenging because of complexity or novelty, ever alert to the potential experiences offered by stimuli not already in the focus of attention, interested in understanding each experience thoroughly and for its own sake rather than contemplating it superficially and promptly filing it away in a category, and able to do all this with respect to the world inside himself as well as the world outside.

Significant positive relations with aesthetic judgment were also found in the Child study relative to aspects of cognitive style:

(a) Tolerance of complexity (accompanied by non-significant correlations in the same direction for tolerance of ambiguity, ambivalence, and unrealistic experience).
(b) Scanning (a tendency toward broad deployment of attention).
(c) Independence of judgment.
(d) Regression in the service of the ego.
(e) Intuition rather than sensation.
(f) Perception rather than judgment.

While this research was done on aesthetic judgment and the subjects were asked to pick one from a pair of slides representing the work which is "better aesthetically," it also showed interesting tentative relations between preference and aesthetic judgment. It was found, for example, that individuals with higher aesthetic judgment scores tended in a color test to choose shades over tints and to some extent shades over hues more frequently than did persons with lower aesthetic judgment scores. Additional preference testing was done in tests of
masculine or feminine qualities in art work and preferences for selected abstract drawings, and particular historical styles with positive results.18

The fact that preferences are not simply a matter of social learning or cognitive development can lead one to ask, "To what degree are preferences the result of a more personal or idiosyncratic learning?"

Kreitler and Kreitler comment on the role of "association" in preference choices.

Associations seem to play a major role in determining the preferences of people for various forms. A person may reject a form when it reminds him of a human face, but may like it as a visiting card or a cigarette case.19

Should this be true, preference choices which are expressed as the result of "associations" would take on the appearance of being quite fickle and unstable, since the operating criteria for the choice are not explicit to the outside observer.

The Kreitler's go on to discuss the role of subject matter and abstraction in the stimuli as they affect association.

It may be expected that forms stripped of explicit object references may stimulate even more associations and of greater variety than forms suggestive of specific objects (Fanderplas and Garvin, 1959). Similarly, while the clear-cut form of a tree tends to restrict associations to the theme of trees or settings in which they have been seen, the form of a circle on top of a vertical line is potentially more likely to evoke associations to a great many things outside the realm of trees.20

McWhinnie's review of experimental research in this area supports this notion that specific properties of the stimulus are of great importance in preference choices.

There seems to be a high correlation between aesthetic preference for geometric and abstract drawings with preferences for reproductions of works of art. Based
on this finding from the work of Barrow and Eysenck we might conclude that figure preference depends upon the arrangement and use of visual elements in the stimulus object rather than on the subject matter found in the work of art.21

Associations appear to increase with certain arrangements and visual elements. Symmetry and forms with many curves seem to elicit more associations than rectilinear or asymmetrical forms.22 The Kreitler's furnish a more thorough discussion of this subject in their book.23

**Critiques of Preference Research**

The preceding section has been a review of research on some of the variables affecting aesthetic preference. Those variables found to have a positive correlation are: age and maturation, social learn­nings, association, specific properties of the stimuli, cognitive style and personality characteristics, as well as background in art. All of the researchers are careful to stress the tentative and inconclusive nature of their findings, however.

Some authors have been critical of the research in visual preference. In a review of twenty recent empirical studies which dealt with preference for visual arts stimuli, George W. Hardiman and Theodore Zernich portray methodological questions critical to the proper utilization of the judgment-task research strategy.24 (Table I, prepared by the reviewers, shows the studies reviewed as well as methodological characteristics of the studies.) The reviewers examine the degree to which the studies selected utilized (a) control of stimulus properties, (b) precision of measurement, and (c) generalizability over subjects.
They argue that judgment-task is the primary operational mode for making observations about preference for visual arts stimuli.

Regarding the control of stimulus properties in the studies reviewed and in general, Hardiman and Zernich make the following observation.

One of the many problems in preference research using visual arts stimuli is how to construct a workable taxonomy of stimulus properties with which to describe works of art (Berlyne, 1972; Goude, 1972). In addition to describing a range of styles and artists, such a system must be capable of classifying their similarities and differences.25

Five of the studies reviewed directly focused on style as an influencing factor in preference judgments (Bernard, 1972; Kloss and Dreger, 1970; Loveless, 1968; Rosenbluh, Owens and Pohler, 1972; Roubertoux, Carlier, Chaguiboff, 1971). The reviewers are critical of the way the variable of style was treated in these studies.

Little effort has been given to the identification of the specific attributes that make observable differentiations among visual art stimuli from various stylistic periods possible. Since there is little continuity associated with style as an influencing variable in preference research, it is not possible to reach closure on this issue.26

They also comment on the difficulty of isolating the variables of dimensional preference and complexity when using visual arts stimuli. Some of the stimulus dimensions used in the various studies were: content, color, degree of realism, pattern of light, quadrant distribution, depth of field and complexity. Most of the dimensional variables listed, however, "have not demonstrated a great deal of reliability or strength in shaping preference judgments," according to the reviewers.27
<table>
<thead>
<tr>
<th>Study</th>
<th>Research Strategy</th>
<th>Stimulus</th>
<th>Instrumentation</th>
<th>Subjects</th>
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<th>Related Variables</th>
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</thead>
<tbody>
<tr>
<td>Bernatz 1972</td>
<td>Judgment task, survey</td>
<td>Picture postcards of 20 paintings</td>
<td>Questionnaire/ interview</td>
<td>20 M, 22 F</td>
<td>Frequency</td>
<td>Sex, style</td>
</tr>
<tr>
<td>Child &amp; Iwan 1968</td>
<td>Judgment task</td>
<td>80 pairs of slides of paintings</td>
<td>Paired-comparison, questionnaire</td>
<td>32 M, (Japanese)</td>
<td>Frequency</td>
<td>Personality, culture</td>
</tr>
<tr>
<td>Iwan, Child &amp; Garcia 1968</td>
<td>Judgment task, survey</td>
<td>54 pairs of photographs of art objects, 24 pairs of postcards of paintings</td>
<td>Interview, paired-comparison</td>
<td>4 M, 27 F (Japanese)</td>
<td>Frequency</td>
<td>Culture, training</td>
</tr>
<tr>
<td>Jamison 1972</td>
<td>Judgment task</td>
<td>7 photographs, ranging in degree of abstraction</td>
<td>Survey, Personality</td>
<td>7 M, 7 F</td>
<td>Correlation</td>
<td>Personality</td>
</tr>
<tr>
<td>Klein 1968</td>
<td>Judgment task</td>
<td>25 pairs of drawings</td>
<td>Rating scale</td>
<td>26 art professors</td>
<td>Correlation</td>
<td>Judge characteristics</td>
</tr>
<tr>
<td>Klein, Shager 1967</td>
<td>Judgment task</td>
<td>60 drawings</td>
<td>Sorting</td>
<td>10 untrained judges</td>
<td>Chi Square</td>
<td>Spontaneity, deliberateness</td>
</tr>
<tr>
<td>Klee, Getlin &amp; Segal 1973</td>
<td>Judgment task</td>
<td>12 slides of paintings</td>
<td>Rating scale</td>
<td>36 F</td>
<td>Mean ratings</td>
<td>Exposure time</td>
</tr>
<tr>
<td>Lowther 1968</td>
<td>Judgment task</td>
<td>160 slides of paintings</td>
<td>Binary judgment</td>
<td>216</td>
<td>Correlation, factor analysis</td>
<td>Style</td>
</tr>
<tr>
<td>Reference</td>
<td>Judgment task</td>
<td>15 pictures of paintings</td>
<td>Content analysis</td>
<td>120 boys (6-12 years of age)</td>
<td>Frequency</td>
<td>Development</td>
</tr>
<tr>
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<tr>
<td>Nelson &amp; McDonald 1971</td>
<td>Judgment task in laboratory setting</td>
<td>15 pairs of pictures of paintings</td>
<td>Paired-comparison</td>
<td>10M, 19F</td>
<td>Frequency</td>
<td>Lateral organization of paintings</td>
</tr>
<tr>
<td>Osborn, Farley 1970</td>
<td>Judgment task</td>
<td>62 color reproductions of paintings</td>
<td>Sorting, ratings</td>
<td>30S6</td>
<td>ANOVA</td>
<td>Complexity</td>
</tr>
<tr>
<td>Rosenbluth, Owens &amp; Pohler 1972</td>
<td>Judgment task</td>
<td>11 pairs of sides of paintings</td>
<td>Paired-comparison and Mander Personality Inventory</td>
<td>25M, 2SF</td>
<td>ANOVA</td>
<td>Personality, style</td>
</tr>
<tr>
<td>Roubenaris, Carter, Chemnoff, 1971</td>
<td>Judgment task</td>
<td>28 pictures of paintings</td>
<td>Art Preference Scale, Calli Personality Inventory, Zulliger Test, paired-comparison</td>
<td>70M, 17SF</td>
<td>Likert</td>
<td>Personality, style</td>
</tr>
<tr>
<td>Rump &amp; Southgate 1968</td>
<td>Judgment task</td>
<td>46 art objects</td>
<td>Questionnaire, content analysis, paired-comparison</td>
<td>65M, 70F (3 different age groups)</td>
<td>Frequency, correlation, Chi Square</td>
<td>Development</td>
</tr>
<tr>
<td>Salkind &amp; Salkind 1971</td>
<td>Judgment task</td>
<td>30 color postcards of paintings</td>
<td>Single preference judgment</td>
<td>45th &amp; 4th grades</td>
<td>Chi Square</td>
<td>Degree of representation</td>
</tr>
<tr>
<td>Skeger, Schults &amp; Klein 1966</td>
<td>Judgment task</td>
<td>46 drawings</td>
<td>Judgment ratings</td>
<td>26 trained judges</td>
<td>Correlation factor analysis</td>
<td>Training, structural-organizational</td>
</tr>
<tr>
<td>Swartz &amp; Hewitt 1970</td>
<td>Judgment task</td>
<td>20 pairs of slides of paintings</td>
<td>Paired-comparison</td>
<td>20M1, 20F</td>
<td>ANOVA</td>
<td>Lateral organization of paintings</td>
</tr>
<tr>
<td>Swartz &amp; Swartz 1971</td>
<td>Judgment task</td>
<td>12 sets of photographs of paintings</td>
<td>Paired-comparison</td>
<td>25M, 2SF</td>
<td>Chi Square</td>
<td>Lateral organization of paintings</td>
</tr>
<tr>
<td>Wilson, Ausman, &amp; Mathews 1973</td>
<td>Judgment task</td>
<td>20 slides of paintings</td>
<td>Rating scale, Willm- Patterson Conservation scale</td>
<td>14M, 16F</td>
<td>Correlation, Likert</td>
<td>Complexity, conservation/ liberalism</td>
</tr>
</tbody>
</table>
The researcher's ability to identify a range of cases or samples representative of any one dimension has been a difficult task. In the column marked "Stimulus" Table 1 shows the range of stimulus samples in twenty recent studies. The stimulus range in these studies is from seven photographs to 160 slides of paintings. Fifteen of the twenty studies worked with fifty or fewer stimulus samples. It cannot be claimed that "more is always better" in preference research; a given study may by design choose to test preference within a limited set of samples. It is argued here, however, that in many cases it would be advantageous to substantially increase the quantity of stimulus. A major impediment in doing so is the present taxonomical structure used to identify visual stimulus dimensions.

II

VISUAL PREFERENCE AND THE TEACHING
OF ART CRITICISM

Distinguishing Between Appreciation and Criticism

Thomas Munro uses the term "appreciation" in a broad sense and refers to evaluation and criticism as subsets or forms of appreciation. "It (appreciation) refers to the whole process of responding aesthetically to art, nature, or other objects." In appreciation, according to Munro, one should:

... seek to understand the full richness of the cultural heritage that enters consciously into each work of art, to distinguish also those elements of real originality that each artist has achieved, and to estimate them at their proper worth in light of carefully thought-out standards.
Criticism, on the other hand, appears to be a public act. It is involved with the evaluative aspects of appreciation; it can be held accountable to justification. "By criticism I mean especially the process of explaining, analyzing, and appraising particular works of art in relation to general standards of value." Munro also uses the term evaluation and describes it as a kind of appreciation.

"Evaluation," in the sense of an explicit judgment of value based on general standards, is a kind of appreciation that requires intellectual development in addition to likes and dislikes. It may even be performed in a purely intellectual, deductive manner when the individual feels no definite emotional attitude one way or the other.

Mary Jane Aschner supports the public and evaluative aspects of criticism in her article, "Teaching the Anatomy of Criticism."

Criticism, as it will be discussed here, is a verbally expressed act of evaluation. A person expresses an opinion or a preference, an acceptance or a rejection of something. He will usually, if called upon, give reasons for his opinion. If these reasons are then brought into question, he may be called upon to state the criteria or standards of judgment upon which he has based his appraisal.

Harry S. Broudy agrees with Munro in that he sees criticism as a kind of appreciation. He defines appreciation as "an enlightened taste that combines likings and reasons." The critical response is seen as a level of appreciative learning.

There are four levels of aesthetic judgment on which the critical response can be made:

1. The vividness and intensity of the sensuous elements in the work of art; the affective quality of the sounds, colors, gestures, and so on;
2. The formal qualities of the object; its design or composition;
3. The technical merits of the object, the skill with which the work is carried out;
4. The expressive significance of the object, its import or message or meaning as aesthetically expressed.

These four levels also mark off the domains of appreciation instruction.34

David W. Wcker adds weight to the arguments of those writers who link evaluation and judgment to appreciation. "Of the body of complex acts which collectively may be identified as appreciatory in nature, the act of justifying one's judgments is an essential feature of appreciation."35

Kenneth Marantz refers to appreciation as "the human action of (1) comprehending works of art with knowledge, judgment, and discrimination and (2) being critically and emotionally aware of their aesthetic values."36 For the purposes of instruction, Marantz suggests a schematic of two categories, analytical and synthetic.

The analytical categories are the ones which either teachers or students use to find out what might have gone into the creation of the work of art. The synthetic categories are those which depend upon the individual's capacity to get something out of the work other than the facts of analysis.37

Within such a schematic Marantz attempts to account for and integrate both the cognitive and affective aspects of appreciation contained in the definition.

Stephen Pepper, consistent with the gestalt position, describes the experience of appreciation as an interaction between stimulus and observer. "The possibility of that experience lies in the structure of the physical object to which we respond. The condition for our having the experience lies in ourselves."38

One difficulty most of the authors have in writing on the nature of appreciation is that of properly characterizing both the
cognitive and affective aspects of the experience. This difficulty has led authors like Broudy to invent hyphenated terms like "Enlightened-Cherishing" to accommodate both domains equally. Appreciation appears to operate in both domains. Benjamin S. Bloom places knowledge, analysis, and evaluation in the cognitive domain and receiving (attending), responding, and valuing in the affective domain. Evaluation is claimed to involve all the behaviors of knowledge, comprehension, application, analysis, and synthesis plus criteria including values.

Evaluation represents not only an end process in dealing with cognitive behaviors, but also a major link with the affective behaviors where values, liking and enjoying (and their absence or contraries) are the central process involved.

In an attempt to distinguish between the act of "appreciating" and the act of "criticizing" it can be argued that the two operations share common qualities with "appreciating" being more generic than "criticizing." Criticism has several distinct elements which are not necessary to appreciation. It demands a public report of some type, appreciation does not. It places more emphasis on analysis and evaluation than does appreciation. While one might be tempted to say that criticism is a form of appreciation, cases can be found where an individual may be said to be engaged in criticism and yet not manifest the "valuing" necessary for appreciation.

The Teaching of Criticism and Appreciation in Art Education

The teaching of appreciation and criticism in art education must attend to learning in both the cognitive and affective domains.
Bertram Jessup calls our attention to the components of criticism in the following:

The experience of art, which it is the business of the critic or, allowing for division of labor, of the collective critical discipline to instruct, to guide, to foster, has two phases, understanding and appreciation (feeling).  

Jessup is quick to admit that these phases are not separate and independent of one another but rather are interdependent in the aesthetic experience. "The art object to be felt in appreciation must be understood, and the understanding to be aesthetically significant must lead to felt appreciation."  

Broudy addresses himself to components of criticism and makes some useful distinctions.

The most noticeable characteristic of our value experience . . . is that it contains two components that are only loosely related. One may be called the attitudinal component, the other the theoretical or justifying component. The first tells what one likes; the second tries to give reasons for liking it.  

Broudy goes on to speak of the age-old war between heart and head and speaks of its pedagogical counterpart, cognitive and affective learning. The literature on criticism is filled with references to knowledge and understanding art objects as well as references to felt-appreciation, valuing, empathy, liking and enjoyment. There appears to be consistent agreement among the writers in the literature on the nature of art criticism that both cognition and affect are involved in the aesthetic experience and that these are significant components of criticism itself. The dual components create clear pedagogical problems for the teaching of criticism.
Problems Involved in the Teaching of Appreciation

The first problem which presents itself is that of organization of content for instruction. Appreciation, we have seen, is a complex act which requires many knowledges, skills, and attitudes. It is difficult to conceive of teaching the diverse skills of description, analysis, evaluation and the attitudinal components as a whole and simultaneously. Marantz argues that instruction "can attend to various aspects of appreciation at different times for different educational objectives." He suggests that such a division could be based on a series of fundamental questions asked of the work, designed to achieve a given educational objective. Smith's verbal classifications of Syntaxics, Semantics and Pragmatics is suggested. David W. Ecker presents a similar schema in his article, "Categories of Aesthetic Content in Aesthetic Education." Marantz also refers to Stephen Pepper's simpler system of analyzing details in terms of their relevancy or irrelevancy to the perception of the work of art. As we have seen earlier, the division he proposes is that of the Analytic and Synthetic. The Analytic is made up of (1) Identification, (2) Description (literary, technical, and formal), and (3) Context. The Synthetic is made up of (1) Association, (2) Critical, and (3) Friendship. The accumulated experience gained from these instructional subsets is "preparatory for the ultimate experience of appreciating a work of art, for developing a friendship with it."

A second problem related to instruction in appreciation is in the selection of appropriate works of art, reproductions, and objects.
The question of "appropriateness" can be addressed from several points of view. Munro raises the issue of "appropriateness" in relation to age and intellectual development of the student.

... I propose that the training of critical powers should be one of the dominant aims of art instruction on all levels. It is a process which can be continued from early childhood through graduate school, in application to different materials, and with changes in method to keep pace with the growth of mental ability.48

He suggests that with the young child the teacher should encourage him to express his preferences and to give reasons for these preferences. The child should be encouraged to notice and point out qualities which distinguish one object from another. As this ability to observe and compare increases, he should be encouraged to raise his discussions to the level of abstract ideas and general principles. During the "self-conscious" adolescent period students could be directed to study personalities and biographies of artists, or a study of portraiture and caricature. Munro also suggests that these students study instances of "dramatic situations" and expressive attitude in works of art. He goes on in an attempt to search for content "appropriate" for appreciation for various levels in college.

Marantz addressed the questions of "appropriateness" in relation to certain age groups and social classes.

Much more might be gained in appreciating the emotional effectiveness of color through an analysis of advertisements in periodicals like Life, Look and The New Yorker with some students than in seeking similar understandings in paintings by Ensor and Van Gogh.49

"Appropriateness" is used in the same chapter in reference to reproductions and their quality, the number of objects used in appreciation
classes, appropriate comparisons between objects and the instructional environment conducive to appreciation.

**Problems Involved in the Teaching of Criticism**

The educational problems of teaching criticism are similar to those of appreciation. Division of content and appropriateness as detailed above apply here as well. The additional demand of a necessary "report" not found in appreciation calls for additional instructional procedures. The general method proposed for the teaching of criticism popular today calls for a phenomenological description of "what is there in the object." Then the student moves through the stages of analysis, interpretation and evaluation. In each successive stage the student is to make new generalizations only in relation to the referent, the object itself.

Aschner sees the process as threefold in having students recognize that judgments are expressed and explained by Ratings, Reasons and Rules. Aschner's methodology begins with encouraging students to make preference ratings and to move through the stages of Reasons and Rules, using the students' ratings as judgments in need of a defense. This is very similar to Munro's method of teaching appreciation to the young child. This method draws the individual student into the study, in that his preference is the subject of the study as well as the original art work.

A distinct educational problem in the teaching of criticism is that the phenomenological approach calls for a kind of "disinterested"
description and analysis. This process tends to become too cerebral, as the student is cautioned to avoid associative responses, at least in the beginning. It is hoped that the emotive responses will return once the work is described, analyzed and interpreted. The Aschner method permits an integrated response in the beginning; one that may be personal and idiosyncratic and moves on to analysis from that point. This approach demonstrates to the student that a judgment he may make has merit based on the reasons he provides and the application of reasons to "rules." It points out that not all judgments are of equal value. Democracy of opinion and ideas is a common value held by students unfamiliar with critical reasoning and calls for a sensitive, non-authoritarian methodology of instruction. Such a method would permit the student to maintain and hold his personal preferences, but encourage him to examine the relative merit of his position in light of reasons. Accomplishing this delicate task is a major problem in the teaching of art criticism.

The influences of the phenomenological tradition, which asks for a high degree of objective accuracy, can be seen in models developed for the teaching of art criticism. Most of these models place the accurate description of the work of art as their first step and the following steps of interpretation and evaluation are to refer only to that which can be objectively verified and supported by the description. Statements which are labeled as psychological reports, associative responses and intentional fallacies, in other words, any individualistic or idiosyncratic response or expression of preference, are discouraged as not being objectively verifiable. Admittedly, this
direction in the teaching of art criticism follows upon many excesses in the other extreme. The need to be systematic has taken teaching of art criticism back to the research model of the physical sciences.

If it can be assumed that one of the goals for the teaching of art criticism is to heighten the student's appreciation of art and to increase his aesthetic experiences both quantitatively and qualitatively, the methods proposed above seem to systematically exclude any response that is personal or individualistic. This establishes a kind of scientific, objective distance between the student viewer and the object of criticism. While this "scientific attitude" assumed for the purpose of detailed study of the object does not eliminate the possibility of more personal involvement with it, the current methods of teaching art criticism offer no systematic way for this to occur. A student may be able to describe, interpret, and evaluate a work of art with great erudition using these methods, and yet have an extremely meager aesthetic experience with it.

This study argues that the systematic inclusion of the personal, idiosyncratic responses of the student are important in his learning of any method of art criticism. It is argued that this importance is established by the nature of the aesthetic experience itself, which is made up of many aspects which are personal and individualistic in nature; and from the goals and aims outlined for the teaching of art criticism and aesthetic education in general. Munro establishes that one of the principle aims for such aesthetic education is as follows:
(1) It should foster the aesthetic and artistic strains in individual personality through active exercise and application in the observation, production, performance, and discussion of works of art. The aesthetic and artistic strains in personality do not constitute a distinct separate faculty, but consist in certain distinctive applications of the common psychophysical functions and processes. Their development must proceed hand in hand with the development of other functions and abilities.

This study presents a method that begins with the student's responses which are personal and idiosyncratic in nature. It argues that a systematic model for the teaching of art criticism can be developed from a preference base; one which directs the student's attention to one special phase of his own experience after another for analysis of his visual preferences.

The bulk of the studies in experimental aesthetics regarding visual preference have provided this data for comparisons with other persons or groups, or with experts. This was done toward the end of forming generalizations which apply to large numbers of people regarding preference. While this study is designed not to preclude data-gathering for this purpose, the major intent is to provide this data in an interactive, computer-controlled setting, for the participant for his own immediate analysis.

III

THE STATE OF THE ART OF COMPUTER GRAPHICS

The term computer graphics is used to cover four principle areas of investigation: (1) graphical data analysis, (2) graphical data synthesis, (3) graphical data manipulation, and (4) pattern
Much of the graphics treated under these four categories does not strongly resemble what one familiar with the arts would call "graphics." The term is used to cover a wide variety of picture processing for a wide variety of purposes. Picture processing is either the transformation of graphical material, or the generation of pictures from data or abstract rules alone, or combinations of these operations. This picture processing, more often than not, is done for other than aesthetic purposes. A relatively small number of artists, engineers, and computer scientists have an interest in the application of graphics to aesthetic areas.

Man-Machine Communication

The field of computer graphics rises out of a general concern for increased communication capability between man and computers. The emphasis is on "naturalness" of communication and the term "habitability" represents the capability of a computer language to accommodate natural user interface with the computer. The degree of "naturalness" is obviously relative. It clearly would be considered "a natural interface" if the user could simply sit next to the computer and tell it in quiet conversational tone what to do. Simple acts of human communication such as talking, drawing, and gesturing are surely to be considered more natural than keypunching computer cards. Many analog devices have been designed (e.g., light pens, sonic pens, virtual keyboards, function switches) to increase the "naturalness" of the interface between the
human user and the machine. Yet these are a far distance from the future goal projected by A. Michael Noll.

... the communication of the actual subconscious emotional state of the artist could lead to a new aesthetic experience. Although this might seem somewhat exotic and conjectural, the artist's emotional state might conceivably be determined by computer processing of physical and electrical signals from the artist (for example, pulse rate and electrical activity of the brain). Then, by changing the artist's environment through such external stimuli as sound, color and visual patterns, the computer would seek to optimize the aesthetic effect of all these stimuli upon the artist according to some specified criterion.  

While Noll admits that such a man-machine interface system is far in the future, he points to research using advanced signal analysis techniques and electroencephalograms to justify his projection.

At present there is no truly habitable system for the unininitiated. A reasonably habitable system is an important feature in any graphics language.

A reasonably habitable system ... is one whose conventions are easy to learn and whose commands are powerful, yet easy to use. A truly unhitable system would be one that required the user to program all his requests in binary machine code, and a fairly unhitable system might necessitate describing all interactions within FORTRAN syntax.  

While there may be some support for the claim that the computer is anthropomorphic in its design, some gestalt psychologists would argue that there is a vast difference between human intelligence and machine "intelligence." This difference is characterized by the process of pattern recognition in each. The human mind, it is claimed, will take a given stimulus and organize it spontaneously according to the simplest, overall pattern and thus grasp its structural features. This procedure is called by the gestaltists, the approach "from above,"
from the whole to its constituents. It is argued that the computer proceeds "from below." In any routine pattern recognition task the computer takes the stimulus which has been broken into point-sized bits and runs mechanically through the entire set of instances for a match against lists of criteria. In a given case of observing a stimulus the human will notice qualitative characteristics of placement, relative size, shape, etc. The computer's reading of the stimulus must set out from the metric properties of the stimulus in its attempt at recognition.

Citing recent research in the use of computers to model human personality, Gross et al. argue that a simulated human personality may be beneficial in its interpretive value in the man-computer interface.

...it is possible that a great deal of semantic specification of computer input could be relegated to on-line, or even off-line personality models, which in turn would produce from the input a reasonable semantic interpretation.61

Such discussions raise the fundamental question: "How can man and a non-biological device (such as a computer) communicate?" In the early years, the question was answered by putting the burden on man to learn the "ways of the machine." Millions of dollars were spent on teaching man the idiosyncratic ways of machine programming and design. Much of the current research is asking the question in reverse. "How can the machine be made to communicate better; more directly with man?" The proliferation of various analog devices, the concern for "habitability" in program design and a general concern for interaction and human factors, attest to this change in direction. The growth of the graphics industry within computer science attests as well to this
concern. The directness of visual perception, without the necessary step of breaking concepts down into symbolic code, is an important source of knowledge for man. Arnheim speaks of education's general lack of concern for this fact.

We are neglecting the gift of comprehending things by what our senses tell us about them. Concept is split from perception, and thought moves among abstraction. Our eyes are being reduced to instruments by which to measure and identify—hence a dearth of ideas that can be expressed in images and an incapacity to discover meaning in what we see.62

Various educators working within the computer science field are attempting to achieve this direct perceptual-link between man and his symbolic-code machine, the computer.63

Peter Drucker brings to light some of the human factor problems in relation to man-machine communication.64 He states that we are presently dependent upon a translator, the programmer, in our communication with the machine. We are dependent upon him to translate our ordinary language into computer code. Besides the inherent communication difficulties in dealing through a translator, it is a very inefficient method of communication. It slows the computer's speed down to the speed of a human being. Drucker claims that for the problem to be solved man must be "able to put information into the computer directly in something akin to ordinary language and to get out of the computer something akin to ordinary language."65 The research on personality simulation would need to continue for this to be possible. Ordinary language is filled with vagary, tentativeness, and ambiguity, qualities which do not allow for easy reduction to metric code. Research in artificial intelligence, simulation, and heuristics have
demonstrated, however, that ways can be found to include "soft data" in programming without reducing the computer's efficiency. It puts more responsibility on the human interpretation of the computer's output, but can provide much needed data to aid human decision making.

L.A. Zadeh addresses the problem in an article called "Toward A Theory of Approximate Reasoning." He encourages computer scientists in the field of artificial intelligence to simulate approximate reasoning.

The area in question is that of approximate reasoning (or AR, for short), by which we mean a type of reasoning which is neither very exact nor very inexact; e.g., the reasoning that we employ when we decide how to cross a traffic intersection, which route to take to a desired destination, how much to bet in poker and what approach to use in proving a theorem. Such reasoning provides a way of dealing with problems which are too complex for precise solution. However, approximate reasoning is more than a method of last recourse for coping with insurmountable complexities. It is also a way of simplifying the performance of tasks in which a high degree of precision is neither needed nor required. Such tasks pervade much of what we do on both conscious and subconscious levels.66

Charles Csuri suggests that there are presently methods employed in the area of artificial intelligence which would allow one to approach the computer in a somewhat "intuitive" manner.

... certain operations which apparently require an "intuitive" approach can, in fact, be formalized and transformed into algorithmic ones. It is not necessary that the algorithms always be completely formalized; one could advantageously employ heuristic techniques which lie at the heart of the artificial intelligence methodology.67

He contends that in a given case when all the formal requirements may not be known for a particular solution, partial lists of criteria can be used to cut down the number of possible solutions. Csuri suggests that such a strategy may be particularly helpful to the designer.
One might think of it as a useful interactive half-way house: the partial, perhaps heuristically-oriented, perhaps more mathematically-oriented formalisms for "intuitive" criteria enable generation of many more options than the designer can hope to generate, but which may not fully meet the requirements due to partial formalization.

Interactive Computer Graphics

Large amounts of symbolic data (Alpha-numeric) are difficult to process with understanding. It is read sequentially and is subject to one's capabilities to hold or suspend important features in memory as they are compared with new features. It is particularly difficult to suspend important features in memory when the representation depicts movement, or change through time. An early solution to this problem was the design of the simple bar graph, which could represent the function of time in a progressive manner. Such graphs are able to present the basic gestalt or structure of the information in a direct perceptual way.

Ralph Stromquist discusses the effects of interactive components when introduced to such an iconic display.

Apart from avoiding large volumes of printed data, the flexibility and speed of an interactive graphics system allows the user to easily view many alternative cases or solutions in whatever combination of drawings and textural information is most appropriate. Thus projections of three-dimensional layouts can easily be viewed from many angles, or the results of input parameter changes considered for many cases of a problem. This factor of interactive graphics may be described as the time compression factor. Because the user can easily and quickly view the effect of new input data, he will probably take time to do so. This may often lead to better solutions to the problem at hand.
Several authors detail aspects of "interactiveness" other than the time compression factor. Richard Dorf describes the experimental applications.

The essential feature of the man-computer partnership and the use of a visual display graphics terminal is the immediate interaction between man and machine. Ideas and problems are communicated to the machine and their effects and results are displayed rapidly so that the author can change and improve them gradually to produce the desired results. The user is able to think, experiment and design with the aid of the computer and so improve his ideas in a dynamic manner. . . .

Dorf goes on to distinguish between the roles of man and the computer in this interaction.

The computer is adept at calculating rapidly and accurately and storing the results while the person is adept at linking concepts and applying insight and reasoning to a problem.

J.C.R. Licklider describes interactiveness in the computer graphics environment as similar to the design process of the visual artist. Interactiveness in a computer program, according to Licklider is "amenability to intervention, alteration, influence or control by an external agent while 'running' in the dynamic form." The external agent would be a person at a computer terminal or display console.

In review, interactiveness offers the capability to view pictorial displays from multiple points of view, as in a three-dimensional layout. It permits the acceleration or extension of time factors in the study of a model or visual simulation. It permits intervention, alteration and adjustment to new input, while displaying the picture in dynamic form. Such adjustment can be made to the surface qualities of the picture as well as to its structural qualities.
One of the most interesting applications of the various capabilities of the field of interactive graphics is in the area of kinostatistics. Barry M. Feinberg in an article, "Kinostatistics: Communicating a Social Report to the Nation," describes the various uses of computer graphics in kinostatistics. In the same article he quotes Keven J. Kinsella, formerly with Adage Corporation, a manufacturer of interactive computer systems.

In such an interactive environment, the user can very often acquire an intuitive grasp of behavior of complex models exhibiting nonlinear multiloop feedback behavior. System dynamics work could acquire more intuitive significance for observers if the effects of parameter changes were immediately obvious on a CRT rather than having to wait for the interminably slow teletype to print out the graphs line by line.

Successful applications of this method of representing social indicators in dynamic graphical form have been made in the health sciences and in urban growth analysis.

Data Generation in Computer Graphics

Interactive computing existed prior to the development of computer graphics and is not necessarily dependent upon the visual display of the output. Maintaining the interactiveness of the output as it moves into pictorial form, however, has been a prime objective of much of the graphics research. Another prime objective has been the increased quality of the pictures represented in the graphics environment. Initial experiments were restricted to linear representations of simple two-dimensional forms. Since the picture to be presented needs
to be reduced to digital information for the computer's use, the field faced the problem of data generation for more complex pictures. The digital information required for a linear complex form, such as an airplane, is tremendous.

Attempts at solving the data generation problem have been made in the form of program design for various automatic digitizers. These are coordinate scanning devices which transform various input into digital code for machine storage and processing. One such device is the Sonic Pen. The sonic pen is a stylus which is hard-wired to the machine. The user draws on a tablet to input a two-dimensional drawing or within the confines of the spatial volume of a 15 inch cube to input a three-dimensional drawing. A sensitive microphone system picks up sound emissions from the sonic pen and transforms these to digital information. It can be used as a control device as well as an input device as is the case when it is used as a pointer or perhaps an indicator of direction of movement for objects already displayed.

The Light Pen (Figure 1) is a stylus similar to the sonic pen and serves as another example of a coordinate digitizer. It permits the user to draw on the surface of the display screen rather than on a separate tablet. A light-emitting diode is contained in the tip of the stylus and activates a point of light on the display screen through the internal software program. It is often used as a control device as well as for pointing or selecting from a menu of choices displayed.

Other data-input programs have been designed using function switches (Figure 2), dials (Figure 3), and a joystick (Figure 4). Generally in such programs a cursor appears on the display screen and
the user controls the movement of the cursor through a coordinate field with one or more of the above mentioned devices. These various analog devices represent attempts to allow an intuitive, straightforward approach to graphical data input and control. These methods, however, limit quality of the image to a basic line-making paradigm or at best wire-frame versions of the objects they represent. Algorithmic solutions have been sought for the data generation problem. These often involve constructing the object mathematically from various combinations of geometric forms. The surface of the object is seen as if covered with small triangles, polyhedra, or the result of intersecting parabolas. These techniques tend to be much more awkward to use than the analog devices, but do allow for the relatively rapid creation of simple three-dimensional models.

It is a relatively straightforward task, given present technology, to digitize an image of the quality of a half-tone photograph. However, this yields a vast amount of data which require considerable storage area in the computer's memory. These data are two-dimensional in form as well and limit their use as a dynamic model. An additional problem is that the data are listed in an order in which they are scanned by a digitizer. This makes it difficult to identify that part of the data which makes up a given segment of the picture. In the case of a photo of a man's face, it is not clear which part of the data represents the mouth area and consequently independent control or manipulation of the mouth is impossible were the task to simulate movement of the mouth, as in speech. The computer graphics group at the University of Utah have approximated a half-tone quality image of a
The face is divided into polyhedra surfaces in the appropriate format for a hidden-surface algorithm. The group produced an animated film simulating human speech using a cosine interpolation technique to achieve motion.

There have been some attempts at design of voice and tactile response systems for computers. Karen E. Geyer and Kent R. Wilson at the University of California, San Diego, have developed two touch systems for communication with a computer. The first is a three-dimensional force-position system called "Touchy Feely." In this system the operator grasps a ball ("Touchstone") and controls its position in space, while the computer controls the force on the ball via the torques on four motors. The designers hope to eventually simulate a force measurement and feedback system similar to man's neuromuscular feedback system. The second system in operation, "Touchy Twisty," is a force, torque, position and orientation system. It allows the user to feel the docking of one three-dimensional object with another; in other words, to allow the assembly of computer simulated objects. Other touch systems are under development, such as "Magic Glove" which will involve whole hand touch communication, and an "Exoskeleton" for whole body touch-motion interaction with the computer. Geyer and Wilson are working in a field pioneered by A. Michael Noll and J. Batter and F. P. Brooks. Noll has been working on man-machine tactile communication since 1970. Batter and Brooks developed "Gropel-A Computer Display to the Sense of Feel" in 1971.

Virtual keyboards represent another application of tactile communication with the computer. Kenneth Knowlton of Bell Laboratories
has developed a keyboard system which is made up of a large array of black, unlabeled pushbuttons. The buttons can be made to represent a typewriter, a telephone operator's switchboard or any number of other possible symbolic configurations. The system employs a television projection device which allows the blank buttons to be labelled and relabelled individually or in a group. While the buttons are two-dimensional they provide the convenience and kinesthetic feel of physical buttons.

**Color Video Systems and Digital Color Image Synthesis**

There are many research efforts presently going on which use a standard color television for the display of computer-mediated image synthesis. General Electric developed a real-time color display for NASA. It is capable of displaying relatively simple (250-300 edges) 3-D objects in real time. The Philco-Ford Corporation and the Evans and Sutherland Corporation built a real-time simulation system of a harbour scene (CAORF), Computer Aided Operations and Research Facility. It portrays a 240° horizontal field view from the bridge of a simulated moving ship. The visual simulator was constructed for the U.S. Maritime Administration for use in training and research. Evans and Sutherland have also designed NOVOVIEW 6000, a real-time, color simulation of an airport as seen from various altitudes. The System is used in the training of commercial and military airline pilots. The current systems simulate more than 6000 lights.
Researchers at the University of Utah, MIT, North Carolina State University and Ohio State University are making significant advances in the representation of 3-D objects on a color TV monitor interfaced with a computer. In the May-June, 1972 issue of *Art in America*, Robert Mueller postulated a system in which "a person could draw by hand directly into video, in full color, using regular brushes or pens (but without pigments of any sort)." Since that time both Xerox and the Architecture Machine Group at MIT have developed programs which substantially fulfill Mueller's prophecy. The Xerox program is controlled by a program language called "Smalltalk" and has been tested on children ranging in age from eight to fifteen. A child can either paint or draw on the display in black and white or in color using up to sixteen different colors. The program developed at MIT is called "PAINT." The user has a multiplicity of tablet inputs through which he can deploy brush strokes, colors, patterns, textures, line work, pictures and text. After the user has worked with the system for a while he can pick up an existing area in the video painting and begin to use it as his paint brush. The colors used are selected as percentage mixtures of the primaries, with control over saturation and intensity. One can "ink one's brush" by pointing to existing colors on the display as well as by pointing to the "pallet." Flooding a shape mixes the brush color with the existing color in the area. Mistakes can be corrected by pointing to the color "null" which is used to erase desired areas.
Alan Myers of Ohio State University's Computer Graphics Research Group describes some applications of a digital video storage and retrieval system currently under development.

The uses of this system are many and varied. Entire libraries of static and/or dynamic sequences may be developed. The graphical results of experiments may be stored for later retrieval of the results for study and comparison. Perhaps more important than its use as a storage system is the fact that the video data may be read back and calculations done on it. Thus computerized comparisons and manipulations are possible. There are applications to research into visual perception.84

This ability to store, retrieve and perform calculation on a video image is of great importance to this study and will be discussed in Chapter IV. It is important to mention that the Ohio State System uses a conventional Sony television set as opposed to more expensive display devices. Myers continues to mention a major benefit of digital video—improvement of image quality. Currently in video technology, each successive copy made of an original results in degradation of the image as the result of noise and replication inaccuracies. A digital system would permit exact copies, a feature important in research applications from video.

Peter Caranicas, in a report on the work of Bill Etra with an (IVS) Intelligent Video System, announces the availability through Intelligent Video Systems Corporation of a system permitting hand colorizing of video images.85 In this system the color is added by using a light pen on a monitor screen. The system is available with computer software in the range of $50,000. The system is designed primarily for video production and post-production enhancement of video images. In a production context a single director can control three
cameras and their lenses as well as lighting through the computer's mediation. In light of these advances, Robert Mueller's projections in 1972 appear to indeed be naive. He was criticized as being such in several letters to the editor in subsequent issues of Art in America.
NOTES TO CHAPTER III


2. This definition is essentially the one provided by Irvin L. Child in his chapter on "Esthetics" in the Handbook of Social Psychology, edited by Gardner Lindzey and Elliot Aronson.


11. As reported by Child in "Esthetics," The Handbook of Social Psychology.

12. Ibid.

13. Ibid.


16. Ibid., p. 80.

17. Ibid., pp. 79-80.

18. Ibid., p. 75.


20. Ibid., p. 110.


25. Ibid., p. 10.

26. Ibid., p. 11.
27. Ibid.
29. Ibid., p. 117.
30. Ibid., p. 254.
31. Ibid., p. 121.
34. Ibid., p. 316.
37. Ibid., p. 152.
42. Ibid.
44. Marantz, p. 151.

47. Marantz, p. 156.

48. Munro, p. 254.

49. Marantz, p. 178.

50. This method is proposed by Smith, Barkan, Feldman and others.

51. Aschner, p. 431.

52. The work of Smith, Feldman, Barkan, Ecker and others is referred to here.


57. A more detailed discussion of habitability can be found in *Real-Time Film Animation*. Annual Report to the National Science Foundation, Office of Computing Activities, Computer Graphics Research Group, Ohio State University, 1973, pp. 19-44.


65. Ibid.


68. Ibid.


72. Ibid.


75. Ibid., p. 8.


80. Reports on the work of these various groups can be found in Computer Graphics, SIGGRAPH-ACM, Vol. 10, No. 2.


83. PAINT is described in several issues of Architecture Machinations, a weekly newsletter of the Architecture Machine Group, Department of Architecture, MIT, Room 9-518, Lee Nason, editor.


CHAPTER IV
THE MODEL: ITS ELEMENTS AND PROCEDURES

NUMERICAL TAXONOMY

Taxonomists working in the physical sciences have faced the problem of classification according to form, shape and structure for many years. The development of a system to accommodate the two million or so species of living organisms that inhabit the earth has been a formidable task. Robert R. Sokal, a leading proponent of numerical taxonomy, describes it as a system based on "Phenetic" relationships, one which looks for overall similarity among objects to be classified. Other methods of classification have looked for common lines of descent or the temporal relationship among various evolutionary branches. Numerical taxonomists base classifications entirely on resemblance and assume that quantification of degree of similarity is possible. A variety of mathematical coefficients have been devised to represent similarity between objects. In this method various characteristics of objects are identified and are referred to as operational taxonomic units, or OTU's. Sokal describes the procedures following the identification of particular characteristics.

All the characters and the taxonomic units to be classified are arranged in a data matrix, and similarities between all possible pairs of OTU's are then computed based on all the characters.
The similarity between pairs is evaluated by a computer program which generates a similarity matrix showing the similarity value of each OTU with respect to every other one.

In the early classification systems developed by modern science, classification was based on a single property or characteristic. Metals were divided into conductors and nonconductors, other substances into soluble and non-soluble and organisms into unicellular and multicellular. Such classification is called "monothetic" when it is based on one or only a few characteristics. The particular characteristic selected as the sorting criteria was often arbitrary and reflected value bias. Sokal discusses the arbitrary nature of much of this system of classification. He points to the fact that there is often a continuum of properties—as in the case of solubility, for which the line between soluble substances and insoluble ones is not distinct.

The point of arbitrariness in classification is similar to the one made by Hardiman and Zernich in their critique of five recent studies where style was used as the sorting criteria. Their objections were cited in Chapter III, but for the purpose of review:

Little effort has been given to the identification of the specific attributes that make observable differentiations among visual art stimuli from various stylistic periods possible. Since there is little continuity associated with style as an influencing variable in preference research, it is not possible to reach closure on this issue.

Classifications based on many characteristics, rather than on one or a few, are called "polythetic." No single property need be universal for a class. In a discussion of "polythetic" classification Sokal provides the following examples:
Thus there are birds that lack wings, vertebrates that lack red blood and mammals that do not bear their young. In such cases a given "taxon," or class, is established because it contains a substantial portion of the characters employed in the classification. Assignment to the taxon is not on the basis of a single property but on the aggregate of properties, and any pair of members of the class will not necessarily share every character.5

It is obviously easier to establish classifications based on a single property than to do so on the basis of many properties. (This fact accounts in part for "monothetic" classification in a large number of preference studies.)

The classification systems used for visual stimuli in preference research has been monothetic in most cases. Stimuli have been sorted into classes using only a few characteristics. Often a single, value-laden character such as style is used. This practice, the monothetic classification of visual stimuli, has led to research findings which are open to criticism. A subject's preference vote for a given visual stimulus may or may not relate to the particular character used to classify the stimulus. Since other properties of the stimulus are not a part of the classification scheme, it is impossible to verify the nature of the subject's response. The monothetic classification of complex stimuli, such as works of art, has discredited much of the visual preference research at its beginnings. It is not claimed here that these researchers were naive or misguided in their procedures. The polythetic classification of a substantial number of stimuli was unmanageable prior to the computer age. Such classification procedures were not widely known until Sokal's article in 1966.6

The first two elements of the model are Phenetic and Polythetic classification of the visual stimulus. Both are seen to be responsive
to the critics of visual preference research. Both are seen to increase fidelity. The descriptive procedures involved in such classification are examined below.

**DESCRIPTIVE PROCEDURES IN NUMERICAL TAXONOMY**

The description of a given picture by numerical taxonomy is based on many numerically recorded properties. Various digital scanning devices would yield numerically descriptive information in coordinate form. Individual points within the picture would thus be identified as to their location on an X, Y, and Z axis. The number of edges could be generated from the coordinate data. (Image complexity has been one stimulus property used in past preference research. The number of edges in the picture could be used as one OTU describing image complexity.) The point coordinate data would be useful in generating percentage of symmetry, and object placement within quadrants and within the frame as a whole. Most of the picture properties normally associated with formalism could be easily generated by using automatic digital scanning devices. Light level, direction of light source(s) and, to a limited degree, digital specification of color is possible.

**KINDS OF ATTRIBUTES**

Clifford and Stevenson distinguish between six different kinds of attributes in their book, *An Introduction to Numerical Classification*. 7
(i) **Binary** - possessed of two contrasting states. The presence or absence of a given quality would be designated as binary data. Gross digitization by mechanical means can "search" the surface of a half-tone photograph and register the presence or absence of a half-tone dot at selected intervals. A selected visual stimulus could be coded by hand as possessing or not possessing a particular quality. This would be appropriate in studies which examine subjects' responses to particular qualities.

(ii) **Disordered multistate** - possessing three or more contrasting forms each ranking equal. A painting comprised of equal areas of three or more colors could be coded using data in this form.

(iii) **Ordered multistate** - possessing a hierarchy of contrasting forms. Such attributes are also known as *ordinal* or *graded*. The relative position of each form in the hierarchy is designated numerically. The hierarchy must represent in its scale the total variation in the range of entities under study. Depth of field (image focus) in photographs could be designated as ordered multistate data.

(iv) **Ranked** - an ordinal index except the grading applies only within a single entity. This data does not allow for comparison between entities. This method would only appear valuable in those cases where preference for properties within a single stimulus is the object of study. It is important that the data from such studies not be compared with that of other studies using a different stimulus. Ordered multistate data would be required for such a comparison.

(v) **Meristic** - possessed of several values each of which is a whole number. The number of edges of a given shape or the number of points in a given picture could be indicated as meristic data.
(vi) Continuous - measures of size on a continuous scale. Length and weight would be indicated as continuous data for example.

There is an additional category called nonexclusive multistate. Clifford and Stevenson claim to have little experience with this category. The example they provide for the category is in the case of color combinations as well as basic distinct color areas. The multi-colored plumage of birds is such a case. One would think that this category would be useful in coding visual art stimuli. Additional study is called for in this area. The properties might just as well be expressed in binary form or as disordered multistate data until such time as techniques within this category are developed.

PROCEDURES FOR THE MODEL

Stimulus description and codification is based only on the Phenetic (visual) aspects of the stimulus and the code is established using polythetic classification techniques.

STEP ONE: STIMULUS SELECTION

The number and kind of stimuli is determined by the nature of the study.

STEP TWO: GROSS MECHANICAL DIGITIZATION OF THE STIMULUS (Optional)

This step may or may not be valuable to the study in question. In the case of a complex stimulus, gross digitization yields an extremely large volume of data. This large volume greatly enhances image reconstruction capability (the test for fidelity), but also requires a large amount of computer memory. Such a volume of data may neither be practical nor necessary in many research studies.
STEP THREE: SELECTIVE DIGITIZATION

Selective digitization makes use of the attribute categories described in the preceding section. The various stimulus properties are translated into numerical equivalents as binary, disordered multistate, ordered multistate, ranked meristic or continuous data. Polythetic classification requires a large number of OTU's (units of descriptive data in digital form) for validity.

STEP FOUR: GROUPING THE STIMULI BY ATTRIBUTE

Clifford and Stephenson present five different ways of grouping phenomena for classification. Some establish the relationship of an individual to a group and others the relationship of a group to other groups.

1. Clustering - the formation of nonoverlapping groups defined by hierarchical or nonhierarchical methods.
2. Clumping - the formation of groups defined by their internal properties and not necessarily defined with respect to other clumps.
3. Dissection - the formation of nonoverlapping groups defined by fixing boundaries in a continuous distribution.
4. Identification - the location of an individual within a group previously defined by one of the above classificatory procedures.
5. Ordination - the disposition of individuals in a reduced space the original of which was defined by a series of axes corresponding to the number of properties studied for these individuals.

Step Four, the Grouping process, can be mobile within the sequence of steps of the model. The grouping would be done at this stage for studies designed to test for responses to particular groups of properties within the stimuli. It can also be done later in the response analysis phase to determine which individual properties or groups of properties were preferred and with what frequency.
STEP FIVE: PRESENTATION OF STIMULUS TO THE SUBJECT

The stimulus presentation can take one of three different forms within the context of this model.

Off-Line Presentation

This presentation format is consistent with current practice in visual preference research. Conventional testing methods and environments can be utilized. Stimulus presentation can take the form of photographs, transparencies, two-dimensional works of art, etc. The subject's preference choices are analyzed by the computer at some point after the test.

On-Line Presentation

In an "on-line presentation" the subject's preference votes are placed directly into the computer at the time of the test. Votes are entered by means of a keyboard or other analog device. The computer analyzes the choices as they are being made. The sequence or type of stimuli can be altered based on the computer analysis. This flexibility in sequence allows the researcher to "test for strength" of preference votes. Should the computer analysis indicate that a subject prefers a particular property (OTU) or group of properties, additional stimuli possessing those properties can be provided. This provides the opportunity to study preference for properties within the stimulus.

On-Line, Interactive Presentation

In this presentation format the subject has control over certain properties of the stimulus. The computer performs an on-going analysis of the changes the subject makes and records all OTU's of the preferred state of the stimulus. Chapter V presents an example of such
### The Model

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| Off-Line | On-Line | Interactive |

**Table 2**
an "on-line, interactive" presentation. The example is cast as though it occurs in an instructional context. The analysis provided the student is the kind of information a researcher would collect in a research context. In this presentation format the stimulus is displayed on a color television display. The display is directly under computer control. The subject alters the image on the television display by means of analog control devices and a keyboard. The section of Chapter III titled, "Interactive Computer Graphics," details the methods involved in this form of presentation.

Environment

In making such applications, the testing environment will of necessity undergo change from more traditional environments. The applications suggested require on-line hook-up to a computer. This is particularly true of procedures described as "interactive," or where the image display is "dynamic" or results occur in "real-time." The testing environment would need to include a visual display screen which in most cases would be a standard color television set. This television set would be hard-wired into a computer. The computer need not, and perhaps should not, be in the immediate environment. Additional analog devices, such as a light pen, function switches, and a computer terminal may be required depending on the particular research procedures. To the degree that these specific items appear foreign to the subjects being tested, the research is conducted in a laboratory setting. Efforts could be made to reduce the "laboratory" nature of the setting by placing the television display in a lounge or traditional classroom environment. A variety of routine tutorial tasks would be required to instruct the
subject in the use of the analog devices. These tasks might take on a "play" quality in an effort to reduce their "foreignness" prior to testing.

Another departure from traditional visual preference research is in the nature of the visual stimuli itself. It would be necessary for the stimuli to be presented as a television image. This would be particularly true for on-line, interactive testing. The visual stimuli in more traditional research has been drawings, reproductions of art work, photographs, etc. Undoubtedly, any medium has properties which are peculiar to it. The television image is characterized by low resolution, scan lines, a horizontal, rectangular format, a distinct frame and a number of other special qualities. Hardiman and Zernich comment on the nature of the stimuli used in preference research. They take a position which is assumed by this writer.

After reviewing over one hundred studies in preference research which used a variety of stimuli, it was apparent that preference behavior was not altered by the type of object or event being preferred. In our view the notion of aesthetic preference as a separate dimension of a larger preference cluster is unfounded. Thus, whether one is making a judgment about a preference for polygons or objects of art, the overt behavior manifests itself in a general evaluative factor that is unidimensional and consistent across various types of stimuli.

Critics of numerical picture description may ask, "But can one describe meaning or content in digital form?" The obvious answer to the question would be, "No," although certain symbolic relationships might have a digital code established for them. For example, a picture depicting a mother and child could have a code system established representing that relationship. In this sense, the naming of objects and
relationships between objects could be codified using an operational taxonomic system. Such a codification could at least approach what the critic asks for in content description. Such description becomes more accurate relative to the number of taxonomic descriptor-units used. The use of code for both formal characteristics and content characteristics would advance the comprehensive nature of the description.

There is a developing literature in computer science on scene analysis, picture description and picture processing. In recent years there has been intensive study in these pattern recognition areas prompted by applications to space research, astronomy, medicine and engineering.

T. Kasvand of the National Research Council of Canada described the differences between human and machine pattern recognition.

The "biological pattern recognition systems" have two eyes and are mobile. The computerized approach to scene analysis in most cases uses a single grey level photograph or a TV image of the 3D scene. The data is further coarsened by a scanning (digitation) procedure before the analysis can be started, due partly to computer architecture and our customary programming practices. In so doing a large part of the information available to the biological system has been lost.

Computerized versions of pattern recognition are seen as inferior to the biological systems they attempt to simulate. Scene interpretation by mechanized means is judged to be successful or not depending on how well it matches human perception of the same scene. Computerized systems have been able to surpass human systems, however, in the areas of image enhancement where our innate capabilities are insufficient. (Computerized enhancement of lunar photographs provide such an example.)
Various attempts are being made to develop web grammar systems and graph analysis systems for picture description, analysis and processing. Presently, none of these techniques is developed to the point of usefulness in a research context for testing visual preference. The various graphing techniques may hold future promise as an alternative to language taxonomical systems presently used for picture description. The work being done on scene analysis may hold particular promise in areas of content description.

The question of codification of the meaning of a picture is an extremely difficult one. It is assumed here that the meaning of any stimulus demands a referent, "to whom?" and "in what context?" One might even ask the question in relation to degree, "How meaningful?" The expression of meaning has been primarily linguistic and often characterized by complexity of expression. Research using polygraph, electroencephalograph or pupillar-response techniques may hold future promise for the identification of degree of meaning, if not meaning itself to a specific subject.

Present computer technology can perform the record-keeping function of "what" a given stimulus means to a given subject being tested. In this way the verbal report of the subject could be stored together with a particular preference selection. Using an interactive program mode for testing, a subject could consistently be asked for a verbal report on meaning of a given preference selection.
THE MODEL VERSUS TRADITIONAL METHODS

It has been argued in a preceding section that a numerical specification of stimulus properties would significantly increase identification and control. Once such a move is made in research methodology, the data available from research would be available in a numerical taxonomic form. It can be argued that data in this form is several times removed from the "naturalness" of language (even research language) and consequently, the difficulty of understanding, interpreting and generalizing from the data is substantially increased. In its digital form the data is available only to the initiated. However, a computer graphics research environment offers two methods of data output. It offers the advantages of numerical codification of results and the subsequent statistical analysis of the data as well as the graphical display of the data in a dynamic form. It affords the presentation of results in picture form for interpretation by those less initiated in research methodology.

A kinostatistical display at a recent computer graphics conference made this point well. The display depicted a map of downtown Buffalo. At the bottom of the display was a digital calendar and clock showing the date, day of the week, and the time of day. Each time there was a personal property accident, a small light went on indicating the location of the accident on the map. The display depicted accidents which occurred over a year's time in less than ten minutes. The availability of the data in a direct perceptual form allowed the viewer to form hypotheses as to problem locations in relation to problem times and to test these hypotheses. The viewer could easily see problem areas in
certain locations of the city Tuesday through Sunday at 2:30 a.m.,
(bar-closing time). Problems existed in different areas of the city on
Sunday mornings as people were going to church. These same generaliza-
tions could no doubt be made by analyzing the numerical data. The
findings would then need to be translated into a language which is
understandable to a group needing to act on the information. In the
case above, the police, city council, urban planners and highway engin-
eers might all need access to the information.

The point made by this example is that a numerical taxonomic
system combined with a computer graphics environment allows access to
research results by the practitioner of a field as well as by the
research community. In light of this fact it can be argued that a
numerical taxonomic system significantly increases communication of
research findings in both efficiency and scope. Graphical data results
can be distributed in standard video-tape format to practitioners of a
given field in a form which is communicative.

SUMMARY

The point made here is that procedures exist in numerical
taxonomy for identification, classification and comparison of forms
based on degree of similarity. Also, that computer programs presently
exist to perform sophisticated comparison of the formal characteristics
of objects. Such programs would appear to significantly increase a
researcher's control over independent characteristics of visual stimuli
in a research environment. Chapter V, A Computer Graphics System for
Visual Preference Detection and Analysis, presents the programming
structure for subject interaction with the model. The visual stimuli
used in the sample program would be numerically-coded as outlined in this chapter. Chapter V is designed for implementation in an instructional context. It is similar in structure, however, to the dialogue-oriented structure required in a research context.

The program directs the student's attention to a single aspect of the stimulus at a time (placement, scale, texture and pattern, motion, shading and intensity). A tracking algorithm is following and clocking all aspects (OUI's) of the stimulus choices made by the student. Certain research studies may call for this directed attention of subject, others may not. It is presented in the "directed-attention" fashion in Chapter V as a model for instructional applications.
NOTES TO CHAPTER IV


2. Ibid., p. 113.

3. Ibid., p. 107.


6. Ibid.


CHAPTER V

A COMPUTER GRAPHICS SYSTEM FOR VISUAL
PREFERENCE DETECTION AND ANALYSIS

This chapter presents an interactive, computer-assisted instructional unit for college art students which provides data on an information feedback system. The data are furnished to the student permitting him to detect and analyze patterns in his own visual preference selections and build generalizations to form a set of personal preference criteria.
LESSON ONE: PLACEMENT

PLACEMENT OF PICTURE(S) WITHIN A FRAME

Activity 1. Placement of a single picture within a frame.

Activity 2. Placement of a duplicate copy of a picture within a frame in relation to existing static picture(s).

Activity 3. Placement of multiple copies of a picture into static positions on an incremental basis.

Activity 4. Placement of multiple, diverse pictures in relation to existing, diverse, static pictures.

Activity 5. Placement of multiple diverse pictures, in random motion, into static positions on an incremental basis.
LESSON ONE: PLACEMENT

ACTIVITY 1.
PLACEMENT OF A SINGLE PICTURE WITHIN A FRAME.

The student user types his I.D. number and program number on the VTO-5 and gains access to the system.

Picture (NO1), the number one appears on the screen as a training picture.

MESSAGE:
"This picture is moving across the screen following a random path. Observe this movement for a period of time, considering the picture in the various positions within the frame of the screen. You may stop this movement at any point by pressing the button marked "PAUSE." Should you wish to observe the random movement again, press the button marked "RESUME." You may make fine adjustments in the placement of the picture by moving the Joy Stick. At the point that you find a position within the frame which you prefer, press the button marked "STORE." The picture will then be stored in that position by the computer."

MESSAGE:
"If a second position is favored with equal strength the above procedure may be repeated after you select appropriate descriptors for your first placement from the list below."

MESSAGE:
"Select the descriptor(s) which apply to the picture placement within the frame."

1. ____________________________________________ 5. ____________________________________________
2. ____________________________________________ 6. ____________________________________________
3. ____________________________________________ 7. ____________________________________________
4. ____________________________________________ 8. ____________________________________________

MESSAGE:
"Select a secondary descriptor(s) which details the way in which you are using the primary descriptor."

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
MESSAGE:
"Select another picture from among those displayed. Type the number of
the picture here _____."

MESSAGE:
"Perform the same procedures with this picture as the previous one."

MESSAGE:
"You can perform this procedure with all of the pictures displayed if
you wish or with any number of them. When you are ready to proceed to
the next activity, type "ACTIVITY TWO."

ACTIVITY 2.
PLACEMENT OF TWO IDENTICAL PICTURES WITHIN A FRAME, ONE STATIC, ONE
DYNAMIC.

MESSAGE:
"Select a picture from among those displayed. Type the number of the
picture here _____."

MESSAGE:
"Follow the same procedure for placement as in activity one."

"Now that you have placed the picture, you will note that a duplicate
copy of it is moving along a random path. Select a favored position
for this second picture in relation to the first static picture follow­
 ing the same procedures as before."

MESSAGE:
"Select the descriptor(s) which apply to the picture placement within
the frame."

1. ___________________________ 5. ___________________________
2. ___________________________ 6. ___________________________
3. ___________________________ 7. ___________________________
4. ___________________________ 8. ___________________________

MESSAGE:
"Select a secondary descriptor(s) which details the way in which you
are using the primary descriptor."

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. ____________________________________________
ACTIVITY 3.
PLACEMENT OF THREE IDENTICAL PICTURES WITHIN A FRAME, TWO STATIC, ONE DYNAMIC.

MESSAGE:
"Now that you have placed the second picture you will note that another copy of it is moving along a random path. Select a favored position for this picture in relation to the other static pictures following the same procedures as before."

MESSAGE:
"Select the descriptor(s) which apply to the picture placement within the frame."
1. __________________________ 5. __________________________
2. __________________________ 6. __________________________
3. __________________________ 7. __________________________
4. __________________________ 8. __________________________

MESSAGE:
"Select a secondary descriptor(s) which details the way in which you are using the primary descriptor."
1. __________________________________________________________________________
2. __________________________________________________________________________
3. __________________________________________________________________________
4. __________________________________________________________________________

PLACEMENT OF FOUR IDENTICAL PICTURES WITHIN A FRAME, THREE STATIC, ONE DYNAMIC.

MESSAGE:
"Now that you have made your selection you will note that another copy is moving along a random path. Select a favored position for this picture in relation to the other static pictures following the same procedure as before."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select a secondary descriptor(s), etc."
PLACEMENT OF FIVE IDENTICAL PICTURES WITHIN A FRAME, FOUR STATIC, ONE DYNAMIC.

MESSAGE:
"Now that you have made your selection you will note that another copy is moving along a random path. Select a favored position for this picture in relation to the other static pictures, following the same procedure as before."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select a secondary descriptor(s), etc."

ACTIVITY 4.
PLACEMENT OF MULTIPLE, DIVERSE PICTURES WITHIN A FRAME IN RELATION TO EXISTING, DIVERSE, STATIC ONES.

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here _____."

MESSAGE:
"Follow the same procedure for placement as in activity one."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."

MESSAGE:
"Now select another picture and place it in relation to the other static pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Now select another picture and place it in relation to the other static pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."
MESSAGE:
"Now select another picture and place it in relation to the other static pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Now select another picture and place it in relation to the other static pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."

MESSAGE:
"Now select another picture and place it in relation to the other static pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."

ACTIVITY 5.
PLACEMENT OF MULTIPLE, DIVERSE PICTURES, IN RANDOM MOTION, INTO STATIC POSITIONS.

MESSAGE:
"Select two pictures from among those displayed. Type in the numbers of the pictures here _____, _____."

MESSAGE:
"The pictures are now moving across the screen in random fashion. The PAUSE button will stop the motion of all the pictures at the same time. Select a favored position for the pictures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Select four different pictures from those displayed. Type the numbers
of the pictures here, ___, ___, ___, ___. Perform the same
procedure as before."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Select five different pictures from those displayed. Type the numbers
of the pictures here ___, ___, ___, ___, ___. Perform the
same procedure as before."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

_____________________________________________________________________

THIS CONCLUDES THE PLACEMENT EXERCISES.

THE FIRST COMPUTER ANALYSIS OF THE STUDENT'S PLACEMENT PREFERENCES
TAKES PLACE HERE IF SUFFICIENT DATA ARE AVAILABLE. SHOULD NO STRONG
CLEAR PREFERENCES BE DETECTED THE ANALYSIS MAY CONSIST OF A STATISTICAL
REPORT ON FREQUENCY OF PLACEMENT IN VARIOUS POSITIONS WITHIN THE FRAME.
THIS ANALYSIS IS DESCRIBED ON THE FOLLOWING PAGES.

THE STUDENT RANKS THE ANALYSIS STATEMENT ACCORDING TO IMPORTANCE TO HIM
USING A (1-5) RANKING SYSTEM. "1" REPRESENTS THE HIGHEST IMPORTANCE
AND "5" THE LEAST IMPORTANT.
PLACEMENT.
PROGRAM CAPABILITIES.

PLACEMENT ANALYSIS

The program analyzes the placement of each picture stored by the user. Each image will be "SOFT" when stored permitting retrieval at a later date in the exact position selected by the user.

The program first performs a "gross" analysis of placement according to the following:

<table>
<thead>
<tr>
<th>Upper half</th>
<th>Left hand</th>
<th>Right hand</th>
<th>Upper third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower half</td>
<td>Center horizontal third</td>
<td>Lower third</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Center vertical third</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 41          | 4r         | 91          | 9c          | 9r          |
|-------------|------------|-------------|-------------|
| 41          | 4r         | 91          | 9c          | 9r          |
| 141         | 14r        | 191         | 19c         | 19r         |

The program then proceeds to specify the placement within the "gross" categories established above.
First the program searches for the best "gross" analysis screen (overlay) and then proceeds to more specific overlays to provide more detailed information on the picture placement.

The sample below shows the procedure in the various stages.

<table>
<thead>
<tr>
<th>Pic</th>
<th>Pic</th>
<th>Pic</th>
<th>Pic</th>
<th>Store Code</th>
</tr>
</thead>
</table>

**STAGE 1.**  
Stage 1. establishes that the Picture is in the upper half

**STAGE 2.**  
Stage 2. establishes that it is (u4r) in the upper, right quadrant

**STAGE 3.**  
Stage 3. establishes that it occupies all of the four quadrants within (u4r)

**STAGE 4.**  
Stage 4. The information is coded and stored in each of the categories that apply: upper half, right half, upper right quadrant, etc.

If the picture above had a slightly different placement the "gross overlay" which breaks the screen into thirds might have been selected by the computer.

The program must be able to keep a running count of the number of times a picture placement falls into any given category. When a pattern of placement is observed by the program it calls up an appropriate message for the user (perhaps eight times will constitute a pattern in the beginning of testing).

The additional features of the placement program include:
- stores image (Soft) and description of image placement (verbal) that the user selects.
- keeps track of the Rank (1-5) of importance the user assigns to each preference analysis statement the program provides.
LESSON TWO: SCALE

SCALE OF PICTURE(S) WITHIN A FRAME

Activity 1. Selection of scale of a single picture within a frame, maintaining a constant x, y ratio. (TRASCL with modifications.)

Activity 2. Selection of scale of multiple, duplicate pictures according to placement on Z axis. (Scale and perspective.)

Activity 3. Selection of scale of multiple, diverse pictures according to placement on Z axis.

Activity 4. The extension of a picture into multiple versions of itself on the X, Y, and Z axis. (THICKR)

Activity 5. The selection of the scale of a picture using only one axis. (SCALE/X, SCALE/Y, SCALE/Z. Distortion)

Activity 6. The distortion of scale of a part of a picture between two specified points. (WARP)
LESSON TWO: SCALE
(PLACEMENT ANALYSIS CONTINUES AS WELL AS NEW SCALE ANALYSIS.)

ACTIVITY 1.
SELECTION OF SCALE OF A SINGLE PICTURE WITHIN A FRAME, MAINTAINING A CONSTANT X, Y RATIO.

MESSAGE:
"Select a single picture from among those displayed. Type the number of the picture here ____. Your choice is now displayed to you in its original scale. You can change the scale of the picture by typing in a positive or negative number.

  10 will increase size by 10%
  20 will increase size by 20%
 -10 will decrease size by 10%
 -20 will decrease size by 20%, etc.

"You are limited to intervals of ten with a maximum of +500 to -500 which will either increase the size or decrease the size respectively five times.

"You may make fine adjustments in scale by using Dial #_____."

"You may move the picture by using Dials #_____ and #_____."

"Once you find the scale and placement you prefer press the button marked 'STORE'."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 1 with a new picture."

MESSAGE:
"Repeat activity 1 with a new picture."

MESSAGE:
"At this point you may continue with activity 1 or move on to activity 2."
"Do you wish to continue with activity 1? Yes No."

ACTIVITY 2.
SELECTION OF SCALE OF MULTIPLE, DUPLICATE PICTURES ACCORDING TO PLACEMENT ON Z AXIS.

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ______."

MESSAGE:
"You now see the picture you selected together with a duplicate copy of it. You are to scale and move either or both pictures so that one appears to be in front of the other in space. You can move picture #1 using Dials #____ and #____. You can move picture #2 using Dials #____ and #____. Scaling is done following the same procedure as in activity 1."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."

MESSAGE:
"Repeat activity 2 with a new picture."

MESSAGE:
"Repeat activity 2 with a new picture."

MESSAGE:
"Make another picture selection. At this point you note there is a second copy of your selection displayed. You are to scale and move the pictures so that each appears to be on a different plane in space. Movement is accomplished using the Dials. Scaling follows the same procedures as before."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."
MESSAGE:
"Make another picture selection. At this point you will note that there are four identical pictures to be placed on separate planes in space. Follow the procedures as before."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

ACTIVITY 3.
SELECTION OF SCALE OF MULTIPLE, DIVERSE PICTURES ACCORDING TO PLACEMENT ON Z AXIS.

MESSAGE:
"Select two different pictures from among those displayed. Type the number of the pictures here ____, _____. Follow the same procedures as in activity two and place the pictures in different planes in space."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Select three different pictures from among those displayed. Type the number of the pictures here ____, _____, _____. Follow the same procedure as before and place the pictures in different planes in space."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Select four different pictures from among those displayed. Type the number of the pictures here ____, _____, _____. Follow the same procedures."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."
ACTIVITY 4.
THE EXTENSION OF A PICTURE INTO MULTIPLE VERSIONS OF ITSELF ON THE X, Y AND Z AXIS. (THICKER)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ______. You will now have the opportunity to respond to a series of questions relative to the number of copies you would like to see of the picture you have selected. The questions will relate to the number of picture versions you want to see on the X, Y, AND Z axis and the spacing between these pictures."

"Answer all questions."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select the secondary descriptor, etc."

MESSAGE:
"Repeat activity 4 with a new picture selection."

MESSAGE:
"Repeat activity 4 with a new picture selection."

MESSAGE:
"Do you wish to continue with activity 4? _____Yes _____No."

ACTIVITY 5.
THE SELECTION OF SCALE OF A PICTURE USING ONLY ONE AXIS.

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ______. You can now scale this picture on the X axis by using Dial #____. You can also move the picture by using Dials #____ and #____. Select a scale which you prefer."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"You now see the picture you selected in its original form. You can now scale this picture on the Y axis using Dial #____. You can also move the picture using the same Dials as before. Select a scale which you prefer."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"You can now see the picture you selected in its original form. You can now scale the picture on the Z axis by using Dial #____. You can also move the picture using the same Dials as before. You will need to rotate the picture to see Z axis scaling. Use Dials #____ and #____ for this. Select a scale which you prefer."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 5 with a new picture selection."

MESSAGE:
"Repeat activity 5 with a new picture selection."

MESSAGE:
"Do you wish to continue with activity 5? _____Yes _____No."

ACTIVITY 6.
THE DISTORTION OF SCALE OF A PART OF A PICTURE BETWEEN TWO SPECIFIED POINTS. (WARP)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here _____. You will now have the opportunity to distort a small section of the picture displayed. An arrow has appeared on the
screen. You can move this arrow by moving Dials 8 and 9. You will be distorting the picture between two points which you are to specify by moving the arrow to the first point and then pressing button #____, and then moving the arrow to the second point on the drawing and again pressing the button. Then by touching the arrow to any point between the two specified points and moving it you can change the picture's scale in that isolated area."

MESSAGE:
"Select a descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 6 with a new picture selection."

MESSAGE:
"Repeat activity 6 with a new picture selection."

MESSAGE:
"Do you wish to repeat activity 6? _____Yes _____No."

THIS CONCLUDES THE SCALE EXERCISES.

THE FIRST COMPUTER ANALYSIS OF THE STUDENT'S SCALE PREFERENCES TAKES PLACE HERE IF SUFFICIENT DATA ARE AVAILABLE. SHOULD NO STRONG CLEAR PREFERENCES BE DETECTED THE ANALYSIS MAY CONSIST OF A STATISTICAL REPORT ON FREQUENCY OF SCALE TO THE POSITIVE AND TO THE NEGATIVE AND TO THE DEGREE OF DISTORTION PREFERRED. THE ANALYSIS IS DESCRIBED ON THE FOLLOWING PAGE.

THE STUDENT RANKS THE ANALYSIS STATEMENTS ACCORDING TO IMPORTANCE TO HIM.
SCALE.
PROGRAM CAPABILITIES.

SCALE ANALYSIS

1. Keeps a running record of the scale increase factor or decrease factor for each choice stored by the user.

2. Reads variables off Dials used for scaling.

3. Keeps records on the degree of scale or distortion from the original picture version.

4. Continues the placement analysis as described in Lesson One.
LESSON THREE: TEXTURE AND PATTERN

TEXTURE AND PATTERN WITHIN A FRAME AND PICTURE

Activity 1. Selection of a single element to randomly fill a picture outline. (FILL)

Activity 2. Selection of a single element to fill a picture outline at a prescribed angle. (FILL/P)

Activity 3. Combining pictures which have been filled and deleting outlines.

Activity 4. Selection of picture outlines and reducing them to Dots and Dashes.

Activity 5. Selection of line patterns between points drawn by the user on the screen (JSDRAW) (LINEAR INTERPOLATION)
LESSON THREE: TEXTURE AND PATTERN

ACTIVITY 1.
SELECTION OF A SINGLE ELEMENT TO RANDOMLY FILL A PICTURE OUTLINE (FILL)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ______. You now see a number of small marks displayed. You are to select one of these marks which will be used as the textural element for your picture selection. Type the number of your mark selection here ______. Dial # ______ will control the speed with which your picture is filled. Press button number 13 when you wish to stop the process and press the button marked 'STORE'."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select the secondary descriptor, etc."

MESSAGE:
"Repeat activity 1 with new selection."

MESSAGE:
"Repeat activity 1 with new selection."

MESSAGE:
"Do you wish to continue with activity 1? _____Yes _____No."

ACTIVITY 2.
SELECTION OF A SINGLE ELEMENT TO FILL A PICTURE OUTLINE AT A PRESCRIBED ANGLE. (FILL/P)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ______. Select a mark from among those displayed which you would like to combine as textural forms without their picture outlines. Type the numbers of your selections here ______, ______, ______. You will note that the outlines have been removed. You are to move the texture patches into positions on the screen which you prefer using Dials # ______, # ______, # ______, # ______, # ______. Press the button marked 'STORE' when you have completed this task."
MESSAGE: "Select the descriptor(s), etc."
MESSAGE: "Select a secondary descriptor, etc."

MESSAGE: "Repeat activity 2 with new selections."

MESSAGE: "Repeat activity 2 with new selections."

MESSAGE: "Do you wish to continue with activity 2? _____Yes _____No."

ACTIVITY 3.
COMBINING PICTURES WHICH HAVE BEEN FILLED AND DELETING OUTLINES.

MESSAGE: "You now see your filled picture selections displayed from the previous two activities. Select three from among those displayed which you would like to combine as textural forms without their picture outlines. Type the numbers of your selections here _____, _____, ____. You will note that the outlines have been removed. You are to move the texture patches into positions on the screen which you prefer using Dials #____, #____, #____, #____, #____. Press the button marked 'STORE' when you have completed this task."

MESSAGE: "Select the descriptor(s), etc."
MESSAGE: "Select a secondary descriptor, etc."

MESSAGE: "Repeat activity 3 with new selections."

MESSAGE: "Repeat activity 3 with new selections."
MESSAGE:
"Do you wish to continue with activity 3?  ____Yes  ____No."

ACTIVITY 4.
SELECTION OF PICTURE OUTLINES AND REDUCING THEM TO DOTS AND DASHES
(DOTS) (DASHES/R) (DASHES)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here _____. Button 3 ____ will reduce the picture outline to dots. Button ____ will reduce the picture outline to dashes. Make the selection you prefer. You may move the picture using the dials."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 4 with another selection."

MESSAGE:
"Repeat activity 4 with another selection."

MESSAGE:
"Do you wish to continue with activity 4?  ____Yes  ____No."

ACTIVITY 5.
SELECTION OF LINE PATTERNS BETWEEN POINTS DRAWN BY THE USER ON THE SCREEN. (JSDRAW) (INTERP)

MESSAGE:
"Using the Joy Stick and Button # _____, you are to draw a series of lines on the screen. The Joy Stick is used to identify points on the screen. Each time you press Button # _____ a line will be drawn between the point the Joy Stick indicates and the previous point of the drawing. Use Button # _____ to create a 'Jump' in the line drawing. Your drawing must have at least one 'Jump' in it but can have more."
"Once you have completed your drawing press Button #____. You will then be asked to indicate the number of lines to be used in connecting the points of your drawing. Number of lines?____. The limit of lines is____." 

"Once you have completed this task press the button marked 'STORE'."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 5."

MESSAGE:
"Repeat activity 5."

MESSAGE:
"Do you wish to continue with activity 5? ____Yes ____No."

THIS CONCLUDES THE TEXTURE AND PATTERN EXERCISES.

THE FIRST COMPUTER ANALYSIS OF THE STUDENT'S TEXTURE AND PATTERN PREFERENCES TAKES PLACE HERE IF SUFFICIENT DATA ARE AVAILABLE. SHOULD NO STRONG PREFERENCES BE DETECTED, THE ANALYSIS MAY CONSIST OF A STATISTICAL REPORT ON THE DEGREE OF COMPLEXITY OF THE TEXTURE-PATTERN SELECTIONS. THIS ANALYSIS IS DESCRIBED ON THE FOLLOWING PAGES.

THE STUDENT RANKS THE ANALYSIS STATEMENT ACCORDING TO IMPORTANCE TO HIM.

THE THIRD PLACEMENT ANALYSIS TAKES PLACE AT THIS TIME. THE STUDENT ALSO RANKS THIS STATEMENT IN TERMS OF IMPORTANCE TO HIM.
TEXTURE-PATTERN.
PROGRAM CAPABILITIES.

TEXTURE-PATTERN ANALYSIS

1. Records the number of (FILL) marks used in each preference selection made by user.

2. Records the angle of selection used in (FILL/P) exercises.

3. Records the number of points used in (INTERP).

4. Continues the Placement Analysis.
LESSON FOUR: MOTION

SELECTION OF SPEED OF MOTION AND PATH OF MOTION

Activity 1. Drawing a path of motion for a single picture.

Activity 2. Drawing multiple paths for two or more pictures for simultaneous motion.

Activity 3. Movement of a single picture across a path at discrete intervals of time. (Single-frame movement) (FILM)

Activity 4. Selection of the rotation pattern of a single 3-D picture. (X, Y, Z ROT)

Activity 5. Selection of rotation patterns for multiple, duplicate or diverse 3-D pictures.

Activity 6. Selection of movement patterns for pictures made up of one or more moveable parts. (FLAP)
LESSON FOUR:  MOTION

ACTIVITY 1.
DRAWING A PATH OF MOTION FOR A SINGLE PICTURE.  (JSDRAW) (PATHMOV) (PUTLIB PATH).

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ____. Now using the Joy Stick draw a path on the screen which you would like the picture to follow. Dial #____ will control the speed of motion along the path. Press Button #____ to begin the motion. Press Button #____ to stop the motion."

MESSAGE:
"Select the descriptor(s), etc."  
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat activity 1 with new selections."

MESSAGE:
"Repeat activity 1 with new selections."

MESSAGE:
"Do you wish to continue with activity 1?  ____Yes  ____No."

ACTIVITY 2.
DRAWING MULTIPLE PATHS FOR TWO OR MORE PICTURES FOR SIMULTANEOUS MOTION.

MESSAGE:
"Select two pictures from among those displayed. Type the number of your selections here ____, ____. Now using the Joy Stick draw a path for each of the pictures to follow. Dial #____, ____ will control the speed of motion. Press Button #____ to begin the motion. Press Button #____ to stop the motion."

MESSAGE:
"Select the descriptor(s), etc."  
MESSAGE:
"Select a secondary descriptor, etc."
MESSAGE:
"Repeat activity 2 with new selections."

MESSAGE:
"Repeat activity 2 with three picture selections."

MESSAGE:
"Repeat activity 2 with four picture selections."

MESSAGE:
"Do you wish to continue with activity 2? _____Yes _____No."

ACTIVITY 3.
MOVEMENT OF A SINGLE PICTURE ACROSS A PATH AT DISCRETE INTERVALS OF
TIME. (FILM)

MESSAGE:
"Select a picture from among those displayed. Type the number of your
selection here ______. Draw a path for your picture. Dial # _____ will
control the speed of movement. Button # ______ will begin the motion.
This motion will take place in the single frame mode and the picture
will move along the path in a choppy fashion. Button # ______ will stop
the motion."

MESSAGE:
"Select the descriptor(s), etc."  
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."
MESSAGE: "Do you wish to continue the activity? _____Yes _____No."

ACTIVITY 4.
SELECTION OF THE ROTATION PATTERN OF A SINGLE 3-D PICTURE. (X, Y, Z, ROT)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ____. You will be able to rotate this picture in space. Dial #____ will control the speed of rotation. Dials #____, #____, #____ will control the X, Y, and Z axis respectively. You can control the tilt of the picture by changing these dials. When you find a rotation pattern you prefer press the Button marked 'STORE'."

MESSAGE: "Select the descriptor(s), etc."
MESSAGE: "Select a secondary descriptor, etc."

MESSAGE: "Repeat the activity with another selection."

MESSAGE: "Do you wish to continue this activity? _____Yes _____No."

ACTIVITY 5.
SELECTION OF ROTATION PATTERNS FOR MULTIPLE, DUPLICATE OR DIVERSE 3-D PICTURES. (X, Y, Z, ROT)

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ____. You now see the picture you selected with a duplicate copy of it. You are to select rotation patterns for each. Dials #____, #____ will control the speed of rotation. The previously assigned dials will control the rotation of the first picture. Dials #____, #____, #____ will control the rotation of the second. When you find the rotation pattern preferred for each press the Button marked 'STORE'."

MESSAGE: "Select the descriptor(s), etc."
MESSAGE:
Select a secondary descriptor, etc."

MESSAGE:
"Repeat the above activity."

MESSAGE:
"Repeat the above activity only selecting two different pictures."

MESSAGE:
"Repeat the activity selecting two different pictures."

MESSAGE:
"Do you wish to continue this activity? _____Yes _____No."

ACTIVITY 6.
SELECTION OF MOVEMENT PATTERNS FOR PICTURES MADE UP ON ONE OR MORE
MOVEABLE PARTS. (FLAP)

MESSAGE:
"Select a picture from among those displayed. Type the number of the
picture here ___. This picture is made up of at least two moveable
parts which can be moved independently of one another. Basically both
are to be rotated using the Dials in the previous activity. However,
you can put limits on the rotation of each by specifying the degree of
the angle of rotation thus achieving a flapping motion for each part.
(Example: 100, -120 will limit the rotation to only the degrees speci-
ified.)"

"After you have begun the rotation of each part specify the angle of
rotation for each part on the following lines:
Part one: ______, ______.
Part two: ______, ______."

MESSAGE:
Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."
MESSAGE:
"Repeat the activity with another selection."

MESSAGE:
"Repeat the activity with another selection."

THIS CONCLUDES THE MOTION EXERCISES.

THE FIRST COMPUTER ANALYSIS OF THE STUDENT'S MOTION PREFERENCES TAKES PLACE HERE IF SUFFICIENT DATA ARE AVAILABLE. SHOULD NO CLEAR PREFERENCES BE DETECTED THE ANALYSIS MAY CONSIST OF A STATISTICAL REPORT ON SPEED AND PATH MOVEMENT. THIS ANALYSIS IS DESCRIBED ON THE FOLLOWING PAGE.

THE STUDENT RANKS THE ANALYSIS STATEMENTS ACCORDING TO IMPORTANCE TO HIM.

THE FOURTH PLACEMENT ANALYSIS ALSO TAKES PLACE TO DETECT IF THE STUDENT IS AVOIDING ANY AREA OF THE SCREEN CONSISTENTLY.
MOTION.
PROGRAM CAPABILITIES.

MOTION ANALYSIS

1. Stores each path drawn by the user then imposes the placement analysis screens over them as described in Lesson One.

2. Reads Dial settings for each rotation pattern stored by the student.

3. Reads speed of rotation off the dials used for each rotation preference stored by the student.

4. Stores the rotation limits set for (FLAP).
LESSON FIVE: SHADING AND INTENSITY

SELECTION OF SHADING AND LIGHT INTENSITY FOR 2-D AND 3-D PICTURES

Activity 1. Selection of shading for a single 2-D picture.

Activity 2. Selection of shading for a single 3-D picture.

Activity 3. Selection of light intensity for each plane of a 3-D picture. (SETINT)
LESSON FIVE:   SHADING AND INTENSITY

ACTIVITY 1.
SELECTION OF SHADING FOR A SINGLE 2-D PICTURE.

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ___. Shading is accomplished by the computer placing lines close together to fill the picture outline. You can control the shading by specifying how far apart these lines are to be within a range of 4 to ___. Please indicate the spacing you would like here ___. If you do not like this spacing press the Button marked 'ERASE' and try another number. Once you have made a selection you prefer press the Button marked 'STORE'."

MESSAGE:
"Select the descriptor(s), etc."

MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Do you wish to continue the activity? ____Yes ____No."

ACTIVITY 2.
SELECTION OF SHADING FOR A SINGLE 3-D PICTURE.

MESSAGE:
"Select a picture from among those displayed. Type the number of the picture here ___. You are to perform the same task as in the previous activity only this time the picture can be seen in 3-D as it is rotated using Dials #___, #____. Select the shading you prefer and store your preference."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Do you wish to continue the activity? _____Yes _____No."

ACTIVITY 3.
SELECTION OF LIGHT INTENSITY FOR EACH PLANE OF A 3-D PICTURE. (SETINT)

MESSAGE:
"Select a picture from among those displayed. Type the number of your selection here _____. The picture you have selected is made up of many closed planes each of which can be shaded separately. Dial #_____ will be used to control the intensity of each plane. Once you have selected the desired intensity press Button #13 and then proceed to select the intensity for the next plane, etc. Once you have completed the task press the Button marked 'STORE'."

MESSAGE:
"Select the descriptor(s), etc."
MESSAGE:
"Select a secondary descriptor, etc."

MESSAGE:
"Repeat the activity with a new selection."

MESSAGE:
"Repeat the activity with a new selection."
MESSAGE:
"Do you wish to continue the activity? _____Yes _____No."

THIS CONCLUDES THE SHADING EXERCISES.

THE FIFTH COMPUTER ANALYSIS OF THE STUDENT'S PLACEMENT PREFERENCES TAKES PLACE HERE. A COMPUTER ANALYSIS OF SHADING PREFERENCES ALSO TAKES PLACE HERE. IF NO CLEAR PREFERENCES CAN BE DETECTED THE ANALYSIS MAY CONSIST OF A STATISTICAL REPORT ON THE INTENSITY OF SHADING PREFERRED.

THE STUDENT RANKS THE ANALYSIS STATEMENTS ACCORDING TO IMPORTANCE TO HIM USING 1-5.
SHADING AND INTENSITY.
PROGRAM CAPABILITIES.

SHADING AND INTENSITY ANALYSIS

1. Stores each of the variables typed in by the user for shading.
2. Reads off the Dial for variables used in (SETINT).
3. Continues placement analysis.
4. Stores "Soft" pictures and corresponding description in user's area.
CHAPTER VI

CONCLUSIONS AND IMPLICATIONS FOR FURTHER STUDY

Facts and objects must be arranged in an orderly fashion before their unifying principles can be discovered and used as the basis for prediction.1

This study presents a model designed to furnish procedures for treating the complexity of picture description. Visual preference research has been limited in its ability to be both descriptive and predictive as a result of this complexity. The above quote by Robert R. Sokal, a numerical taxonomist, summarizes the criticisms of visual preference research made by Hardiman and Zernich as well as the Kreitlers.2

The model presented in Chapter IV presents the elements, their sequence and relationship, and the procedures necessary to establish order within this complexity.

The model's validity is based on its meeting the criteria of Fidelity and Utility.

Test for Fidelity

The argument for the model's fidelity is based on an "a priori" assumption: numerical methods give better fidelity than conventional languaged-based descriptive methods because they involve consideration of a much greater proportion of the total data.3
The relative ability to reconstruct (Reconstruction as a test for fidelity) the visual stimulus from its descriptive code (Gross digitization and selective digitization) is presented as a second argument for the significant increase in fidelity. It is not argued that there is identity between the original stimulus and the "code-reconstructed stimulus," but rather that the fidelity is significantly increased over that found in current practice. Reconstruction is demonstrated in a computer graphics environment in those cases where a stimulus is digitized, reduced to numerical code and then displayed in a coarsened form on a television monitor. The section of Chapter III entitled, "Color Video Systems and Digital Color Image Synthesis," details this process. Alan J. Meyer's report, "A Digital Video Information Storage and Retrieval System" is also called to the reader's attention in this regard.

Test for Utility

As is stated in the Limitations of the Study, Chapter II, the model must be empirically validated. The real test of its utility is in "how well it works!" It is argued here that there is correspondence between the needs and descriptive procedures of biological taxonomy and the needs and procedures required for visual preference research. Numerical procedures have demonstrated utility in classification for biological, zoological, ecological and medical purposes. This utility is widely acknowledged and reported on in the research literature of those fields.

One problem encountered with phenetic, numerical classification in biology relative to utility is its objective adherence to the criteria
of visual similarity. Taxonomists found that males and females of certain species had little visual similarity. As a consequence, numerical procedures were placing them at considerable distance from each other in the classification structure. Taxonomists have developed procedures to eliminate such a problem. While this is seen to be a problem for the biologist, it is a demonstration of the kind of objective description called for by the critics of visual preference research.

The general utility of numerical procedures for description and classification is widely acknowledged by the scientific community. It has demonstrated a usefulness in sorting among and establishing an order within extremely complex phenomena and extremely large samples of such phenomena. Its use in research involving visual stimuli will, no doubt, bring new and unanticipated problems. It is presented in this study as a strategy for treating complexity in the process of stimulus description.

IMPLICATIONS FOR FURTHER STUDY

The prime area for further study is in the area of empirical validation of the model. Such a study would necessitate the selection or design of a computer data management system to handle the large volume of data required for numerical classification procedures. A large amount of computer memory is required and would demand disc storage and recall capabilities. The existing data management designs need to be examined for their adaptability for this special-purpose visual stimulus description. Existing computer languages and common equipment should be utilized to the extent possible to facilitate the
Implementation of the model by other researchers. Efforts should be made to avoid becoming machine-dependent or site-dependent in the experimental stages of the model's validation.

Various numerical description techniques need to be studied. Language taxonomies developed for the visual arts and from morphology need to be examined in an effort to uncover appropriate descriptors (OTU's) for the visual stimulus. The descriptors need to represent a variety of kind, extensive and cover a wide range of characteristics. Operational taxonomic units selected for biological classification may not have the same utility in describing visual arts stimuli. Careful study of taxonomies from art criticism should reveal useful OTU's.

The empirical study must present a sufficiently large number of visual stimuli of varied image complexity. In so doing it can avoid the reductionist criticisms leveled at current practice by this author and others. It should involve a relatively large sample of subjects in order to demonstrate the model's computational capabilities and potency.

Attention needs to be paid during the design phase to the kind of data selected, the similarity/dissimilarity coefficients utilized to group the data and the analysis of that data relative to the subject's choices.

Implications for Other Research

The model is presented in the context of picture description as it applied to visual preference research or instruction in art criticism that is preference-based. It may have a usefulness in research relative to art instruction. The procedures could be used to describe children's artwork. Careful study could be made of the changes in the
visual characteristics of children's artwork as the result of a particular instructional intervention. A longitudinal study could be conducted in the changes in students' artwork over extended periods relative to their exposure to art instruction. It may be possible to identify characteristics of students' artwork that can be attributed to a particular art instructional practice.

The model's descriptive techniques may prove of some value in art historical research. Stylistic analysis of individual artists' work or perhaps historical attribution may be enhanced by the proposed procedures.

In summary, the design of a data base management system appropriate to visual stimuli could advance the many research areas dedicated to the systematic study of visual phenomena.

The Appendix contains a discussion of issues related to the evaluation of computer art. While these issues are not directly related to the study at hand, they are presented to help contextualize this study within the larger area of art and technology. The concerns of each area are often seen to be at odds with each other. This perception accounts in part for the reluctance of art researchers to utilize technology in assisting their research.
NOTES TO CHAPTER VI


5. Much of this research is documented in the following sources:


APPENDIX A

AN INVESTIGATION OF CRITERIA FOR THE EVALUATION OF COMPUTER ART
An Investigation of Criteria for Evaluating Computer Art

As the aesthetic object moves on a continuum from a stable, non-changing piece of material to a changing, progressively dematerializing expression of an aesthetic idea, criteria for the evaluation of the aesthetic object/idea must change as well. As physical structure dematerializes into conceptual structure there are inherent problems for the critic. What is to be criticized, the fading ghost of matter, or the emerging aura of concept?

In its brief history computer art has stretched the full breadth of the continuum from static art object to dynamic, "real-time," interactive displays. Books by Reichardt and Davis detail this progressive movement. Computer prints made from CRT displays or mechanical plotters first raised the issue for the critic as to whether man or machine was to be credited with this new type of "artifact." Another question raised was, "Is the work of art the computer-generated object, the generating program or both?" Early computer art objects also demonstrated a certain playfulness in regard to respected historical art work (Csuri, "Vitruvius Man," by DaVinci; Noll, Variations on "Current" by Riley and "Composition with Lines," by Mondrian, etc.). These works appeared to be calling attention to the unique new dimension of the process by which they were made. Noll in fact stated in this regard, "The artist's 'ideas' and not his technical ability in manipulating media could be the important factor in determining artistic merit." Harold Rosenberg was led to remark in The New Yorker, "The inspiration of machine art is problem-solving; its chief aesthetic principle is the
logical adjustment of means to end." Both positions espouse the evaluation of "idea" as a principle focus for criticism. Burnham claims that the contemporary systems artist has brought us to a "post-formalist aesthetic." The "formalist aesthetic" is replaced by a "systems aesthetic."

A systems aesthetic presumes that the patterns of advanced technology should not be abandoned for simpler life patterns. Machines and information systems are not alien to human welfare, but appear to be compatible extensions of it. Within this context the place of the artist becomes less precisely defined. He is not so much an artisan forming handcrafted artifacts in the traditional sense, but someone supremely sensitive to the evolving environment.5

Burnham never explicates the criteria to be used in this proposed "systems aesthetic." He does, however, go on to point out that much of contemporary art appears to be calling for the end to formalist criteria.

The specific function of modern didactic art has been to show that art does not reside in material entities, but in relations between people and the components in their environment.6

While early computer art-graphics tended to create problems for the critic and computer-animated art films complicated the problems, he at least had the touch-stone of the material object as point of reference. Rightfully or not the graphic work and the animated film could at least be subjected to criteria commonly used for works belonging to these classes. However, computer artists like Csuri have raised distinct problems for the critic as their work dematerializes and moves on the continuum progressively closer to pure "idea" expression. Csuri speaks of "real-time computer art objects."

Real-time computer art objects are an intellectual concept which can be visually experienced rather than a finalized material object. This kind of computer art exists for the time, the participant and the computer with the CRT
display are interacting as a process. The art object is not the computer or the display, but the activity of both interacting with the participant. In addition to its artistic parameters, the content of this art form is dependent upon the dynamics of a real-time process which gives vitality and life to the visual display through animation and user interaction.

In this context the traditional aesthetic object is not a "finalized material object," but rather a "visual experience." This "experience" is characterized by an "interactive quality" which has set "artistic parameters." It would appear that the artist in this case is acting like an "aesthetic manager" or an "aesthetic systems engineer." He determines the outside limits for the experience but permits a wide latitude of participant action within the set confines. While the "real-time computer art objects" may have qualities which visually resemble the traditional aesthetic object, these are in fact lists of coordinate data which are subject to constant change and manipulation. These lists of coordinate data are like physical pictures in only an analogous way.

The serious problem for the critic is that formalist criteria which might look for such things in the aesthetic object as unity, complexity, balance, tension, expressiveness, etc., can only be applied to expressions of ideas or experiences in an ancillary way. When these are applied to literature, for example, the verbal components and structural organization are criticized and these are seen as the aesthetic object. In this sense the "real-time computer art object" may be seen as akin to a work of literature and its components and structural organization subjected to a formalist criticism. A model of criticism taken from drama might appear more appropriate in that it could also account for spatial and temporal organization. Models for film criticism would
appear to account for the periodic nature of the "real-time computer art object" but none of these can account for the crucial component of "interactiveness."

It might appear that aesthetic system designers have led the critic to the point where formalist criteria can only be applied in a secondary way and that "means-end" criteria become the primary touchstone for analysis and evaluation. Such criteria as utility, economy, efficiency, instrumentality, conservation, etc., are traditionally conceived of as extra-aesthetic. However, the continued application of formalist criteria to shrinking forms appears illogical.

Figure 1 depicts the progression of the computer art object from material object to expressive idea and demonstrates the corresponding change in emphasis from "formal criteria" to "means-end" criteria. This essentially sets up a system which accommodates at one extreme the evaluation of the systems artist's idea or concept. In current methods of phenomenological art criticism this would be seen as committing the intentional fallacy. It is argued that the artist's idea or concept may never be known and that criticism should only be based on the work itself. However, the systems artist works in a different fashion than his more traditional counterpart. A systems design method demands an elaborate plan; one in which goals, objectives and anticipated outcomes are clearly specified. Options within the system are clearly delineated and interaction of components is specified. The systems artist leaves "tracks" throughout the planning process in the form of flow charts, computer programs and testing results. Consequently there is data on which the design process can be determined and evaluated. While
<table>
<thead>
<tr>
<th>Aesthetic Object</th>
<th>Continuum</th>
<th>Aesthetic Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static object embodiment of aesthetic idea</td>
<td>Object moving or changing but under static control of aesthetic idea</td>
<td>Object in motion modified in time by forces outside the aesthetic idea but subject to set parameters of the aesthetic idea</td>
</tr>
<tr>
<td>Computer graphics</td>
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<td>Interactive art objects</td>
</tr>
<tr>
<td>Computer paintings</td>
<td>Computer controlled video</td>
<td>&quot;Real-time&quot; computer art objects</td>
</tr>
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</table>

**Means-Ends Criteria**

**Formal Criteria**

Figure 1
ultimately it is the "aesthetic outcome" which needs to be evaluated by the critic, a systems view would argue the necessary interconnectedness of outcome with the design and planning process.

This position is essentially consistent with the conception of the artistic process as qualitative problem solving. This is a methodological conception of the artistic process. Ecker has developed this view in much of his writing.

... it may be said that qualitative problem solving is a mediation in which qualitative relations as means are ordered to desired qualitative ends. Thus to choose qualitative ends is to achieve an artistic problem. Whenever qualitative problems are sought, pointed out to others, or solved, therein do we have artistic endeavor--art and art education.®

The term "quality" has been used to refer to a standard of excellence and to an attribute of something; however, Champlin and Villemain argue for a methodological definition as well. In the ordering of qualitative means such as lines, colors, textures, the artist applies a "method" which searches for a pervasive quality which may be common to his previous work or consistent with a desired style. This pervasive quality acts as a "control" or directive criterion in the process of ordering qualitative means to qualitative ends.

In such a conception of the artistic process it is impossible to criticize the "qualitative ends" apart from the "method" and "means" and the problem solving process employing them. This conception more closely approximates the processes in which a systems artist engages and should provide a context of criticism of his work.
1. "Real-time" pertains to the performance of a computation during the actual time that the related physical process (the display) transpires in order that the results of the computation can be used in guiding the physical process.

"Interactive" describes the interplay, the communication, the reciprocal stimulation that goes on between two or more reactive organisms. In this context, the organisms are the person(s) at the console, on the one hand, and the programmed computer(s), on the other.


BIBLIOGRAPHY


