A CURRICULUM IN SUBTRACTIVE COLOR LEARNING

FOR POST-SECONDARY EDUCATION

by

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ABSTRACT

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In the 1920's, Johannes Itten developed and taught the Basic Course at the Bauhaus. As part of the basic course, he developed a syllabus in subtractive color learning. One of Itten's former students, Josef Albers, formalized the instruction into a series of specific color exercises. Although the Itten-Albers syllabus is the most consistently used color instruction format in post-secondary education today, there exists no published validation for contemporary color learning. As its major thrust, this work is the first to present a critical analysis of the Bauhaus color syllabus by developing a curriculum in color learning that provides a sufficient balance of verbal and visual information.

A review of color texts and empirical research was conducted, and an evaluation of the relevance of the applicable citations was made and found inadequate for guidance in curriculum development. Of the available literature, none provides a comprehensive guide for course development, leaving the curriculum developer-reformer without guidance for constructing a logical and comprehensive syllabus.

In addition to the review of literature, a questionnaire was submitted to selected post-secondary institutions to determine how and by whom color was being presented, and what published and/or

unpublished literature, and what methodologies were being used in the field. Data indicated the lack of a subtractive color curriculum guide, and a disparity in the content and quality of color instruction.

Using the survey data and related literature, a curriculum in subtractive color instruction was designed which outlined the relationships of color history, and human color vision and discrimination to the physical aspects of reflected light color. The curriculum can be described as a detailed sequence of practical instructional exercises, each preceded and accompanied by verbal and visual instructional content, providing the instructor with a guide for presenting color theories and the student with a method for learning how to translate those theories into practical examples of color relatedness.

This work revealed that authors of color texts and research do not generally present them as curriculums. While the curriculum of Itten, Albers, and Sargent appear to be the most comprehensive, each lacks either sufficient verbal or visual content. Limitations of the completeness and efficiency of this curriculum suggest that an item analysis of the mid-course written examination be conducted, that the potential for a final examination be explored, and that the curriculum be presented in other classes to evaluate the sequencing of practical exercises.

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INTRODUCTION

An artist uses color, as he or she uses form, to create an artistic product. In the formal education of college students whose major interest is in developing their talents as artists, instructors have always provided some experience with color. In some programs the color portion of instruction is incidental to or integrated with the other instructional components. In other programs a whole course is devoted to color with an emphasis not on the physical properties of color, but on the perceptual and artistic uses of color.

However, despite the unanimous agreement that color is a key component of artistic endeavor, the art education world has not addressed directly or systematically the question of how color perception should be introduced to the neophyte artist. This dissertation addresses the issue: what should be the content of a course in color, which is a component of an art education program?

Background

During the instruction of the color portion of a course in two-dimensional design, the author attempted to find a way to evaluate changes in a student's ability to perceive color visually. Finding no published instrument with which to make such an evaluation, this author, with the help of a psychologist, set out to devise a visual test which would allow for the measurement of change in an individual's ability to perceive (discriminate) color.

In order to measure adequately a change in human color perception, it would be necessary to test the individual's discrimination ability before and after training in color principles (theories) and color relationships. Instruction of the color portion of the design course was evaluated to determine how best to train an individual student so that he would be exposed to a quantity and quality of information that would account for any change in his color perception. As the evaluation progressed, it became evident that the color portion of the design course would have to be expanded in order to provide adequate color training. This proposed expansion precipitated a search by the author for a curriculum (syllabus) that could be used as a basic color instruction guide at the post-secondary level. Such a curriculum guide would have to provide enough breadth and depth to fill a normal semester adequately, and be directly applicable to an art studio-type course. Above all, the curriculum must provide a means by which a student's visual perception, memory, and judgment would be objectively trained, and by which his instincts and intuition would be subjectively exposed to the principles of subtractive color.

Research indicated that a color curriculum guide which would act as the basis for training in color principles either did not exist or had not been published. Contemporary texts, some of which were nearly twenty years old, did not present color principles in a way that would permit them to be classed as curriculum guides. Even those texts which presented principles of color in a quasi-curricular manner provided either too few visual examples or too little verbal explanation. Without the means to train individuals adequately in color discrimination, testing change in visual perception became meaningless. Abandoning the

idea of testing change in color perception, the author decided to use existing literature to develop a color curriculum for use at the post-secondary level of art studio instruction. This curriculum would serve as the training instrument, assisting in the development of an individual's visual color discrimination.

Statement of the Objectives

Once the development of a training program in subtractive color discrimination for individuals at the post-secondary level became the author's major objective, a detailed search of all relevant literature was required. A previous cursory search had revealed no extant post-secondary curriculum guide for color instruction. A review of literature to determine the availability of texts and research studies on general curriculum development in color instruction became the next logical objective.

The second objective of subtractive color training program development required that each citation be evaluated for its relevance to course development in color instruction. Since it was expected that there would be few items of relevant literature, a survey of instructional methods at other post-secondary institutions was considered as a means of providing needed information regarding the content of color courses.

The objective of a survey of selected post-secondary institutions was to determine how and by whom color instruction was being presented and then to determine what literature was being used in the field, as well as to discover unpublished literature useful for instructional purposes.

The final objective of the dissertation research was to construct a curriculum in color instruction. The proposed curriculum would provide a detailed description of practical instructional exercises organized into a pedagogically defensible sequence. The exercises are preceded and accompanied by verbal and visual instructional content. The function of the exercises would be to provide the student with a method for learning how to translate color theories into practical examples.

Procedure

In order to establish a basis for the construction of a curriculum in the instruction of subtractive color principles, it was first necessary to conduct a search of the related literature. It is sufficient for our purposes here to think of subtractive color as the principle in which selected frequencies of the electromagnetic spectrum are absorbed or subtracted from the total spectrum of visible light by a pigmented surface, leaving the remaining frequencies to be reflected to the eye. Texts comprised the first segment of this literature. Such a procedure was conducted to establish which contemporary texts would directly relate to the development of a color curriculum. One problem encountered in the search was that a number of texts using the term "color" in their respective titles were little more than procedural guides directed toward a specific media or technique, not toward the instruction of color principles alone. This fact greatly limited the number of texts which were found to relate even in part to the development of the curriculum.

While the procedure for researching color studies was similar

to that of the texts, it was necessary to consider the multitude of disciplines in which the study of color was being conducted, which complicated the search of related literature because it required the review of a wide variety of discipline areas, thirty-two in all, to determine the extent to which they might influence the construction of the color curriculum. Conclusions of the search for related work revealed that only a few studies remotely influenced the subtractive color curriculum model; no guides to color curriculums were found.

The second major procedural endeavor was to conduct a survey of the methods and content of color instruction within a select group of four-year post-secondary art departments. The purpose of the survey was to supplement the related literature. First, a pilot survey was sent to local institutions. The questionnaire asked if and how subtractive color principles were taught, or if the institution was planning for such instruction; if color was taught as part of any other studio course, or if color was taught outside the department, but within the institution.

Pilot survey responses dictated several modifications to the design of the questionnaire. With those modifications completed, a similar questionnaire was sent to 1100 post-secondary art departments in the eastern half of the United States. The population of this first color instruction survey was purposely large because it was suspected that only a small percentage of institutions would respond affirmatively, yet the greatest possible number of affirmative responses was desired.

A second and more detailed questionnaire was sent to those institutions responding affirmatively to the first color instruction survey. This second questionnaire asked for responses concerning

institutional and departmental population; specific facts about the general curriculum; the method and rationale for the type of instruction; training and qualifications of the instructional staff; and method and criteria for the evaluation of students, course content, and instructor / instruction. Responses from this second survey were used to supplement the literature search and provide justification for the development of the color curriculum (see Appendix A). Justification for the curriculum came in large part from the wide diversity of instructional methods being used by the institutions responding to the second color instruction survey. These responses confirmed the author's suspicions that a standard color curriculum did not exist, nor was a standard color system in general use.

Once the search for relevant literature was completed and responses to the second color instruction survey were tabulated, construction of the color curriculum was begun.

More than just a series of practical exercises, the subtractive color curriculum was developed with the intention of providing the student with a foundation-level background in color history, the relationship of the physical and physiological aspects of human color vision, and the psychological aspects of color perception. It should be remembered that the color curriculum was proposed because the literature search revealed that many texts on color were not relevant to use as instructional guides. Of those texts that were relevant most provided too little verbalization and/or too few visual examples. The curriculum was also developed because the survey revealed the use of no standard instructional method.

Having developed a background lecture series providing for

course orientation, color history, the physics of color and the physiology of the eye-brain, and elemental characteristics of color, development of the practical exercises was undertaken. Evaluation of current literature, and responses from the second color instruction survey, revealed that the exercises in Josef Albers' text, Interaction of Color,[1] were most applicable, and should become the basis for development of the practical application portion of the color curriculum. The sequencing of Albers' exercises was revised to reflect what this author considered a more reasonable presentation of color principles. A number of Albers' exercises were modified to provide the instructor and the student with a content that was less complex or that presented a specific color concept from a different perspective.

In addition to some variation of the content of most of Albers' original exercises, extensive modification was made of the verbal (lecture) presentation of each exercise. To accompany each exercise, the author developed an outline for the instructor's use in presenting each specific color concept and practical experiment. To supplement and complement the instructor's exercise lecture, each student is provided with a handout which presents the objectives and a brief discussion of the exercise, a list of required readings, and a diagram and explanation for producing the physical portion of the exercise. The color curriculum also includes an outline to assist the instructor during group critiques. Group criticism periods are planned upon completion of each exercise.

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[1]Josef Albers, Interaction of Color (Rev. ed.; New Haven, Connecticut: Yale University Press, 1976).

The practical exercises of the color curriculum have been developed primarily from Albers' curriculum. A variety of other sources was used to supplement the presentation of individual color characteristics because the author felt that Albers' verbal presentation lacked the necessary depth to explain adequately the reasons for studying specific color principles and relationships. Through additional sources, lecture outlines and handouts of the color curriculum have been expanded beyond those of Albers.

Most of the literature related to the instruction in color principles is primarily verbal and lacks sufficient visual examples, the writing of many authorities on color is pertinent and directly related to the practical exercises of this curriculum. Because the principles of subtractive color are generally accepted, the writing of many authors who express identical or similar spectral models has been included in the exercise lectures, student handouts, and critique outlines. Opposing theories are noted in the lecture on color history.

Historically, European color scientists and writers like J. C. Le Blon, Moses Harris, Ignaz Schiffermuller, Johann Wolfgang von Goethe and Phillipp Otto Runge, Charles Hayter, M. E. Chevreul, and Charles Blanc, and American colorists like Louis Prang, Milton Bradley, Arthur Pope, Herbert E. Ives, Faber Birren, and Ellen Marx, have helped to develop and maintain the red, yellow, and blue spectrum model used by Itten and Albers, as the tradition in art education.[2] While a variety of other scientists and artists have

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[2]Faber Birren, "History of Color Circles," Birren: Principles of Color (New York: Van Nostrand Reinhold Company, 1969).

proposed a multitude of opposing spectral systems, the system which has been acknowledged as the educational tradition, the one used at the Bauhaus, has been justified as the basis for the color curriculum model.

Limitations

The color curriculum has been designed as a post-secondary art course, substantially made up of practical exercises; therefore, several factors may limit its use. First, presentation of the curriculum may require additional staffing and/or library holdings, and second, the curriculum needs to be presented to a variety of populations.

Research data indicate that instruction in subtractive color principles as a separate course is not generally provided in most post-secondary institutions; therefore, the lack of a properly trained instructional staff and appropriate library holdings may pose some limitations. Any institution and/or department wishing to provide for separate color instruction should first evaluate the ability and desire of the person selected to be the instructor. Equally important, an evaluation of the institution and/or department holdings of representative texts and visual aids should be made to determine if library support is sufficient to supplement and complement the color curriculum.

During research and development of the color curriculum, its exclusive presentation was as part of a required post-secondary art studio program; the majority of students involved were art majors. While this setting may appear to be the most appropriate for color instruction, the curriculum should be presented in different settings

and to different populations in order to evaluate properly its general concept.

Finally, the color curriculum has been developed in an art studio course within a liberal arts institution and has not been evaluated in any way to determine its general effectiveness. While this author is desirous of publishing this color curriculum, it is imperative that the limitation posed by the lack of its evaluation be overcome by putting the curriculum into general use as soon as possible.

It is the desire of this author that the color curriculum be used as it has been developed and is presented herein, and that it be applied to the widest variety of populations and settings possible. The curriculum should be considered and used as a catalyst for deeper and more expansive instruction in subtractive color principles.

Chapter 2

REVIEW OF RELATED LITERATURE

Chapter two deals with the literature related to the development of a studio art course in subtractive color instruction, with specific attention to post-secondary art education.

Curriculum Development in Higher Education - Art

Citations in the area of art education curriculum development appear to be relatively scarce until the late 1960's and early 1970's, with only a few making consistent reference to higher education. In the introduction to The Visual Experience, Bates Lowry discusses the differences and similarities of a variety of objects all presented in different ways because each fulfills a different activity. Underlying these varied activities and their particular problems there exists a certain unity that allows a single artist to operate in a number of different fields either as an artist or as an artisan, limited only by his technical knowledge and abilities. Lowry says, "the foremost requirement of all these activities is the ability to work with the eye."[3]

Lowry notes that visual sensitivity is not some talent that is mysteriously inherited, but is learned through training and study of the visual arts. More importantly, Lowry notes "our ability to communicate visually is equally affected by neglect of training or study."[4]

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[3]Bates Lowry, The Visual Experience: An Introduction to Art (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964), 12.

[4]Ibid., p. 13.

We must learn how to see (perceive or interpret) aesthetically. The aesthetic act of seeing as distinguished from the mechanical act of looking, occurs only with effort and training, and in learning how to see one cannot rely exclusively on reading books but must act for oneself building up experiences with visual forms.

In 1966, Herbert Read wrote about the increased understanding of both the nature of art, and of human nature through modern psychology. The first relates to the significance of visual imagery called "eidetic", originating from an imagination so vivid that it must be considered particularly significant. The second, relates to a protest against a logical conception of knowledge and science called Gestalt psychology. Read defines the Gestalt theory by saying that "there are no facts apart from the act or process of experiencing them, that the 'facts of the case' are not grasped by enumeration, but must be felt as a coherent pattern. The word 'felt' must be emphasized, for this factor of feeling in perception is aesthetic. It is not only the perception of a particular pattern, but also a discrimination in favor of that particular pattern."[5]

While Read is not expressing his theories in terms of curriculum development alone, what he implies is that through the relationship of the human psyche and contemporary aesthetic concepts, art cannot be taught; i.e., curriculums cannot be developed by way of the lecture-demonstration-discussion alone, but must also be experienced

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[5]Herbert Read, The Redemption of the Robot: My Encounter with Education Through Art (New York: Trident Press, 1966), 21-22.

by the individual directly. This implication may be related to Lowry's statement that the basic requirement of any aesthetic activity is the ability of the artist to approach his subject from a visual mode.

While amplifying the "hands-on" relationship to art instruction espoused by Lowry and Read, Stuart Macdonald, writing in The History and Philosophy of Art Education, defines the teaching-learning process as not without direction, but rather that students should work on open-ended but planned projects of a general nature, with the individual results being critically analyzed by the class.[6] This methodology of aesthetic instruction would appear not only to allow for physical contact with the materials, but, with the resultant practical experiences being satiated, to emphasize the general approach to design concepts and the personal handling of both materials and techniques, and to allow for the development of the individual student's cognitive abilities as well.

Macdonald says, "Divergences of opinion abound on the nature of a desirable basic course, but it is possible to define certain aims held in common by leading protagonists."[7] And while the following descriptions refer to basic art instruction, it should be noted that the concepts may be applicable at any and all levels of curriculum

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[6]Stuart Macdonald, The History and Philosophy of Art Education (New York: American Elsevier Publishing Co., Inc., 1970), 368.

[7]Ibid., p. 370.

development in higher art education:

> Firstly, a course should be designed to free the students from a disorderly conglomeration of previous art knowledge (. . .) a course should encourage an analytical outlook by imparting a knowledge of the visual elements through creative work. A student may then be able to think in terms of visual grammar, and a standard terminology may eventually be achieved (. . .) a course should also acquaint the student with the structure of natural objects (. . .) finally, a course should train the student to look critically and analytically at the work of notable masters.[8]

In 1975, Vincent Lanier states that all that has to be insisted upon is that the psychological, sociological, and anthropological facts of individual growth need not and should not be the principal focus of the art teacher, but that the pre-eminent concern of the teacher of art should be a development within the domain of visual aesthetic transactions.[9]

One of the objectives of curriculum development must be a distinction between artistic creation and aesthetic experience. Regarding the aesthetic experience, Smith and Smith reporting in the Teachers College Record, say:

> While there are reasons for thinking that the aesthetic, as a value held by persons, has probably found a place in the value schemata of more individuals than ever before, considerable confusion appears to exist about aesthetic value as a property of objects, that is, as the capacity of objects to make a favorable difference in the lives of people. There seems to be no clear notion of what that favorable difference would be, that is, what persons can reasonably expect from art or in what way their lives would be made more worthwhile by it. How many know for example,

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[8]Ibid.

[9]Vincent Lanier, Essays in Art Education: The Development of One Point of View (New York: MSS Information Corp., 1967), 123.

> what would qualify an object as possessing aesthetic value or, indeed whether any object at all can be disqualified on the grounds of being devoid of such value?[10]

For the art educator as a curriculum developer-reformer, the value of the aesthetic for education means that the artist, the preferred role model, imagined as one who does creative things, needs to be taken from the studio, placed in the educational setting, and made the representative of the aesthetic. The artist becomes the catalyst for educational change. While this may appear a logical solution for stirring a lethargic aesthetic spirit, it is counter to what previous curriculum developers suggest is a logical approach to curricular development, because tradition has shown that most practicing artists do not make their experiments objective. Since the artist's approach to his discipline may tend to be subjective, the educational reformer is either asking the artist to deal unnaturally with the media or technique by making it objective or allowing the curriculum to have little objective logic in its construction.

In another arena of curriculum design the developmental and cognitive psychologists are to be taken much more seriously in their current involvement with the arts, note Smith and Smith. With the relatively recent interest in the relationship between the arts and cognition, questions of whether the arts have a potential for promoting general cognitive development have become a major stimulus for research. This designates yet another application of and instance where

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[10]Ralph A. Smith and Christiana M. Smith, "Aesthetic Value and Education", Teachers College Record, LXXX (May, 1979), 720.

curricular development in aesthetic education may be valued.

During the search of related literature it has become evident that curriculum development in art is moving toward what is contemporarily entitled "aesthetic education". This trend appears to be causing art education to move in two concurrent directions. One direction is that of educating the entire population of a culture or society of the aesthetic or artistic designs seen in its immediate environment. The other is to extend some credence to the fact that art possesses a cognitive element, as well as one which is practical or functional.

In a report in the Journal of Aesthetic Education, sociologists Paul DiMaggio and Michael Useem raise questions about the consequences of educational programs in aesthetic education and arts for equality of aesthetic and cultural opportunity.[11] They state that "no one is born with the ability to appreciate and participate in the arts", and "One must possess the knowledge, motivation, attitudes, and experience necessary to understand what one is hearing and seeing."[12] These characteristics, note DiMaggio and Useem, require learning, and since learning occurs in educational institutions, the inequitable allocation of resources devoted to aesthetic education and the arts may prevent some students from experiencing an adequate education in this area. Lack of an aesthetic education may also deprive the

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[11]Paul DiMaggio and Michael Useem, "The Arts in Education and Cultural Participation: The Social Role of Aesthetic Education and the Arts", Journal of Aesthetic Education, XIV (October, 1980).

[12]Ibid., p. 57.

student of participating in the arts and a variety of other cultural activities.

DiMaggio and Useem state that by being provided an adequate aesthetic education and by being involved in cultural activities, the individual may develop the cognitive and non-cognitive skills characteristic of creativity, flexibility, and a capacity for abstract thought. They continue at great length to empirically validate such predictors as an individual's attendance at, attitudes about, and participation in art and cultural events. They note that there is empirical evidence that formal aesthetic education is the best predictor of an individual's involvement in art and cultural activities, but they have yet to determine why.

The literature related to curriculum development in art at the post-secondary level has been presented with no major contributions in some fifteen years. In the years immediately prior to 1967, art curriculum development was seen as a material versus a cultural approach, and was probably the reason for perceiving the arts in general as closely related. One of the most notable approaches to art curriculum development contrasted the act of aesthetic seeing to that of mechanical looking, theorizing that art as a visual experience must be learned and that this learning must be experienced as direct contact with the materials. During the 1970's, art curriculum development modified and honed previous approaches and began to approach the teaching of art as analytical and evaluative, emphasizing visual thinking as directly working with the materials of creation. This approach is manifested most clearly with the emphasis on the teaching of aesthetics as distinguished from the teaching of the

psychological and sociological aspects of individual growth. The late 1970's and early 1980's reiterated the need to approach art education curriculum development as a series of learned experiences, adding to the literature an emphasis on curriculum development in post-secondary art education as a cognitive experience.

While the texts and studies relating to curriculum development in post-secondary art education tend to be few in number and general in nature, those specifically related to subtractive color instruction are more numerous. Although the research and publication in subtractive color instruction utilizes some of the curricular development concepts noted previously, the majority of these presentations are not conceived as curriculum guides, nor do they note specifically their curricular intention.

Current Texts and Studies in Subtractive Color Instruction

In the contemporary version of Ogden Rood's original text on color, Faber Birren has written the preface, introduction, and commentary notes regarding Rood's influence on 19th century French art, as well as on a variety of art critics and historians, scientists and philosophers. In the preface, Birren refers to the relatedness of the scientific and aesthetic approach which Rood emphasized, noting, "to present in a simple and comprehensible manner the underlying facts upon which the artistic use of color necessarily depends".[13] In his commentary, Birren discusses the significant theories, research

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[13]Ogden N. Rood, Modern Chromatics: Students' Text-book of Color with Application to Art and Industry (New York: Van Nostrand Reinhold Company, 1973), 76.

and findings of each segment.

While Rood's text includes extensively researched theories of color and an abundance of tables and figures, it is still a text written by a scientist. He had a background in art and could therefore approach his research findings with intelligent artistic intent, however, Rood's text is not set forth in curricular fashion. However, because of its wealth of color information, Rood's text has been used in the establishment of the practical curriculum in color instruction.

Throughout the text Rood discusses color phenomena with regard to both the scientific and artistic viewpoints. While some chapters tend to be scientific, he does devote some chapters to detailed discussions of the artistic approach to his theories and research. Of the artists and scientists influenced by Rood's text, Albert H. Munsell was possibly more influenced than any other American artist-scientist. Munsell's study and expansion of Rood's experiments led to a colorimetry standard in use throughout the world today.

Munsell realized that numerous books had been published treating the physical and psychological aspects of color, yet to the average person it remained a mysterious expression of nature, taken for granted and not fully understood. In 1905, he wrote a text that presented the whole question of color definition entitled, A Color Notation.[14]

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[14]Albert H. Munsell, A Color Notation (12th ed.; Baltimore, Maryland: Munsell Color Company, Inc., 1975).

With information gained from his experiments, Munsell could have, although he chose not to, put together model exercises which would afford the student a means of better understanding color. It is this author's contention that no matter how universal the information on color phenomena is, it is of less immediate use for vocational or avocational reasons, if it cannot be presented as a series of practical color exercises.

In his translated and edited reprinting of Ostwald's Die Farbenfibel (Color Primer), Birren has reproduced more or less intact all of the original text and all of the illustrations of the original German edition, with liberties taken in translation of some terminology. In the original, Ostwald sets down his classifications and effects of color by way of separate chapters. Chapter one (achromatic colors) and two (chromatic color) are possibly the most important chapters of Ostwald's text because the other four chapters are directly dependent on a thorough comprehension of these two.

Possibly one of the most comprehensive texts in color learning was first published in 1923.[15] In the preface, Sargent notes that the volume is primarily arranged as a textbook for secondary and post-secondary art departments, as well as a book for general reading. In it he has presented a most practical method of color learning which, he says, "will be helpful to that large class of people who do not expect to be artists but who would like to know more about color and its use, and to increase their own enjoyment of color in nature and in

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[15]Walter Sargent, The Enjoyment and Use of Color (Rev. ed.: New York: Dover Publications, Inc., 1964).

art."[16] The compatability of his text and the development of this color curriculum can be understood in this brief statement by Sargent in the section entitled, "Methods of Studying Color":

> We may take up the subject of the study of color in two quite different ways; namely, as a subject in physics, or as a subject in art. If we consider it from the point of view of physics we are dealing with exact laws of light and optics, and may proceed on a basis of fairly well-established facts. If we study it as a part of the language of art we are concerned with what has always been an important source of artistic enjoyment, but a matter of human experiences so varied and individual that we have as yet little knowledge of any systemic way of attaining that experience and enjoyment. Consequently the student of art has usually been left to acquire his enjoyment of color and his knowledge of its use in a more or less haphazard way. His special sensitiveness to color enables him to accumulate a good deal of knowledge, although generally with considerable waste of time and energy. Often he is likely to regard this random approach as the only method because it is the way by which he has arrived. For the general student, however, this uncalculated method is still more wasteful than for the student with special talent.
>
> Now although the study of color as a subject in physics differs essentially in its aim from the study of color in the realm of the arts, nevertheless the two lines of investigation have much material in common, especially at the beginning. The qualities that distinguish colors which we call crude from those which we consider to be beautiful, and that make some combinations of colors mutually consistent, in contrast with other groups which do not go well together, have their basis, in part at least, in the laws of light and optics, and can be stated in terms of these laws as well as in those terms which express our aesthetic pleasure or lack of pleasure in them.[17]

Sargent says that in the study of color as used in the arts, one should take into account the color relationship that exists between the laws of color in physics and the aesthetic qualities of color in art. Instruction must make use of the principles of light and optics,

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[16] Ibid., p. iii.

[17] Op. cit., pp. 3-4.

furnishing a systematic approach and making evident the correlation between external physical causes of color and subjective aesthetic experiences. Sargent develops a relationship between the physical and aesthetic studies of color by establishing a series of "experiments" at the end of text chapters.

A major drawback of Sargent's text may be the lack of practical experimentation with color concepts immediately after their presentation. Further, if Sargent's experiments were presented in smaller segments they might allow for greater ease in learning.

Alfred Hickethier puts forth a system which, as stated on the coverleaf, "is the foundation of the Hickethier Color System, which is made up of sixty-four basic colors from which almost any color can be mixed."[18] The code-number system assigns a three-digit figure to each color which is obtained from the proportional amounts of the three primary colors. The code-number therefore, defines the particular color, and serves as a formula for mixing.

While it is agreed that technical knowledge of color is inadequate, especially with many of our contemporary art students, it cannot be agreed that by teaching such an objective system as has been established by Hickethier, can an individual gain more than knowledge of color principles. While Hickethier's Color System may lead to technical knowledge, it never establishes any consideration for those principles which underlie a true understanding of color fundamentals.

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[18]Alfred Hickethier, Color Mixing By Numbers (New York: Van Nostrand Reinhold Company, 1963), coverleaf.

Another Birren text, published in 1969, presents first the history of color circles beginning with DaVinci's Treatise on Painting and continuing through configurations devised by Rood, Munsell, and Ostwald. In developing this history, Birren cites those theories which establish a variety of perspectives on the nature of color.[19] Birren continues his discussion of color principles with a description of the harmony of color by way of simultaneous contrasts of hue, value, and intensity. As in music, colors work together in pairs, triads, tetrads, and other multiple combinations producing a variety of effects or moods. The knowledge and understanding of color harmony is invaluable to the beginning color student because it will eventually permit a development of the ability to control the language of color.

By relating the information put forth in both the principles of the color circle and the harmonies of color, Birren is able to describe the harmony of forms. Even though he limits his discussion to various combinations of a chromatic hue and its relationship to black, white, and/or gray, Birren describes how the beauty of the proper sequencing of color appears natural and concordant.

Although Birren's text is adequate for the novice, its major drawback is that it does not discuss relationships between specific physical and aesthetic aspects of color. While the novice may gain knowledge of color principles, he should be presented with descriptions

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[19]Faber Birren, Principles of Color: A Review of Past Traditions and Modern Theories of Color Harmony (New York: Van Nostrand Reinhold Company, 1969).

of the visible spectrum, the relationship of additive and subtractive color, some physiological aspects of vision, and when appropriate, some psychological aspects of color.

One widely used text on color instruction was written by Johannes Itten.[20] In the introduction he says, "The doctrine to be developed here is an aesthetic color theory originating in the experience and intuition of a painter."[21] One of his notable concepts is entitled "Subjective Timbre", which encourages the student to express his own private conception of color harmony, each student's work being different from the work of another.

The primary difference between Itten's presentation and this color curriculum is that this curriculum is being approached from a perspective more global than that of the painter. The color curriculum will make applicable the theories of many colorists for general color instruction regardless of the student's vocational considerations.

The color curriculum has been developed with an emphasis on the objective, suppressing the psychological or subjective. This is being done primarily because this curriculum is proposed for the student with no previous background in color instruction. This author is in concert with Itten with respect to the notion that an individual can be released from subjective bondage only through knowledge and awareness of objective principles. As in Itten's text, this color curriculum begins its instruction with a discussion of color physics. Principles

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[20]Ernst van Haagen, trans., The Art of Color: The Subjective Experience and Objective Rationale of Color, by Johannes Itten (New York: Van Nostrand Reinhold Company, 1973).

[21]Op. cit., p. 11.

of color interaction, also noted by Itten, have been cognitively and affectively developed in separate practical exercises within this color curriculum.

Itten's use of a twelve-hue color circle is notable because it is different from the ten-hue circles used by both Rood and Munsell. Rood's ten-hue chromatic circle included three primary colors, three secondaries, and four other distinctly different colors. This circle, however, was contructed with disproportionate spaces between colors and used colors with less describable characteristics, such as cyan and ultramarine blue. Munsell resolved some of these apparent problems in his ten-hue circle by placing five distinctly different colors and their respective complementaries at equal distances from one another. Munsell, however, does not speak of primary, secondary, or tertiary hues, referring instead to principal and intermediate colors. The twelve-hue system used in this curriculum makes harmonious color combinations more easily understood.

Itten notes seven color contrasts which are used to make various color comparisons. Nearly one-half of his text is devoted to the independent discussion of these contrasts. He says, "When we survey the characteristics of color effects, we can detect seven different kinds of contrast. These are so different that each will have to be studied separately. Each is unique in character and artistic value, in visual, expressive and symbolic effort, and together they constitute the fundamental resource of color design."[22] The shortcoming of his lengthy discussion is that Itten did not put these

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[22]Op. cit., p. 36.

individual discussions into curricular fashion so that they could be effectively practiced by the novice colorist.

In the postscript to his text, Itten says, "In this book I have tried to build a serviceable conveyance in which the color artist may travel a longish distance upon his way. Yet this will be no easy pilgrimage. The route is fixed by the inexorable laws of color."[23] And, "In this book, I have discussed a number of masterpieces of painting and tried to discover their hidden meanings. I chose old masters chiefly, because many readers may be familiar with the originals. But the color principles they illustrate are timeless, and as valid today as they ever were."[24]

It should be noted that a treatise on the color system of Johannes Itten, based on his book The Art of Color, was edited and contained a forward and evaluation by Birren.[25] Birren's book, a simplification and condensation of Itten's major work, is an excellent reference text for the student of color as it contains virtually all of Itten's principles, omitting only historical discussions relating to the seven color contrasts.

A text which tends to approach color from a scientific rather than aesthetic theme, discusses the many-colored environment from the standpoint of an individual's sometime subconscious but continuous

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[23]Op. cit., p. 153.

[24]Ibid.

[25]Faber Birren, ed., Itten: The Elements of Color (New York: Van Nostrand Reinhold Company, 1970).

chromatic stimulation.[26] Kuppers determines that because our general education system teaches the basic principles of geometry, we are therefore more attentive to shape and form than to color. Kuppers states the corrective requirement, "Since the various colors of the objects constitute a considerable part of the information in the visual process, this should be duly recognized. This means that correct seeing must be taught and learned, and just as it is possible to develop general taste it should likewise be possible to develop taste in colors."[27]

Kuppers discusses the composition of the electromagnetic spectrum and the color of light, the difference between actual and perceived colors, the process of vision including visual defects, optical illusion, adaptation, and simultaneous contrast.

In a chapter in Kuppers' text for the subtractive colorist, he discusses those principles of color that make up the basis for the practical exercises in the color curriculum. Kuppers discusses the primary colors, both additive and subtractive, and the color circle. The color circle here, while similar in elements to Itten's three primary-three secondary, and Ostwald's twenty-four hue circle, has six "primary" chromatic colors. Additive and subtractive complementaries and mixtures make up a significant portion of Kuppers' discussion of systems, as do discussions of the possibilities of modifying a color and mixing two colors. In the conclusion of this section,

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[26] F. Bradley, trans., Color: Origin, Systems, Uses, by Harald Kuppers (London: Van Nostrand Reinhold Ltd., 1972).

[27] Ibid., p. 7.

Kuppers makes a critical assessment of color systems, including both the Ostwald and Hickethier codes.

There are two different ways to observe color contrasts: additive processes, the optical syntheses of light waves, and subtractive processes, the blending of pigment colors. A book by Ellen Marx demonstrates color's subjective phenomenon using a visual approach.[28] Although it provides an explanation of the principles of color theory, there are no practical exercises. However, Marx's text should be noted as an excellent visual aid for both the color instructor and the student. In its composition, Marx's book takes basic color contrasts and demonstrates the effects that depend on the reactions of the observer by utilizing one-hundred color pages on which twenty-four printed color acetate overlays can be superimposed. Unique to the text are the die-cut pages that allow the reader to immediately experience a variety of possible color contrasts.

William Libby says that his text, "Describes the behavior of color, and in this connection, the nature of art. In doing so, it touches upon many technical and aesthetic aspects of the way in which colors are perceived, named, and related. Its philosophic theme is that colors, like other elements in works of art, have meaning only when they are relational in the structural sense."[29]

In excerpts from the forward of Libby's text, Edmund B. Feldman

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[28]Ellen Marx, The Contrast of Colors (New York: Van Nostrand Reinhold Company, 1973).

[29]William Charles Libby, Color and the Structural Sense (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974), cover.

writes:

> Color has as much to do with human behavior as it does with the physics of light, optics, and the chemistry of paints and dyes (. . .) the great practitioners of color as an art have rarely been able (or willing) to convey their enthusiasm about the subject in writing. So we are happily obliged to examine their work directly (. . .) the serious artist or student of art wants something more: he wants to know the aesthetic as well as the chemical and physiological causes of color effects in his experience; he wants a clear exposition of the coloristic tools available to him; and he wants an explanation of the role color plays in the experiences of viewers.[30]

Libby discusses the variety of theories and principles that cause and allow us to see color as we do. There are no practical exercises and few illustrations, but there is an abundance of scientific and psychological points of view, as well as folklore surrounding the use and meaning of color. The basis for the text is perception and identification of colors as an artist might see the relationships.

Libby's text has been used in the construction of the introductory lecture series of this color curriculum regarding basic information on the source of light, the atmosphere through which light passes, the surface from which light is reflected, and the effect that light has on the receptor system. Libby's book has also provided information used in developing the lecture sections of the respective practical exercises.

A text by Frans Gerritsen presents color instruction similar to that of Libby, stating that its aim is to span the gap between the world of the arts and the world of the sciences by offering new

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[30]Op. cit., pp. v-vi.

insights into the ways in which color is perceived and distinguished, and the way in which we react to them aesthetically.[31] Gerritsen uses numerous pictorial examples to visually support contemporary theories and facts about color perception, including his own new color circle.

Gerritsen provides a brief overview of the historical concepts noting how various theories of the sight process developed into the contemporary scientific approach. The text diagrams the historical lineage of two- and three-dimensional color systems including those of Rood, Munsell, Ostwald, Hickethier, and Kuppers. Gerritsen approaches the same principles and concepts of color as approached by Libby; however, instead of an almost exclusively verbal presentation, he used a number of color photographic reproductions, color overlays, and cut-outs.

In the forward to his text, Gerritsen states, "in this world where color is so important, an elementary understanding of color is difficult to achieve. How can this be? Because there is much material but little clarity. Clarity is certainly badly needed."[32]

While Gerritsen's own theories and color circle are not specifically used in this color curriculum, it should be noted that this curriculum does not espouse any particular theory, but rather a methodology for the presentation of color theory in general.

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[31]Frans Gerritsen, Theory and Practice of Color: A Color Theory Based on Laws of Perception (New York: Van Nostrand Reinhold Company, 1975).

[32]Op. cit., p. 9.

In a fourth text, Birren briefly discusses the development of twentieth-century color expression from the English artist J. M. Turner (1775-1851) to contemporary artists, with special attention to the school of Op Art.[33] The use of both achromatic and chromatic illustrations allows Birren to devote a major portion of this text to the explanation of a variety of visual phenomena and illusions, how the brain is put to creative efforts. In the illustrations, Birren discusses the visual sensation of illumination, concentrating on the neural events in the process of seeing. In the final chapter, Birren discusses a variety of principles of color related to colored illustrations within the text itself.

In 1976, a revised and unabridged text edition of Albers' 1963 masterwork, Interaction of Color, began its fourth printing. While the pocket edition includes only a small number of the original 150 color plates, the text remains the complete text of the original large edition.[34] Albers' introductory statement is that the book is, "a record of an experimental way of studying color and of teaching color."[35] He points out that color, while being continually deceptive, evokes a variety of responses. Albers' aim is therefore to develop an ability to "see", as well as to "feel" color, placing the practice of color before the theory, and omitting the physical and physiological

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[33]Faber Birren, Color Perception in Art (New York: Van Nostrand Reinhold Company, 1976).

[34]Josef Albers, Interaction of Color (Rev. ed.; New Haven, Connecticut: Yale University Press, 1976).

[35]Ibid., p. ix.

aspects of color.

Albers presents a series of brief "lectures" on color recollection, color reading and context, and an explanation of the selection of materials. The majority of the remainder of the text provides brief explanations of practical exercises which explore a variety of subtractive color theories, concluding with exercises that tax the student's color knowledge, comprehension, and imagination. The final section of Albers' text presents several advanced concepts of color theories and systems, and color terms.

The Interaction of Color has been the basis for the development of color instruction at the post-secondary level, and has played a major part in the development of the color curriculum. Its structure of practical exercises was of particular interest because many of the other artist-authors provided no exercises or none with the same simplicity, which would allow the novice colorist ease in relating verbal instruction to practical response.

One reason for selecting Albers' text as the basis for this color curriculum is that it takes the instruction of color principles out of the media-technique curriculum mold and allows it to exist on its own. Because this curriculum refers expressly to the principles of color, the elements and principles of general two- and three-dimensional design may themselves be applied to color. Because Albers and this color curriculum do not utilize the physical mixing of pigments, the approach to color learning as a specific artistic media is more remote, allowing for nonspecific, global applications of color concepts.

The major criticism of Albers' presentation is that there is so little verbalization of the concepts underlying the practical

exercises as to make them incomprehensible to the color student without extensive tutelage. While Albers' text is highly regarded, it does not go into sufficient depth to provide the necessary background relating to the practical exercises.

In this review of the current texts in subtractive color instruction, it should be apparent that a variety of authors have approached the teaching of color from a variety of directions. While the current texts in color instruction may exhibit no evidence of a specific method in the teaching-learning of color theories and/or practice, they do present universal information. The comprehensiveness of information presented by color texts is a result of the writings of a variety of practicing artists, scientists, and theoreticians.

In addition to current texts in subtractive color instruction, it is important to know that no published research studies on color instruction alone were found within the fine arts. Because of its complexity, the discussion of the principles of subtractive color is segmented according to general information and color elements and their related concepts.

General color research. While no research studies regarding color instruction were found, several published articles might be of interest as general background. In his article on color chemistry, Hallas says, "Colour chemistry is one of the few disciplines that cuts across the boundaries of art, science, and technology, and is therefore of general interest."[36] The purpose of his article, one of a series,

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[36]G. Hallas, "Colour Chemistry. Part I: Principles, Colour and Molecular Structure," School Science Review, LVI (March, 1975), 507.

is to help chemistry teachers in the selection of suitable material for an applied chemistry course, of which color chemistry is an optional topic.

While Hallas' article is more scientific than aesthetic, it includes elements which will prove helpful to the post-secondary color instructor in understanding physical aspects of color. Hallas discusses the origins of color verbally and graphically, providing a diagram of the electromagnetic spectrum and summarizing:

> Colour is a subjective phenomenon in that our sensations of colour stem from an interpretation by the brain of signals received from the eye via the optic nerve in response to appropriate combinations of visible electromagnetic radiations. Without becoming too involved in the realms of colour physics, it is important to appreciate that the colour seen by an individual is the result of a combination of (a) the type of illumination falling on the coloured surface, (b) the spectral sensitivity of the eye, and (c) the ability of the colouring matter to change the characteristics of the light by selective absorption and scattering.[38]

Hallas briefly details the individual aspects of the light source, the eye, and absorption and reflection of light. He provides a useful table illustrating the relationship between color absorption and visible color, which discusses additive and subtractive color mixing.

In a separate scientific journal article, S. J. Edwards discusses the study of color from two main aspects: first, the basic facts of how color is seen, and second, the measurement of color.[39] In his discussion of how we see color, Edwards discusses a topic which is suitable for the art and general color student. While Edwards' article

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[37] Ibid., p. 508.

[38] S. J. Edwards, "The Science of Colour," Physics Education, X (June, 1975), 316-321.

is brief, it provides a coherent summary of information that can be used in introductory color instruction lectures as well as with a variety of related practical exercises.

Edwards briefly discusses, from four distinct but related aspects, how color is seen. First, he discusses the physical-physiological relationship between visible radiation and physical stimulus of the retina. In a section about the eye, Edwards describes the placement and functioning of the rods and cones, the light receptors of the retina, and presents the color vision concepts of Young and Helmholtz.

Edwards discusses three independent, but related spatial effects: color constancy, the adaptation of the eye to a scene viewed under different lighting conditions; color contrast, the perception of the color of an object affected by the color of the surrounding area; and color spreading, the shifting of a color toward its neighbors when mixed in small areas. Finally, Edwards describes three temporal effects: after images, flickering, and color blindness in normal observers.

In a second article, reminiscent in content to his 1975 article, Edwards outlines a selection of demonstrations which he has used in teaching color science to students in a variety of courses, including dyeing and textile technology, fine art and interior design.[39] The general structure of Edwards' course is based on four aspects of viewing color: the light source, the colored surface, the eye, and the brain. Edwards' outline is very similar to that of the color curriculum

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[39]S. J. Edwards, "Demonstrations in Colour Physics," Physics Education, XII (March, 1977), 121-124.

which proposes a structure for the initial series of lectures and the subsequent practical exercises. The color curriculum outline includes the light source, the atmosphere, the surface, and the receptor system.

Edwards suggests that demonstrations connected with the light source could include Newton's prism experiment, or more simply, an exhibition of how various illumination sources, such as flourescent and incandescent, affect different color surfaces. He also suggests using photographs of one object or scene taken under varied lighting conditions to demonstrate the principle of color constancy. Edwards' recommendation for explaining the color surface is to mix pigments physically to determine the process of subtractive color production.

In suggested demonstrations involving the eye, Edwards says, "The essential point that has to be clearly understood is the trichromacy of vision,"[40] but he stops short of attempting to develop a thorough understanding for the student by stating, "As one of the fundamental issues that has to be made clear is the difference between mixing pigments and mixing lights it seems unwise to risk this confusion."[41]

In demonstrations involving the interpretation of the color scene by the brain, Edwards says that there is much more to color than the wavelength of light reaching the eye. He does this by looking at two distinct aspects: spatial and temporal effects. Spatial effects include how the color of an object is affected by the color of the environment. Demonstrations could include using a constant "figure"

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[40] Ibid., p. 121.

[41] Ibid.

color against various "ground" colors, the Land effect, and the colored shadow effect. Temporal effects are those which occur because of the time response of the receptors; after-images, caused by fatigue; and flickering, produced by using a rotating disc mechanism.

In the final section on color blindness, Edwards suggests using demonstrations that would cause an observer with normal color vision to be made to confuse colors by changing the viewing conditions. This, he suggests, could be done by looking at colored surfaces in low illumination and asking students to distinguish specific colors, or by viewing a standardized color deficiency test under an illumination source which only provides a limited range of the light spectrum.

The element of hue. The element of hue deals with the distinctive characteristic of a given color that enables it to be assigned a position in the spectrum. The color curriculum deals with subtractive color which is reflected light, having a definite frequency and wavelength. In this curriculum, hue is simply the name of a color, e.g., red, blue, or yellow.

Research constructed from an historical viewpoint is of particular interest in reference to the color curriculum since it is recommended that the student be provided with some background regarding the origins and naming of various hues. This point is most adequately presented by N. B. McNeill through research that deals with the origins of color terms and with their relationship to both natural resources and the physiology of human vision.[42]

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[42]N. B. McNeill, "Colour and Colour Terminology," Journal of Linguistics, VIII (February, 1972), 21-33.

In her opening statement McNeill says:

> The continuous gradation of colour which exists in nature is represented in language by a series of discrete categories. Although there is no such thing as a natural division of the spectrum, every language has colour words by which its speakers categorize and structure the colour continuum. The number of colour words and the manner in which different languages classify the colour continuum differ.[43]

Based on this, McNeill develops the concepts that there is no such thing as a universal sequence of color terms, but that there is a universal human perception of color based on the physiology of vision. She deals with these concepts by approaching a set of color words as representative of a system of structuring the perception of nature. This perception includes the evolution and use of color terms arising from the natural resources and the availability of colors in the environment, and the physiology of human vision.

McNeill summarizes her observations by suggesting that cultural color terms were the common names of available natural resources, supporting her contention that the emergence of color terms is culture specific. McNeill proposes that a similar relationship exists between color terms and human color perception, as between color terms and available natural resources. Of this she says:

> It is believed that the fact that a certain colour name does not exist in a culture does not mean that its people are incapable of perceiving that colour. Colour discrimination is probably the same for all human populations with healthy vision. To normal human vision, nature appears in various degrees of brightness - ranging from black through a variety of shades of grey to white - and in various coloured hues. Among the millions of hues that exist in nature, red, green, blue, and yellow are

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[43] Ibid., p. 21.

> considered primal colours. Of these primal hues some are compatible with each other and may be sensed in the same place at the same time; others are incompatible and will never be simultaneously present in the colour of an object.[44]

McNeill says that the innate tendency of human vision to combine red and green, or blue and yellow, is directly reflected in the color terms of some contemporary languages in the world. She refines this global perception however by writing:

> The invention of chemical dyes is very recent, historically, dating only from the nineteenth century. It is easy to overlook just how highly disrupting the availability of these dyes has been for the traditional colour terminologies, which have been evolving for many centuries. Not only has there been a great need for new colour terms, but traditional terms have been recruited to denote new, articially-made colours. The original referents of these colour terms, which were the colours naturally available to the culture, have generally been relegated to peripheral status, and in their place has appeared a vast new set of colours.[45]

In a research article which investigates the complexity of surface colors, Jacob Beck notes that colors are normally regarded in terms of wavelength and intensity, that is, the amount of absorption-reflectance and the percent of saturation of a particular hue.[46] He also writes that the attributes of hue, value, and intensity do not exhaust the variations possible with surface colors, and he goes on to discuss a variety of exponents of color perception, such as illumination

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[44] Ibid., p. 29.

[45] Ibid., p. 31.

[46] Jacob Beck, "The Perception of Surface Color," Scientific American, CCXXLIII (August, 1975), 62-75.

incident and intensity, and surface texture.

Beck briefly discusses the principle of color constancy which he defines as, "The ability of the human perceptual system to separate the lightness of the surface from the brightness of the illumination, (. . .) the tendency of colors to retain their daylight appearance in spite of large changes in the intensity and wavelength composition of the incident illumination.[47] Beck also cites the classic theories of 19th century investigators Hermann von Helmholtz and Ewald Hering who studied the phenomenon of color constancy.

A lengthy discussion of the subtle variations in the appearance of a surface color as a result of differences in surface composition and texture is presented by Beck. He discusses the characteristic surface appearances produced by differences between the light reflected from the outer surface and the body of an object. This discussion also presents information on specular and diffuse reflectance, and their respective characteristic achromatic and chromatic light.[48]

Beck notes that "The perception of surface color involves the response of the visual system to patterns of stimulation," to which he posits: "The general problem is to account for how a surface that reflects a distribution of luminances and hues yields a specific perception of color."[49] He suggests that the perception of a color as an attribute of a surface that reflects light nonuniformly can be

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[47]Ibid., pp. 62-63.

[48]Op. cit., p. 67.

[49]Ibid.

analyzed as a two-stage process. First, a pattern of nerve signals that relates to the distribution of reflected wavelength is determined by sensory processes. Second, based on these neural cues, the visual system organizes the signals in terms of a single color with deviations seen as highlights, light spots, and shadows. While this is a personal and somewhat complex hypothesis, it provides an interesting discussion which may be too advanced for a beginning color student, but which should be known to the instructor. In essence what Beck suggests is that, in addition to the surface color being a complex element, human perception also accounts for such characteristics as size, shape, edge gradient, pattern, texture and distribution, incident and reflectance of illumination.

Beck concludes his article with several experiments that should be of interest to the instructor of the color curriculum, and could easily be reproduced without the necessity of sophisticated equipment. In one experiment, Beck proves his hypothesis that cues for the illumination can affect perceived lightness by showing that, "a shadow cast on a background can give a viewer the impression that the surface casting the shadow is strongly illuminated by a spotlight, causing the surface to appear darker than it otherwise would. The fact that the shadow condition gave rise to perception of a darker color than the no-shadow condition cannot be explained in terms of lightness contrast."[50] Another experiment demonstrates how the apparent position of a surface can affect the perceived lightness of that surface. By allowing the subject to view, with one or both eyes, a visual set-up while providing

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[50] Op. cit., p. 72, illus.

illumination from various single positions, an upright geometric figure was caused to appear lighter or darker than the surround, and either flat or upright. These experiments are meant to demonstrate the effects of the apparent position of a surface when a luminance variation is no longer consistent with the perception of shadow. The percept changes so that in the area of lower surface reflectance, a darker surface color is perceived.

Finally Beck discusses the color constancy of actual and perceived transparent colors which depend on the perception of one surface behind another. He points to the relationship of additive and subtractive color as he discusses transparent color constancy, explaining that the perception of color transparency follows the rules of subtractive rather than additive color mixture, and is favored by stimuli that give rise to the perception of two surfaces separated in depth.

The element of value. In a series of visual examples of discussions regarding neutral color or color values, the relative light-dark characteristic of surface color, Hans Wallach presents a meaningful explanation of the effects of lightness constancy.[51] Wallach's experiments, illustrations, and discussions relate to the family of "colors" whose equality is not dependent on a wavelength or combination of wavelengths. These are known as achromatic and differ from one another only on a scale of relative lightness. Even though they exhibit neither the dimension of hue nor that of intensity, they are acknowledged as color and are known as neutral colors: white, gray, and black.

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[51]Hans Wallach, "The Perception of Neutral Colors," Scientific American (January, 1973), 107-114, 116.

Wallach explains the relationship between the concept of lightness regarding illumination and reflections and demonstrates the fact that lightness does not depend on a property of the light source, but on the physical property of a surface from which the reflectance is perceived as a neutral color. He provides a detailed explanation and examples of how the amount of light reflected by an achromatic surface is not only dependent on its own reflective capability but also on the intensity of the illumination source. This discussion helps to illustrate the effect known as "constancy".

Expanding the explanation of the constancy effect, Wallach cites several related research reports that provide a variation in the standard explanation of this special lightness effect. Traditionally the standard explanation has been that the viewer takes illumination into account when evaluating the intensity of reflectance. The difficulty, Wallach hypothesizes, is that illumination is never given independently, but is manifested only by the manner in which the surface reflects. By accounting not only for a sample neutral color but also for its surround, a proposal not considered in the standard explanation, Wallach demonstrates the characteristic known as "luminousness". This characteristic allows both neutral and surround colors to be perceived correctly and, therefore, more completely explains the constancy effect.

In a series of rather complicated experiments, more scientific and in-depth than Wallach's demonstrations, Alan Gilchrist investigates the aspects of chromatic value.[52] Work by Gilchrist, and others,

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[52]Alan L. Gilchrist, "The Perception of Surface Blacks and Whites," Scientific American, CCXL (March, 1979), 112-124.

demonstrates that the eye compares light by extracting edge information, so the visual system is provided information about illumination in precisely the same way that it acquires information about surface color; the perceptions of illumination and of surface colors are parallel visual processes. These processes involve the decomposition of retinal images into distinct patterns of illumination and surface color.

In his report of a variety of empirical findings, Gilchrist has published a rather detailed synopsis of the findings which support the hypothesis that the eye perceives and distinguishes reflectance from illumination relative to the definition of a perceptable edge. In establishing a background for his major experiment, entitled the "lightness-contrast display," Gilchrist performs and explains studies in the phenomena of color constancy and lightness constancy. One specific factor that allows Gilchrist to support his hypothesis is the realization that the eye maintains a natural tremor, indicating that the rods and cones of the retina function only under constant change of stimulation. Without this stimulation the visual field will go blank within one to three seconds; the eye only sends the brain information about the changes in light across edges or boundaries.

The characteristic of color space. For many years numerous artistic and scientific experimenters have explored the concept that individual colors exhibit a variety of differing characteristics which may be generally classified as pertaining to the perception of spatial location. Discussions and experiments have taken place in the studio as well as in the laboratory and have encompassed the study of such characteristics as advancing and receding colors, or the perceived or actual temperature of colors; the perceived difference in area which a

given color occupies when compared to another color, or the perceived size differential of a given color area when compared to another color of the same color area. In most areas the scientific community has taken the lead, looking empirically at the subject of color space and exploring the physics of light, the physiology of the eye, and the psychology of human perception. Current research in chromatic-spatial considerations are not, however, in abundance.

One reported physiological study by Virsu and Haapasalo suggests that the eye may contain numerous neural "channels," two of which are specifically developed to respond to color and/or spatial frequency.[53] In their findings, Virsu and Haapasalo reported that the existence of the selective responses of channels to both color and space appears to be a common property to the human visual system. Of this they say, "Channels of this type can form the basis for sensory integration because they tie together two different attributes of the outer world."[54] By virtue of a partial overlap between channels, a system of differentiation and integration allows the eye to respond to color and/or space; without the overlap the eye could only respond to one characteristic at a time.

This information provides the instructor with a basis of empirical physiological evidence that the eye does indeed function to perceive both color and spatial characteristics. It may be assumed that the physiology of the eye may contain neural channels that differentiate and/or inte-

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[53]V. Virsu and S. Haapasalo, "Relationships Between Channels for Colour and Spatial Frequency in Human Vision," Perception, II (1973), 31-40.

[54]Ibid., p. 39.

grate other color-space characteristics such as perceived temperature, area, or size.

In an article regarding the physical characteristic of advancing and receding colors, R. M. Hanes reports on an experiment using a movable wall in a room-sized setting to establish hue distance judgments.[55] Hanes' report raises questions about the validity of relationships between color and apparent distance, based on the hypothetical maximum that warm colors "advance" and cool colors "recede". The problem here is that, unless taken in the context of color contrast, the hypothesis can only be false, for color distance or placement can only be determined relative to at least one other color.

Hanes cites several related studies whose findings suggest that brightness is more important than hue in distance judgments, that dark colors tend to recede more than light value colors. In an attempt to obtain more data regarding these related questions, Hanes performed two experiments. The first, utilizing a special depth perception apparatus and painted test materials, resulted in an indication that "lightness alone could cause differences in apparent distance of as much as five to seventeen percent, depending upon the hue. Hue effects varied between nine and nineteen percent for saturated (strong) colors, and between two and three percent for relatively unsaturated colors, with red and yellow appearing to 'advance' relative to green and blue. The results for saturation were not as clear-cut."[56]

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[55] R. M. Hanes, "The Long and Short of Color Distance," Architectural Engineering (April, 1960), 254-256, 348.

[56] Ibid., p. 255.

The second experiment utilized a room-size setting, constructed with movable end walls and a luminous ceiling given uniform illumination throughout the room. The sides and one end wall were painted a medium gray, the color serving as a standard for all comparisons. Seven other colors were used on a series of movable wall panels, the colors acting as the variables and each relating to an approximate Munsell color notation.

Hanes published his results thus:

> So far as hue effects are concerned, the colors fall in spectral order from most to least advancing, if we allow for effects due to lightness differences. While yellow appeared to advance most, it had a much higher reflectance than the other hues. According to theory, red might have been expected to appear closer than green, but since these hues were highly saturated, it seems likely that the obtained result is due partly, at least, to the strong contrast.
>
> When the lightness dimension alone is considered, it is apparent that the greater the lightness the more a color advances in this situation. The order from most to least "advancing" is white, light gray, and black. Note that this result for lightness is exactly opposite to what has customarily been said on the basis of practical observation about the distance effects of black and white.
>
> So far as saturation is concerned, all the highly saturated colors appeared closer than the medium gray standard, as indicated earlier.[57]

The characteristic of transparency. Some of the more comprehensible scientific research articles, particularly for the artist-humanist, are those published in Scientific American. One such article, by Fabio Metelli, discusses the theory that certain mosaics of opaque

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[56] Ibid., p. 255.

[57] Ibid., p. 256.

colors and shapes give rise to the impression of transparency.[58] This article should be of particular interest to the color instructor, and should be considered as a required reading for the novice color student.

Metelli begins his article by presenting two meanings to the concept of transparency:

> If we are referring to the fact that light can pass through a thing or a medium, then the meaning of "transparent" we intend to convey is physical; if, on the other hand, we mean to say that we can see through something, then the meaning we intend to convey is perceptual (. . .) a more precise definition of the perception of transparency: One perceives transparency when one sees not only surfaces behind a transparent medium but also the transparent medium or object itself.[59]

In particular, Metelli discusses instances where physical transparency is absent and perceptual transparency is present, and he demonstrates this by using illustrations of mosaics of opaque cardboard which create the perception of transparency even though there is nothing about the mosaic that is physically transparent. To explain the phenomenon of perceptual transparency, Metelli explains the pattern of stimulation of the retina. Most importantly, Metelli outlines in detail, and with a multitude of illustrations, three main figural conditions for perceiving transparency in overlapping figures. They are figural unity of the transparent layer, continuity of the boundary line, and adequate stratification.

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[58]Fabio Metelli, "The Perception of Transparency," Scientific American (April, 1974), 90-98.

[59]Ibid., p. 91.

In conclusion, while current publications discuss strategies of the development of art curriculums in higher education, defining global considerations necessary in establishing programs in aesthetic education, none gives evidence of curriculum development in color learning.

Only a small number of current texts, and no studies, address themselves directly to a curricular presentation of color learning. Several texts present a variety of methodologies for the teaching and/or learning of color principles and relationships. These texts provide information regarding various aspects and degrees of the historical, societal, industrial, physical, physiological, and psychological reasons for the existence and perception of color. Cited studies provided information about specific characteristics of color, but none was presented in a curricular fashion.

Chapter 3

THE DEVELOPMENT OF THE SUBTRACTIVE COLOR CURRICULUM

A Description of the Curriculum

The color curriculum is a sequentially designed art studio experience at the post-secondary level. It includes a prescribed series of lectures, demonstrations, and practical exercises, introducing the fundamental principles of the interactions of surface colors. Pre-exercise lectures and demonstrations include a brief overview of the historical, social, and industrial influences and uses of color, fundamental aspects of the physics of light and the physiology of the eye which determine how color is perceived, and an introduction to the characteristics of color that define color principles. The sequence and content has been derived from the review of the literature as presented in Chapter 2.

The mode of instruction in the color curriculum is: lecture-demonstration-practical exercise-discussion-evaluation. The fundamental instructional mode is in the eleven practical exercises (see Figure 1, p. 73). Each practical exercise is introduced by a lecture outlining its objective and providing visual examples of a completed project. Included in the exercise lecture are appropriate demonstrations and discussions. Each of the first five practical exercises will present a single color concept: 1) the relationship of hue to value, 2) hue to intensity, 3) simultaneous contrast, 4) color subtraction, and 5) illusion of transparence. This "introductory" segment of the color curriculum provides the student with a fundamental knowledge and understanding of the elemental color characteristics of hue, value and in-

tensity, and how those characteristics interact.

Upon completion of the introductory segment of the color curriculum, a written examination is provided as the principle means of evaluating the student's cognitive comprehension. Throughout the introductory segment of the curriculum the student responds to instruction by producing physical examples of his understanding. The student is provided the opportunity to evaluate his own and peers' exercises during group critiques. The written examination fulfills two specific areas of evaluation. First, the instructor is able to identify a student who does not sufficiently comprehend the fundamental principles of color. Second, the instructor is able to assess that all of the material of the introductory segment has been clearly presented.

Exercises six through nine, the "intermediate" segment of the color curriculum, explore the more complex aspects of color space, color quantity, and color harmony. This segment of the curriculum relies on the student's comprehension of the fundamental principles presented in the introductory segment since each of the four practical exercises brings together two or more color principles in attempting to develop solutions to a given color problem.

The culmination of the color curriculum, the "advanced" segment, is accomplished through two practical exercises in which the student is given increased freedom in solving a specific color problem. While each of these exercises is noted as a "free design", the student is directed by general guidelines which primarily insure that the final solution emphasizes color relatedness as the primary design element. It is in this final segment of the color curriculum that color psychology is discussed to a limited degree.

Selection of the Curriculum Exercises

The primary bases for the development of the color curriculum are the literature reviewed in Chapter 2, and particularly the teachings of Johannes Itten and Josef Albers, especially during their respective tenures at the Bauhaus, a German art and technology school of the 1920's and 1930's. Itten organized and taught the basic course at the Bauhaus, developing a teaching method which released completely new creative potentialities in the student, i.e., awakening artistic individuality. Two of Itten's most impressive considerations were the problem of the picture as a two-dimensional construction, and the theory of color. Itten's theory of color is based on seven contrasting pairs: hue, value, temperature, complementaries, simultaneity, quality, and quantity.

Itten's instructional and aesthetic considerations are used in this color curriculum. Color is approached both as a single factor of two-dimensional design and as an attribute capable of eliciting potentially numerous responses from the artist and/or observer. Because this is a structured curriculum, the student is provided with both the latent and true capacity to become personally expressive.

Josef Albers, a student of Itten in the early years, joined the Bauhaus staff as an instructor in 1925, and taught in the basic course until 1928, when he became its director. Albers is best known not for his work with color, but rather for what has been called his puritanically rigorous constructivist style of designing and teaching. He defined his style of constructivism as incorporating everything opposed to disorder and chance, e.g., planning, classifying, comparing, and

controlling. Albers also demanded that materials be simple and adaptable, providing an economy of creative means.

As with Itten, the color curriculum will demonstrate the influence of Josef Albers, through the simplicity of materials used in the construction of, and in the arrangement of elementary forms and color contrasts of the practical exercises. The influence of Albers' constructivism may be noted in his own text, and will be discussed at length later in this chapter, in defining the selection and sequencing of specific color curriculum exercises.[60]

The search of related literature for this model indicated that there is no literature of a curricular nature in color instruction, that has been published in the last twenty years. The majority of texts treat color as an elemental factor for a specific media, such as painting, and are therefore no more than "how to" books and of little consequence in developing this presentation.

One exception to the lack of published color curriculums, is the presentation by Walter Sargent.[61] Sargent's text was arranged primarily as a textbook for art departments of secondary schools and colleges, and endeavored to present a definite and practical method of approach to the study and appreciation of color. Sargent's presentation is meant to be helpful to that large segment of people who do not expect to be artists, but who would like to know more about color and its use,

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[60]Josef Albers, Interaction of Color (Rev. ed.; New Haven, Connecticut: Yale University Press, 1976).

[61]Walter Sargent, The Enjoyment and Use of Color (Rev. ed.; New York: Dover Publication, Inc., 1964).

and to increase their enjoyment of color. While Sargent's text specifically establishes a generalist approach to color instruction, the philosophical approach of this curriculum closely corresponds to that of Sargent's.

Another function of the color curriculum is to provide completeness to the apparent omission occurring in both the Sargent and Albers texts. In Sargent's text there is a great deal of written information, but few visual examples. The basis for the learning of color principles in this curriculum relies specifically on the exploration and development of practical exercises. While the use of questions, experiments, and problems, at the end of respective chapters is one of the strongest features of Sargent's text, the color curriculum addresses itself to appropriate questions and experiments throughout all phases of each practical exercise. Questions relating to various principles of color are also dealt with in the written examination.

Albers' text, unlike that of Sargent, provides a wide variety of visual examples, but lacks a breadth and/or depth of description to sufficiently explain the color principles demonstrated visually. The color curriculum relieves the scarcity of verbal explanation for the practical exercises by including an outline for the instructor and handouts for the student. The color curriculum relies on a number of exercises in Albers' color text, some of which have been modified, and is being presented specifically to define and describe those exercises, making instruction in the principles of color easily presented and understood.

The choice of the Albers' practical color exercises has been made because they are presented from a traditional basis, which is con-

sistent with contemporary teaching methodologies and research. Itten's original use of a twelve-color scale (color wheel or circle), provides for traditional color (hue) names and allows for the easy production of two-, three-, and four-color harmonies. Under Albers' influence color instruction in the basic course at the Bauhaus was accomplished using colored papers. Following Albers, the color curriculum utilizes pre-silkscreened papers in the production of the practical exercises. The reasons for using colored paper instead of mixed pigments is explained by Albers stating in essence that the student is afforded more flexibility in when and where a color exercise may be accomplished, and fewer frustrations than when attempting to mix paint and match specific colors.[62]

Of the eleven practical exercises that make up the color curriculum, nine have been chosen from the Albers curriculum because of their simplicity and logic in approaching color principles. Of those nine exercises, all have been ammended by the addition of a lecture-demonstration-discussion to introduce the student to the color principle in question. Several of the exercises have been physically modified so that a smaller segment of a particular color principle, as presented by Albers, can be studied; or so that a particular color principle might be approached from a different perspective.

In discussing the choices of exercises for the color curriculum, it should be noted that research for this presentation has indicated that Albers and Itten, respectively, are still considered the authorities in color instruction, and the inference should be drawn that the validity of the curriculum development at the Bauhaus some sixty years ago has not

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[62]Albers, pp. 6-7.

diminished (see Appendix A).

Since Albers' text has been used as the primary resource for practical exercises in this curriculum, a discussion of the inclusion or omission of each chapter of Albers' text will be presented. The "Preface" to Albers' text has been omitted from the curriculum. The material covered in the "Introduction", Chapter I, "Color recollection -- visual memory", Chapter II, "Color reading and contexture", and Chapter III, "Why color paper -- instead of pigment and paint," are verbally paraphrased by the instructor in the introduction to the color curriculum. Chapter IV, "A color has many faces -- the relativity of color", and Chapter VI, "1 color appears as 2 -- looking like the reversed grounds," have been combined as the first of two exercises on color relativity. Repeating Chapter IV in combination with Chapter VII, "2 different colors look alike -- subtraction of color," make up the second color relativity exercise.

Chapter V is presented in three parts. The first part of Chapter V, "Lighter and/or darker -- light intensities, lightness," has been extrapolated as a separate practical exercise relating to hue-value discrimination. The second part of Chapter V, "Gradation studies -- new presentations," is covered in the pre-exercise phase of the curriculum through the construction of the Value Scale (Fig. 8). And finally, the third part of Chapter V, "Color intensity -- brightness," has been segregated as a practical exercise relating to hue-intensity discrimination. Chapter VIII of Albers' text, "Why color deception? -- after-image, simultaneous contrast", and Chapter X, "Factual mixtures -- additive and subtractive," are covered by the instructor in the pre-exercise lecture on how the eye perceives color. Chapters XIII, "The

Bezold Effect," and XVII, "Film color and volume color -- 2 natural effects," are covered by the instructor in the pre-exercise lecture on the principles of color interaction.

Chapters IX, "Color mixture in paper -- illusion of transparence," and XV, "The middle mixture again -- intersecting colors," are translated directly to the color curriculum as the first of the two exercises on transparent illusions. Chapter XI, "Transparence and space-illusion", and "Color boundaries and plastic action," has been used in this curriculum as the second exercise on the illusion of transparence. Like Chapter IX, Chapters XIV, "Color intervals and transformation," and XVI, "Color juxtaposition -- harmony -- quantity," have been directly translated to the color curriculum as practical exercises.

Chapter XVIII is presented as three separate but related areas. The color curriculum has utilized the second of the three areas of Albers' text, entitled "Stripes -- restricted juxtaposition," with some modification, the last in the series of intermediate practical exercises. The concept of "free studies," relating to personal color expression, has been the basis for the two final practical exercises of this curriculum. Each of these exercises requires the student to present a non-objective color composition of some phase of his environment, the purpose being to encourage the student to put into practice some or all of the color principles learned in the presentation of color relatedness exercises. Chapters XII, XIX through XXII, and XXIV through XXVI have been omitted from the color curriculum because the time frame does not allow for their inclusion. These chapters were also omitted because this author evaluated their content as not being appropriate for the beginning

level student. Chapter XXIII, "Equal light intensity -- vanishing boundaries," is included as part of the discussion in the construction of the Value Scale prior to the beginning of the practical exercises.

In the sequence of practical exercises of the color curriculum it should be noted that some of Albers' exercises have been distributed differently to represent what this author feels is a more logical organization of learning that the student of color should experience. All nine of the Albers exercises used have been augmented with the addition of an instructor's outline for the exercise presentation. It is at this time in the presentation of each practical exercise that the instructor emphasizes a single or multiple set of color principles and how they are to be explored by the student. Additions to the Albers presentation include: a student handout defining the objectives, a list of related readings, construction procedures for the specific exercise, and an instructor's outline to be utilized during the group critique period.

The color curriculum commences with an introduction to the course of study, utilizing information from the Interaction of Color, "Introduction" and Chapters I through III. Introduction to the curriculum includes a description of the course and its objectives, the method of instruction and evaluation, statements regarding required and supplementary readings, requirements for satisfactory completion of the curriculum, an outline of the eleven practical exercises and the mid-course written examination; statements regarding lectures, discussions and critiques, and demonstrations; and a list and explanation of necessary materials. All of the above items are presented in detail in Chapter 4 of this paper.

The second major division of the color curriculum is a series of three lectures which include a discussion of the historical, social, and commercial influences, and uses of color; a discussion of factors influencing the visual perception of color, namely the source of light and the atmosphere through which it passes, the reflective surface, and the eye-brain receptor system; and a discussion of the characteristics which define the principles of color. This series of lecture-discussions also is outlined in some detail in Chapter 4 of this paper.

Immediately following the lecture series, each student is required to complete the Color Chart (Fig. 1, p. 78), and construct the Value Scale (Fig. 8, p. 101). The Color Chart will provide the student with a visual tool for immediate reference to the array of color papers used in the completion of all practical exercises. The Value Scale will assist the student in determining the relative degree of lightness/darkness of any given hue. The Value Scale will be the primary tool used in the completion of the first practical exercise, and will be useful in all subsequent exercises.

The remaining portion of this chapter will be devoted to a brief discussion of the sequencing of each practical exercise, the third major division of the color curriculum.

Unlike Albers, who commences his text with a color relativity exercise, this author feels it necessary for the instructor to first explain and the student explore some of the characteristics of color that will assist in describing the relative effects that two or more colors have when juxtaposed.

The first exercise will provide the instructor with some clues to an individual's color deficiencies, and should be considered the

essential starting point of the model.[63] The student is asked to choose sixteen different colors, each exhibiting a relative lightness/darkness relationship (value) to one of the sixteen gray values found in the color pack.

Two important facts should be noted. The practice in finding a single color which coordinates with a single achromatic gray will reinforce the fact that each color, regardless of its other characteristics, exhibits some degree of value. In particular, this exercise requires that the student learns to use properly the Value Scale, constructed prior to this exercise, to assist in determining the value characteristic of a single color.

The second color exercise requires the student to study the relationship of the characteristic called hue to that called intensity.[64] The student is asked to choose one "color family" from the twenty-four families available in the color pack. In structuring the physical portion of the exercise, the student will demonstrate the changes that occur in one hue's intensity as that hue is moved from its most intense state through four successively lighter tones, and then from full intensity through three successive shades to gray.

It is important to note that this exercise requires a different kind of visual and cognitive knowledge and understanding than the first exercise. The student must be made aware of visual transformations that take place when opposing portions of the exercises are compared.

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[63] Op. cit., pp. 12-15.

[64] Ibid., p. 17.

Depending on the choice of color family, transformation may include apparent changes in hue, value, intensity, and size, specifically preparing and leading the student into subsequent exercises in color relativity.

Now that the student has gained some comprehension of the basic relationships of the three elemental color characteristics (hue, value and intensity), the curriculum returns to Albers' Chapters IV, VI, and VII, and takes up the discussion of color relativity. In the following two practical exercises, the student will be asked to explore how colors relate to one another by first making one color look like two, and then by making two different colors appear to be one.

The third exercise requires the student to select a segment of the color circle which will allow for the establishment of a single "figure" color and two "ground" colors.[65] In the figure-ground concept a small color chip is designated as the figure color and is placed on top of a large color chip which is designated as the ground color. In determining the proper figure color for exercise three, the student must select a single color with characteristics relating to each ground color. By placing a sample of the figure color on each of the two ground colors, each figure color interacts with the characteristics of its respective ground color. This interaction causes the figure color to be moved visually toward the ground color opposite that on which it is placed, causing the single figure color to appear as two different colors. The action of one (ground) color on another (figure) color is

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[65] Op. cit., pp. 8-11, 18-19.

known as simultaneous contrast. In this exercise the characteristics of the ground color affect the visual system and change the figure color.

The fourth exercise requires fundamentally the same considerations from the student as practical exercise three, except that two different figure colors are chosen and placed on two different ground colors.[66] The major difference between exercises three and four is that in exercise four a smaller segment of the color circle is used since it is necessary for each ground color to have the hue characteristic in common with its respective figure color. When juxtaposed, a visual subtraction of the common characteristic(s) between figure and ground occurs. This is considered a special case of simultaneous contrast. The objective of this exercise is to cause the figure colors of both figure-ground combinations to appear the same. This exercise requires a clear understanding of the effects of simultaneous contrast gained in exercise three, because as two colors are pulled together to look like one, the student must deal with more difficult problems than making one color appear to be two different colors.

Having used the three elemental characteristics of color to learn about color relativity, the student is now ready to use his color comprehension to construct a variety of examples of color illusions, specifically the illusion of transparence. In the following two exercises the student is asked to explore simple two-color transparent illusions, and more complex illusions where the use of three colors and

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[66] Ibid., pp. 20-21.

the illusion of space will be the objectives.

The fifth exercise has been taken from Albers' Chapter IX with basically no modification, save a more detailed explanation of the objectives and project construction.[67] In this exercise the student is asked to juxtapose three different pieces of opaque paper so that they appear to overlap, producing the appearance of two pieces of transparent paper showing, as their product or descendent, a third color. The student is asked not to be concerned with the specific spatial placement of the descendant color in relation to the two parent colors, only that the characteristics of the descendant color fall somewhere between the two parent colors.

This exercise requires that the student consider not only the characteristics of each parent color, but how the characteristic of one parent affects the other. It should be noted that the student is no longer asked to explore the relationships of adjacent hue influence using opaque color papers and making those papers appear transparent.

Completion of practical exercise five constitutes the end of the introductory segment of the color curriculum and the point at which the written examination is sequenced. It is here that the instructor should evaluate the level of comprehension of both the affective and cognitive elements of the student. The affective factors can be judged via a group critique of the practical exercises, while evaluation of the cognitive factors can be made using the written examination.

The intermediate segment of the color curriculum begins with a continuation of the transparence exercises. Exercise six expands the

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[67] Ibid., pp. 24-26, 37-38.

exploration of transparence by adding a third "parent" color.[68] The addition of this third color will require the student to consider two more complex factors than dealt with in exercise five. First, the student must consider color characteristic influences through one or two layers of transparent illusion, and second, the student is asked to specify the relative location of each parent color.

The illusion of spatial location is the focus for this exercise because it requires an expansion of the understanding of the characteristics which must be considered when dealing with the specific placement of colors creating a transparent illusion. The student must become aware of the amount of a color characteristic relative to its placement in space.

Before expanding the discussion of the quantity of space a color appears to occupy, (a topic discussed in exercise six and to be dealt with in detail in exercise eight) it is necessary to reinforce the relationships between the elemental characteristics of color through an exercise that Albers has called "Color Intervals and Transformation." Exercise seven asks the student to explore the changes in two color characteristics when the third characteristic is held constant.[69] This author has modified the Albers presentation so that a variety of hues, instead of one, is used to explore how a color's hue and intensity are change (the transformation) as they move from one value level to another (the interval).

The importance of this exercise is not only to recall all factors

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[68] Ibid., pp. 29-32.

[69] Ibid., pp. 34-36.

learned about color characteristics, but to make the student aware that when pushed to certain limits, the characteristics of given colors begin to change the visual appearance of those colors. This factor will be of particular importance when the student begins the physical adjustment of color in an activity such as mixing pigments.

Exercise seven also provides the student with the opportunity to explore and discuss the phenomena known as the von Bezold Effect or the "spreading effect." This effect demonstrates that when a light value is framed by a dark value, the light value will appear physically larger. The reverse occurs when a dark value is framed by a light value. A comparison of the spreading effect is established in exercise seven, and it is appropriate to discuss the von Bezold Effect. Discussion of this effect is also warranted because exercise eight deals with the effects of color quantity, demonstrating that the amount of a single color needed to create aesthetic balance with its complement and relies in great measure on the von Bezold Effect.

Exercise eight is a practical exercise which has been expanded from Albers' original presentation, and which will begin a phase of instruction in which the student will be given more independence in reading a solution than in previous exercises.[70] The student is asked to create two different non-objective compositions using only full intensity primary and secondary colors. In one composition the amount of each color will be related mathematically to its complement. All three complementary pairings will be used in random placement. The other composition will be of identical size and color, but the amount of color

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[70]Ibid., pp. 39-44.

will not be constrained mathematically and may exhibit any non-objective arrangement.

Upon completion of the practical exercise the student is asked to use his intuition to compare and contrast, in written form, the two halves of the exercise. In particular, the student is asked to discuss how he "feels" about the color composition and/or what "mood" the composition expresses. This written statement is not meant as a psychological profile of or for the student, but rather to make him aware that he may perceive a composition for reasons other than color, that specific colors may cause him to react in a particular fashion, and that his peers may have different perceptions than his own. With this rudimentary insight the student may begin to understand that he is able to control the expression of his creativity.

In exercise nine, the last project in the intermediate segment, the student is asked to create a composition of vertical color bands or "strips", using at least four different colors and any variation of strip width and/or placement, so that no one color is dominant.[71] This exercise requires the student to utilize all of the understanding of color principles and concepts previously explored. Additionally, the student is asked to analyze his composition so that it creates a pleasing movement within physical limits, but also permits no segment to become dominant or monotonous.

As in the previous exercise, the student is asked to give a written explanation stating considerations made in color choice, and size and placement of the color strip. This written explanation requires

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[71]Op. cit., 48-50.

the student to demonstrate a verbal command of color terms and concepts, and provides the instructor with an additional chance to evaluate the student's cognitive development.

The final or "advanced" segment in the sequence of eleven exercises is comprised of two practical exercises entitled "free studies," and is intended to challenge the imagination and elicit a psychological response from the student. The concept is derived from Albers' own free studies, but the content is unique to the color curriculum and will be discussed in greater length in Chapter 4 of this paper.

In exercise ten the student is asked to create a non-objective color composition, using any number of colors he feels necessary to describe a given segment of his environment.[72] The subject of this exercise may be purposefully left unstated so the instructor alone, and/or the students might make personal choices. In the color curriculum the student is asked to define in a non-objective color composition some facet of his favorite music. The composition may be derived from a single song, piece of music, or musical score; an artist or group; or a particular school or genre of music. The focus of this exercise is to provide the student with a vehicle for demonstrating his awareness and ability to show color relatedness. The use of a non-objective composition is to make the student use color as an autonomous element; to make the color descriptive, not just cosmetic. As in the two previous exercises, the student is asked to present a written explanation of his use of color.

Exercise eleven is similar to exercise ten with regard to its

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[72]Ibid., pp. 47-48.

physical constraints; the difference is in its content.[73] In this exercise the student is asked to create a non-objective color self-portrait. The self-portrait as a subject is seen as the culminating factor in this basic study of color principles. It asks the student to make some psychological statement not only about how he uses color, but more pointedly how he uses color to describe his perception of himself. As before, the non-objective composition is required so that color choice, placement, and amount (color design) are the fundamental design considerations, and the linear design is secondary.

In this final exercise, more than in the one immediately preceding it, color relatedness is of utmost importance. The student should be capable at this stage of making personal statements about color use and feel that he is able to create a color design that expresses descriptive factors beyond those that are immediately recognizable, as with an objective design.

The sequencing of the color curriculum presented should not only give the reader a clear understanding of the physical ordering of the practical exercises, but also provide a logic for the presentation of those exercises. It should be understood that while this may be only one of a variety of possible sequences, it is one that has been developed, revised, modified, and presented successfully in real classes that have been taught over the last six years.

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[73] Ibid.

Chapter 4

THE CURRICULUM UNIT

Chapter four will present the color curriculum in a detailed explanation of the integral parts of the curriculum. It will include information so that the instructor can provide a coherent verbal and/or written presentation to the student. Used as "handouts" by the instructor, the various parts of the curriculum unit will assist the student in better understanding the overall concept of the instruction, as well as the integral elements of the curriculum.

The Introduction to the Color Curriculum

The introduction to the color curriculum is presented to establish an overall framework of the curriculum for both the instructor and the student. The introduction affords the instructor the opportunity to present a detailed description of the course and its objectives; to describe how the course will be instructed and evaluated; to present the assignment of related readings; to define the course requirements and outline of the practical exercises; to describe how lectures, discussions and criticisms, and demonstrations will be presented; and finally, to describe and list the materials used in the production of the practical exercises.

The introduction, which the instructor can give to the student as a handout, provides a written explanation of the general construction of the course. The handout gives the student a clear explanation of the course that can be referred to outside the class and/or at anytime during instruction so that a proper interpretation of the course can be

made.

A Description of the Curriculum. The color curriculum is an exploration of basic color principles utilizing as bases an historical, a physiological, a physical, and, albeit superficial, a psychological approach in the completion of a series of eleven practical color exercises.

Curriculum Objectives. The objectives of the color curriculum seek to provide the learner with those competencies necessary to effectively work with color in the visual arts as well as in a variety of areas utilizing subtractive color theories and interactions. Upon completion of the course the student will be able to demonstrate both a cognitive and a practical understanding of the basic principles of subtractive color by successfully completing a series of practical exercises, based on subtractive color theories, and a mid-course written examination.

Method of Instruction. The color curriculum is designed to utilize a multitude of instructional methodologies, both individualistic and collective, such as lecture, discussions, related readings, photographic slides of historical works and exercise solutions, commercial filmstrips, demonstrations, practical exercises, individual and group criticisms, and visits to fine art and commercial exhibitions when available and appropriate.

Method of Evaluation. The color curriculum consists of eleven practical exercises and a mid-course written examination, each of which will carry equal weight in the final evaluation of the student's performance. General evaluation will be based on the students' ability to demonstrate a development of the objectives of the cognitive aspects

of color through critical analysis, and the development of the objectives of the practical aspects of color through the physical construction of color exercises based on general color theories. The student will be evaluated on his competent use of materials and equipment, and on his attitude toward craftsmanship and studio maintenance. A mid-course written comprehensive examination will be utilized to assist in the evaluation of cognitive aspects of the course. Specific evaluation of performance will be based, as much as possible, on the instructor's evaluation of the student's approach to and criticism of individual color exercises. A notation on each student handout of the practical exercise will indicate the percentage of the exercise grade given for understanding and application of the "assignment," and the percentage given for the quality of "craftsmanship" demonstrated in the completion of the exercise.

Related Readings. The majority of technical and aesthetic information preceding and supporting each color exercise will be found in the specific reading assignments noted on the student handout. Reading assignments related to specific color theories and/or problems will be provided as each practical exercise is introduced. Supplementary readings will be given to the individual student as deemed necessary or appropriate.

Curriculum Requirements. Satisfactory completion of the color curriculum will be based on the instructor's evaluation of the student's cognitive and practical performance in the completion of eleven practical exercises and the mid-course written examination. Specific elements of satisfactory completion will include the evaluation of a student's ability to: 1) understand a specific color problem or theory used in the

exercise, 2) use the supplies and equipment in the construction of the problem solution, and to approach and complete the problem with a professional attitude toward craftsmanship and maintenance of supplies and equipment, and 3) verbally evaluate his own and his peers' solution to individual problems through individual and group critiques.

The Practical Exercises. Within the color curriculum eleven practical exercises are developed. The practical exercises, amplifying various segments of a specific color theory or theories, will commence upon completion of an overview of the historical, physical, and physiological aspects of that theoretical element. This overview includes a discussion of how the color theory in question relates to the uses of color historically, the conditions of additive and subtractive color relative to the class of color being discussed, and the relationship of the functions of the human visual receptor system to the specific theory of color.

The practical exercises, indicated in the following list, have been developed from the Bauhaus color problems of Josef Albers, with additional exercises to make use of the student's total experience and comprehension of color relatedness gained through the course. Included in the practical exercise listing is a mid-course written examination which is to be used to judge the student's cognitive development upon completion of the basic portion of the course.

INTRODUCTORY SEGMENT

EXERCISE #1: "The Value of a Hue". A comparison of an achromatic scale of sixteen values to a scale of sixteen different hues.

EXERCISE #2: "The Intensity of a Hue". A comparison of the changes of intensity across high and low values within a single hue family.

EXERCISE #3: "The Relativity of Color: Part I". An exploration of how a single figure color is independently affected by at least two ground colors.

EXERCISE #4: "The Relativity of Color: Part II". An exploration of how two figure colors are independently affected by at least two ground colors.

EXERCISE #5: "The Illusion of Transparence". The creation of the illusion of transparency by utilizing the concepts of color interaction and overlapping planes.

Mid-instruction Written Examination: A presentation of a written objective evaluation instrument to judge cognitive development of basic color terms and concepts.

INTERMEDIATE SEGMENT

EXERCISE #6: "Transparence and Space Illusion". A continued exploration of the illusion of transparency by utilizing the concepts of color interaction and overlapping planes to create the additional illusion of spatial placement.

EXERCISE #7: "Color Interval and Transformation". An exploration of the relationship between a constant color dimension and two variable color dimensions.

EXERCISE #8: "Color Quantity and Harmony: The Contrast of Extension". An exploration of the relationship between psychological color balance and color quantity.

EXERCISE #9: "Color Relativity: Spatial Balance". An exploration of the concepts of color relatedness and/or interaction to create spatial balance.

ADVANCED SEGMENT

EXERCISE #10: "Personal Color Expression: Free Study #1". An exploration of personal color expression exemplified via a non-objective color theme.

EXERCISE #11: "Personal Color Expression: Free Study #2". An exploration of personal color expression exemplified via a non-objective color self-portrait.

Figure 1. The Practical Exercises

Lectures. The color curriculum includes a series of lectures, the first of which introduces the overall concept of the curriculum unit. A film strip-cassette presentation of the uses of color by various cultures and industries is presented as the first lecture after the introduction. The second lecture includes explanations of various light sources and atmospheres which cause color to be perceived differently, of how various surface qualities reflect light, and of how the human visual system receives and interprets light and color. Lecture number three includes a discussion of the dimensions, characteristics, and harmonies of color. All three lectures are planned to be presented prior to the beginning of the practical exercise phase of the color curriculum. In addition to the pre-exercise lectures, a discussion of each color theory is presented at the beginning of each practical exercise.

Discussions and Criticisms. Discussion within the color curriculum allows for a question-and-answer-type period to cover appropriate theoretical and technical considerations for each exercise. Criticism, on a one-to-one basis, is provided for the student both during the experimentation with and construction of the practical exercise, and as a group critique session upon completion of each exercise.

Demonstrations. Demonstrations are provided throughout the color curriculum which include examples of various light source effects on surface color and indications of practical solutions and technical considerations preceding each exercise. Because the discipline area of color is extremely visual, the student must be provided with as many visual cues as possible. Especially important is the use of either actual exercise examples or color photographic slide examples of specific

theoretical solutions of the practical exercises providing the student with a variety of possible practical solutions.

Practical Exercise Materials. A materials list will be provided for the student. Accompanying the list will be a verbal explanation describing the reasons for and uses of the materials within the color curriculum. While this particular area may vary in its content among instructors, it must be one of the most closely scrutinized areas of color instruction, as it is through these materials that the student will be capable of manifesting the cognitive portion of the curriculum by way of the practical exercises.

By basing the instruction of color on a specific series of commercially produced silkscreened papers, the student will be more capable of dealing with the manifestation of color theories than when hampered by the physical mixing of pigments, which may precipitate frustration due to the inconsistency of color quality. It will be noted that the color curriculum has been developed as a presentation in the basic principles of color, not as a course in pigment mixing. The following, paraphrased from Albers' text, notes the reasons for the use of commercially silkscreened papers: 1) avoids unnecessary mixing of paints; often difficult, time-consuming, and tiring; 2) maintains interest by discouraging failures of mixing and imperfect matching; 3) permits precision in repeated use of surface quality; 4) rarely demands the necessity of extensive and expensive materials; 5) protects from undesired and unnecessary textures; and 6) provides the consistency of comparison of a large color palette.[74]

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[74]Josef Albers, Interaction of Color (rev. ed.: New Haven, Connecticut: Yale University Press, 1976), pp. 6-7.

Gray illustration board will be used as the mounting surface for all color exercises because it lessens the chromatic changes between the inherently neutral value of the background and the exercise colors, and because it provides a smooth texture. Rubber cement will be used for adhering all color papers to the illustration board as it provides a tight bond but also provides easy removal for corrections. A No. 2 X-acto-type knife is specifically recommended because its size allows for easy manipulation. Likewise, the No. 24 X-acto-type knife blade is especially recommended because its chisel shape allows for clean and straight cutting. A twelve-inch metal straight edge will be used for both measuring and cutting. A piece of regular window glass, purchased from a local hardware store and taped along the edges, will be used as the cutting surface for all color papers. The hardness of the glass will allow the color paper to be cut accurately while preventing the knife blade from becoming dull too quickly.

(1 pkg.) PRE-SCREENED COORDINATED COLORS

(1 each) GRAY ILLUSTRATION BOARD (32" x 40")

(1 each) RUBBER CEMENT (4 oz. bottle with brush)

(1 each) NO. 2 X-ACTO KNIFE

(1 pkg.) NO. 24 X-ACTO KNIFE REPLACEMENT BLADES

(1 each) 12" METAL RULER-STRAIGHT EDGE

(1 each) 12" x 12" GLASS CUTTING SURFACE

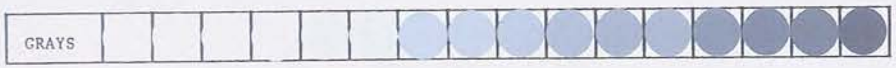
As a supplement to the package of pre-screened color papers, one hue-value chart (Fig. 2) will be included to assist the student in establishing and maintaining an orderly arrangement of color families and their respective value order. The "number chart" will be used to correctly number each color sheet, maintaining order and an easy identi-

fication of individual colors. The "color chart" will be best utilized by having the student place a sample of each color in its corresponding number location, providing the student with a visual array of color included in the entire color package.

Number Index

	Y	YOY	YO	OYO	O	ORO	RO	ROR	R	RVR	RV	VRV	V	VBV	BV	BVB	B	BGB	BG	GBG	G	GYG	YG	YGY
HUE	1	9	17	25	33	41	49	57	65	73	81	89	97	105	113	121	129	137	145	153	161	169	177	185
TINT-1	2	10	18	26	34	42	50	58	66	74	82	90	98	106	114	122	130	138	146	154	162	170	178	186
TINT-2	3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163	171	179	187
TINT-3	4	12	20	28	36	44	52	60	68	76	84	92	100	108	116	124	132	140	148	156	164	172	180	188
TINT-4	5	13	21	29	37	45	53	61	69	77	85	93	101	109	117	125	133	141	149	157	165	173	181	189
SHADE-1	6	14	22	30	38	46	54	62	70	78	86	94	102	110	118	126	134	142	150	158	166	174	182	190
SHADE-2	7	15	23	31	39	47	55	63	71	79	87	95	103	111	119	127	135	143	151	159	167	175	183	191
SHADE-3	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192

GRAYS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16



Color Index

Figure 2. The Color Pack Number - Color Indexes

The Background Lecture Series

Color History. During the second class period the student will be provided with an historical overview of color as an element in the development of religion, commerce, and art.

Because the available historical references to color are broad and varied, and instructional methodologies are equally as diversified, a selection of annotated bibliographies is presented in Appendix B as a guide to the color instruction curriculum. The appendix will provide the instructor with a variety of text citations which present discussions of the earliest uses of color, man's symbolic relationships to religious beliefs, ancient philosophic and alchemic relationships to knowledge and remedies, theories of a variety of colorists, and a review of major color schools and movements. Citations of various color photographic slide presentations provide the instructor with visual representations of color history and physics. Color history is best described by illustrations of various color circles, systems, and harmonies; color physics and physiology are represented by demonstrating various visual illusions.

Each item listed should be utilized by the instructor as an historical reference, early in the curriculum, in order to provide the student with a frame of reference for the sociocultural development of color. Since text references provide few pictorial examples, the instructor should consider emphasizing color history by way of the slide-lecture presentation. Art history slides can be purchased or produced from pictures in art history texts, or an audio-visual aid such as one of the film-strip/audio-cassette series, noted in Appendix B, should be utilized.

Color Perception. In order to properly prepare the student for the production of practical color exercises, two separate lectures regarding color perception and the principles of color, respectively, have been included in the color curriculum. The first lecture, scheduled for the third period of the curriculum, is entitled "How the Eye Perceives Color: Those Elements Involved in Visual Color Perception," and along with a list of color word definitions, is provided to assist the student in understanding the physical and physiological elements necessary to cause and allow visual color perception. This lecture allows for the introduction and discussion of such complex factors as the electromagnetic spectrum, the physics of light refraction and reflection, and the physiological functioning of the eye, without becoming so scientific as to cause the student to lose interest in learning about color.

The outline presented below is meant to be used by both the instructor and the student. Use of the outline by the instructor as a class handout, as well as a basis from which to lecture, will insure that the student has the necessary notes for the lecture. From this handout the student may add personal notations and may use it outside of class for review of the lecture presentation.

"How the Eye Perceives Color: Those Elements Involved in Visual Color Perception"

A. The SOURCE of light.

1. Visible spectrum: the visible band of electromagnetic waves.[75]

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[75]NASA Facts, The Spectrum: There's More Than Meets the Eye, NF-54/1-75 (Washington, D.C.: Superintendent of Documents, U. S. Government Printing Office, 1975).

a. The visible spectrum is that small portion of the electromagnetic spectrum between 400-700 angstrom units.

b. Different parts of visible light travel at different speeds or frequencies.

1) This can be demonstrated by passing white light through a glass prism, bending (refracting) the white light into its various component parts or color bands.

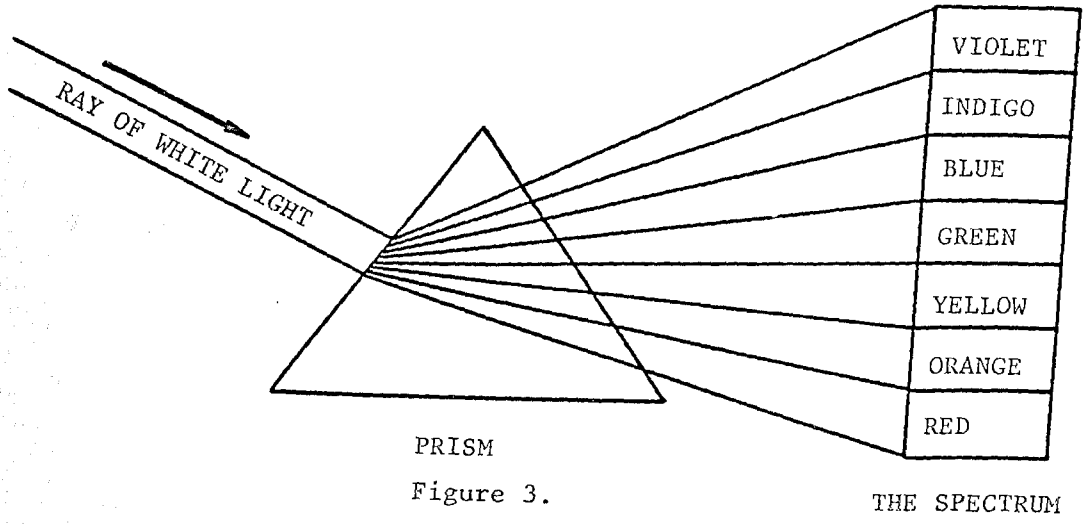

Figure 3.

Light Refraction

2) A continuous spectrum demonstrates no division between colors vs a discrete spectrum in which each color is distinct from its neighbors.

c. A reconstructed continuous spectrum = white light.

1) Colors of the light spectrum (light colors) added together are called ADDITIVE colors.

d. When white light (sunlight) is not available:

1) One must determine the type of light in the environment, e.g., fluorescent, incandescent; flame, e.g., coal oil, wood fire, alcohol, etc.

2) Light has its own color.

a) This is demonstrated by non-human responses to various colors, e.g., attraction or repulsion of insects to blue or yellow light;

bees to specific flower patterns seen under ultraviolet light.[76]

e. Light is made up of all of the colors of the visible spectrum.

1) In order for color to be seen in its purest form, white light must be available i.e., a combination of all colors of the visible portion of the electromagnetic spectrum present.

2) The type of light source, the color of light, will drastically affect the way the color of an object or surface is perceived.

3) This can be demonstrated by the effects of incandescent and fluorescent light on primary and secondary color reflective surfaces.[77]

2. The direction of the light source.

a. Light radiates from its source at a specified angle to the surface and is reflected from the surface at the same angle to the receptor.

1) The angle or incident of light is important when considering the amount of light reflected to the receptor, or the texture of the surface, e.g., shiny vs dull surfaces.

2) One can discuss visual or analytical "seeing" as a right hemisphere brain activity vs a mental perception of color which is left hemisphere "seeing."

b. Color gradation is dependent on the angle of light.

c. Color gradation may be discussed by diagramming the sun moving across the sky showing the change of color of visible light in the atmosphere.

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[76]Rick Gore, "Eyes of Science," National Geographic, March 1978, (photograph) p. 380.

[77]Using a dual element lamp, the instructor can demonstrate the effects of light from a warm or incandescent source and from a cool or fluorescent source, by comparing the visual (reflectance) quality of primary and secondary pre-screened color papers. If two lamps are available, the comparison can be made easier and more meaningful by allowing each lamp to exhibit a different light type.

3. The intensity (strength) of the light source.

    a. One can discuss the effects of light intensity on the way in which color is seen.

        1) The intensity or light energy will effect color perception.

        2) Affects of the sun's intensity is changed due to atmosphere.

            a) Atmospheric density (purity of the air) may change direction or wave length of light.

            b) Ambiance (the character or mood of setting); the light reflected from surfaces of objects may change the intensity of color.

    b. As light intensity changes, colors change.

        1) Atmospheric changes, e.g., various stages of daylight, various conditions of the purity of the atmosphere, various levels of room light affect color perception.

B. The ATMOSPHERE through which light passes.

    1. What happens to light, and hence the color of light, when projected through a specified atmosphere.

        a. Various atmospheres would include water, glass, and air (pollution).

        b. A variety of atmospheric densities cause:

            1) Changes in the amount of light refracted.

            2) Light waves to bend and disperse differently in different mediums and in different directions.

C. The SURFACE from which light is reflected.

    1. Pigmentation of the surface.

        a. A surface may be artificially and/or naturally colored.

        b. Considerations by which different pigmented surfaces are perceived are:

            1) The type and direction of the light source, and the type and purity of the atmosphere.

2) That the color of the surface is directly related to the color of the light being reflected; all other light colors are absorbed.

c. To change the color of the surface one must:

1) Change the chemical make-up of the surface so as to reflect and absorb different parts of the visible spectrum.

2) Change the type (color) of the light source and/or the purity of the atmosphere.

d. The relationship of a single colored light source to a single colored surface may be viewed in three basic ways.[78]

1) When the color of the light source and the reflective surface are the same, the maximum reflection of that portion of the electromagnetic spectrum (the light source) will be perceived.

2) When the color of the light source and the reflective surface are opposite (complementary), the maximum absorption of light occurs and no color will be reflected or perceived.

3) When the color of the light source and the reflective surface are different, but not the same or opposite, the surface will reflect that portion of the electromagnetic surface (the light source) that is most closely related to the surface, thus the surface will tend to exhibit characteristics of the light source.

2. The texture of the surface.

a. Texture causes light to be reflected in all directions.

1) Rough surfaces will create shadows and highlights; smooth surfaces will reflect more light, hence more true color.[79]

2) Color is dependent on the amount of light reflected and the direction of the reflection.

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[78]In a demonstration similar to that in footnote 4, the use of a red, a green, and/or a blue incandescent light bulb can demonstrate the effect of a single colored light source on a single (subtractive) reflective colored surface.

[79]Kenneth F. Weaver, "Electronic Voyage Through an Invisible World," National Geographic, February 1977, (SEM photograph) p. 281.

3) Pigmentation noted as a special case of texture may be discussed as opaque vs transparent.[80]

4) Specular reflection is the ratio of the amount of electromagnetic radiation, usually light, reflected from a surface to the amount originally striking the surface.

b. Characteristics of surface textures that reflect color and/or image are:

1) Surface color: Opaque pigmentation = light reflected directly from the pigmented surface.

2) Volume color: Transparent pigmentation = light reflected is dependent on density of pigmentation.[81]

3) Film color: Opaque and transparent pigmentation perceived at the same time; light reflected is dependent on opaque pigmentation and transparent pigmentation and density.

D. The RECEPTOR (eye-brain) by which light is perceived.

1. The structure of the eye is spherical form, suspended in a socket and controlled by muscles.[82]

a. Cornea: The transparent tissue forming the outer coat of the eyeball and covering the iris and pupil.

b. Iris: The round, pigmented membrane surrounding the pupil, having muscles that adjust the size of the pupil to regulate the amount of light entering the eye.

c. Pupil: The contractile circular opening, apparently black, in the center of the iris.

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[80]Using a mirror and any sheet of pre-screened color paper, the instructor can demonstrate the difference between the total reflection of light (and image) exhibited by the mirror, and that of selective reflectance of the pigmented surface.

[81]James Cerruti, "Belgium: One Nation Divisible," National Geographic, March 1979, pp. 338-339.

[82]Frans Gerritsen, Theory and Practice of Color (New York: Van Nostrand Reinhold, 1975), pp. 46-47.

d. Lens: The transparent, biconvex body situated between the iris and the vitreous humor of the eye; it focuses upon the retina the light rays entering the pupil.

1) Aqueous humor: The watery fluid in the space between the cornea and the lens.

2) Vitreous humor: The transparent, colorless, jellylike substance that fills the eyeball between the retina and the lens.

e. Retina: The innermost coat of the back part of the eyeball, a layer of cells sensitive to light, in part an expansion of the optic nerve fibers; the image formed by the lens on the retina is carried to the brain by the optic nerve.

1) Fovea: The small area, insensitive to light (the blind spot), in the retina where the optic nerve enters; an area where vision is hindered or obscured.

2) Rods: Any of the rod-shaped cells in the retina that are sensitive to dim (light-dark) light; receive and change electromagnetic waves into electroneural impulses.

3) Cones: Any of the flask-shaped cells in the retina that are sensitive to bright light and color; receive and change electromagnetic waves into electroneural impulses.

f. Optic nerve: The cranial nerve which connects the retina with the brain.

2. The method of sensing color in the brain.

a. The eye transforms electromagnetic waves into electroneural impulses and the brain interprets those nerve impulses as color.

b. The brain will produce its own color without light via eye fatigue, a blow to the head, dreams, etc.

3. Areas of vision within the eye.

a. Peripheral vision: The area of vision lying outside the line of direct sight; distinguishing movement, but no image.

b. Rod vision: The area of vision nearer the line of direct sight; distinguishing movement and light-dark image, no color.

c. Cone vision: The area of direct sight; distinguishing movement, light-dark image, and particularly color.

E. Physiological and Sociological Cycles.

1. Cycles of our daily lives are similar to that of the response-rest cycle of the nerves of the retina.

a. Retinal nerves do not respond directly to changes brought about by the action of electromagnetic waves.

b. The chemical make-up of retinal nerves responds to electromagnetic wave action.

1) Specific light wave (red) causes the retina to respond to that frequency only for the time it takes until the chemical action of the retina is depleted.

2) Movement of the eye is such that any specific light wave (red) no longer falling on one point of the retina, allows the retinal chemical to begin regeneration, causing the cones to exhibit the complementary color (green) within the eye-brain system.

3) The significance of the retinal chemical change is that the eye-brain is forced to "see" one color influenced by any or all other colors in the environment.

a) This phenomena is known as SIMULTANEOUS CONTRAST.

b) Eye fatigue develops because of working closely with colors requiring 5 minutes of rest for every 30 minutes of close work to relax the exterior and interior muscles and the retina.

F. Psychological Color Sense.

1. Historical relationships between color and particular events.

a. Relationships can be noted between events such as combat during man's early existence, Medieval times, and contemporary warfare; and how color was or is used to identify, conceal, etc.:

1) Body painting by the early Britons.

2) Heraldic colors of knights and armor.

3) Use of camouflage by contemporary military forces.

b. Relationships can be noted between religious periods and/or

events, and color:

1) White: weddings and funerals of children.

2) Black: Good Friday and funerals of adults.

2. The contemporary marketing use of color.

   a. One can discuss the use of the color red in packaging, because of its visual and psychological impact on the viewer.

   b. One can discuss population studies by manufacturers to determine color preference of potential consumers.

3. Physical vs Mental "seeing".

   a. What is seen physically may be considered different than what is seen mentally.

   b. Because of environmental and/or sociological expectations, the eye tends to "see" colors in the environment that are not physically or mentally the same.

4. The Psychological vs the Traditional Color Circle.

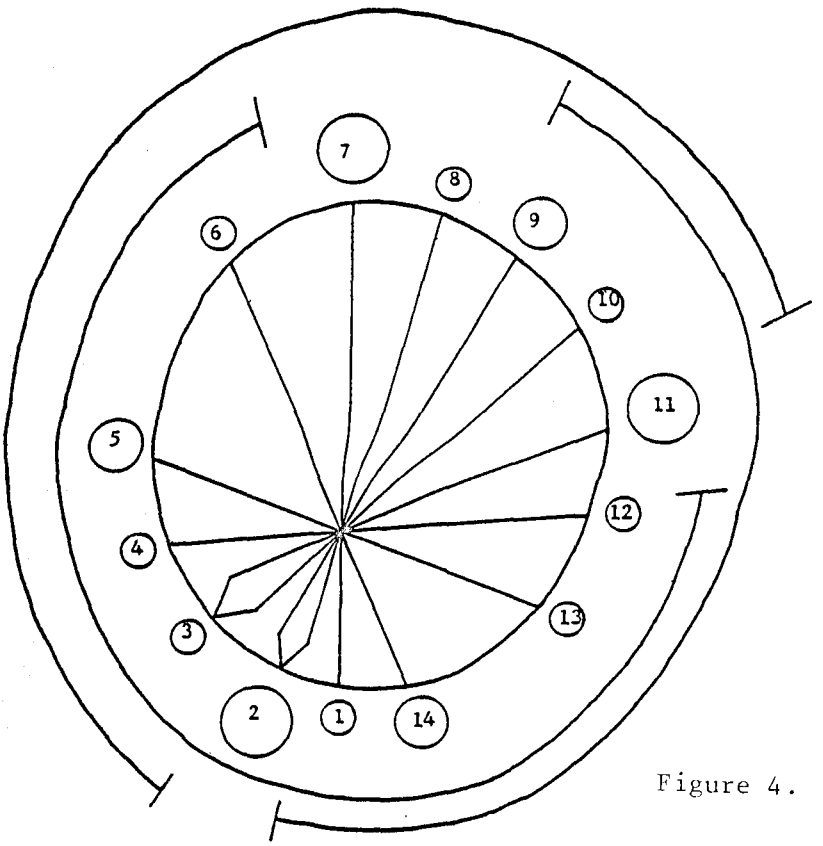

Figure 4. The Psychological Color Wheel

The psychological color circle is based on the psycho-physiological phenomenon known as the negative after-image; colors connected by lines running through the center of the wheel are the negative after-images of each other, called complementaries. The wheel is also based on the Natural Order of Color. Yellow, being the lightest of all colors, is placed at the top of the wheel; violet, being the darkest, is at the bottom. All other colors fall between these two extremes, the cool colors ranging along the left side, the warm colors along the right side. The cool colors, because they are contractive, lie nearer the center. The warm colors, because they are expansive, lie further from the center; hence the warped wheel. The primary colors occupy the large circles; the secondary colors, the medium-size circles; and the tertiary colors, the small circles. Therefore, reading clockwise from violet, we have 1) ultramarine blue, 2) blue, 3) turquoise (green-blue), 4) blue-green, 5) green, 6) yellow-green, 7) yellow, 8) yellow-orange, 9) orange, 10) red-orange, 11) red, 12) crimson, 13) purple, and, finally, 14) violet. The wheel also shows the hegemony of red, yellow and blue, and how semichromes of each of the primaries are to be seen, in diminishing proportions, in those colors that move away from a primary in either direction.[83]

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[83]Calvin Harlan, Vision and Intervention: A Course in Art Fundamentals (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), pp. 85, ___.

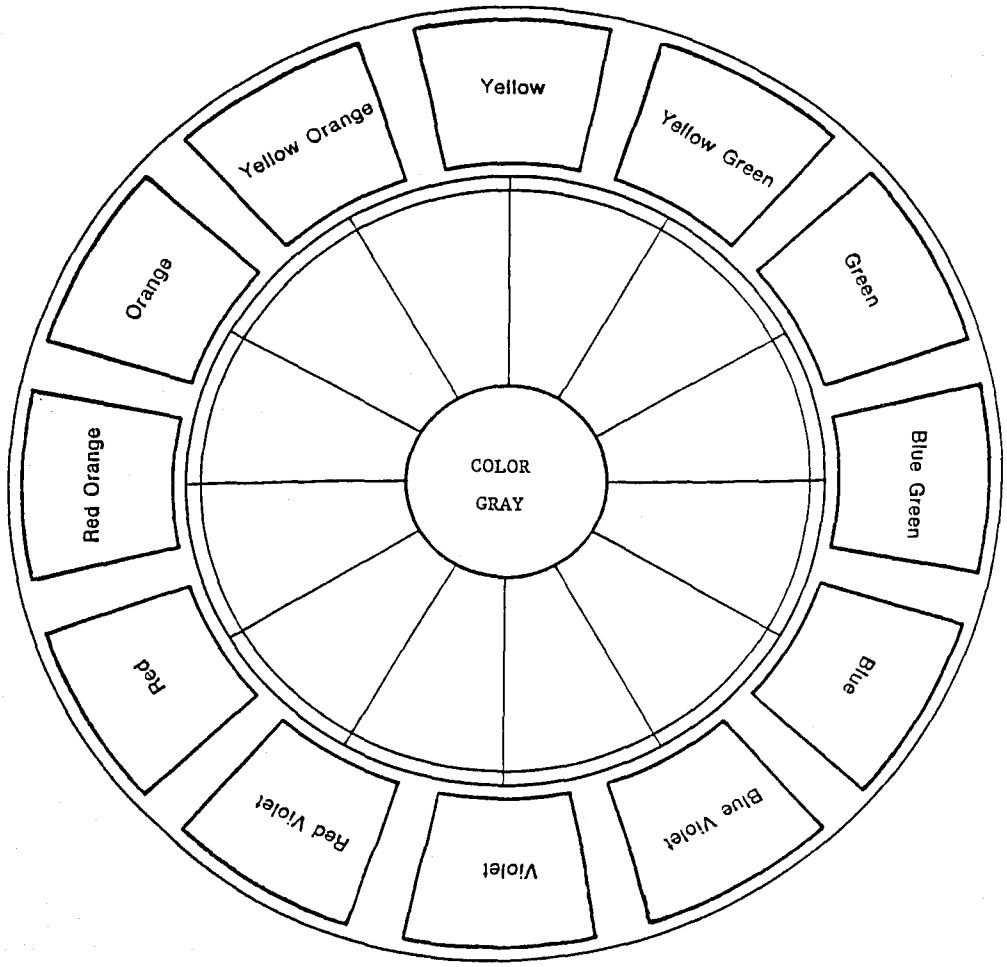

Figure 5. The Traditional Color Wheel

The traditional, subtractive or pigment, color circle is based on the combinations of each pair of the spectral or additive primaries of red, green, and blue. Therefore, red and blue create magenta (red), red and green mix to yellow, and blue and green equal cyan (blue). The traditional primaries red, yellow, and blue, are elemental and will, under normal conditions, form other hues. The secondaries are orange, green, and violet; the complements are red-green, yellow-violet, blue-orange, etc., which are fair visual opposites. Such mixtures are subtractive, selectively absorbing and reflecting light energy; a combination of all three pigment primaries will form a neutral or color gray. The traditional color circle has a fairly equal distribution of warm and cool colors. Thus this circle serves as an excellent tool on which to plot harmonious color combinations, essential in color training and education.[84]

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[84]Otto G. Ocvirk and others, Art Fundamentals: Theory and Practice (3rd ed.; Dubuque, Iowa: William C. Brown Company, Publishers, 1975), p. 85.

Color Terms and Definitions

The following list of color terms and definitions is directly related to terminology and nomenclature that is used in lectures, demonstrations, and practical exercises throughout the color instruction curriculum. This list should be provided as a class handout so that the student may become familiar with color language.

Achromatic - Devoid of hue, colorless.

Advancing Colors - Hues that give an illusion of being relatively nearer to the observer; warm hues in which red-orange predominates are advancing, giving a stimulation sensation.

Analogous Colors - Hues that are closely related to one another, or one of their tints, tones or shades.

Atmospheric Color - An effect produced by vibrations of color which give a feeling or sensation of airiness and space; usually accomplished by the use of broken color.

Broken Color - An effect produced by combining complementary colors; generally related to nature, not being pure color.

Chroma, Intensity, Purity or Saturation - Terms used to differentiate pure color from one that is neutralized by the addition of its complement or an achromatic.

Color - The character of a surface which is the result of the response of vision to the wavelength of light reflected from that surface; the general sensation perceived by the eye and brain that includes all hues, values, and intensities; sensations arising from the activity and vibration of light.

Color Circle - Based on pigment mixtures, a circular arrangement devised to help systematize, visualize, and classify colors.

Coloring Strength - The relative strength of pigments in coloring a white base; sometimes called "tinting strength."

Color Tonality - An orderly planning in terms of selection and arrangement of color schemes or color combinations; concerned with hue, value, and intensity relationships.

Color Triad - A group of three colors spaced an equal distance apart on the color circle.

Complementary Colors - Any two opposite or contrasting hues that furnish completeness to each other; having the power to either neutralize or to accentuate each other.

Cool Colors - Any hue in which blue predominates.

Dark - Low in value; referring to shades, toward black.

Deep - Applied to intense or strong colors with no apparent presence of black.

Diffused Light - Scattered or dispersed light of a somewhat even degree.

Dominant Color - Any color that is predominant in a color scheme.

Double-split Complement - Any color scheme or harmony utilizing four colors, one each on the right and left of a complementary pairing.

Fugitive Colors - Colors lacking in permanence; fading pigments.

Glazing - The process of applying a transparent or translucent pigment to a surface to produce certain blended effects or to alter the color of the surface.

Grayish - Lacking in purity; of weak chroma; neutral.

Ground - The surface upon which a picture is drawn or painted.

Hue - Used to designate the common name of a color and to indicate its position in the spectrum or in the color circle; determined by the specific wavelength of the color in a ray of white light.

Intense - Vivid, strong or full color; pure, fully saturated.

Intensity - (see Chroma).

Irradiation - An optical illusion by which a bright object against a dark background tends to appear larger than it actually is.

Isomeric (Metameric) Colors - Those colors that have different chemical or physical properties, but appear identical.

Key, Keyed - Terms applied to the light-dark characteristic of a hue or color scheme; light values are high key, dark values are low key. The term "key color" also refers to a dominant color.

Local (Objective) Color - The naturalistic color of an object.

Medium - A liquid vehicle or binder giving fluency to pigment; in art the different types of material.

Medium Value - A color approximately midway between a light and dark color.

Monochromatic - When one color is combined with different tints or shades of a hue; a gradation of one hue.

Neutralized Color - A color which has been grayed or reduced in intensity by mixture with any of the achromatics or a complement.

Neutrals - Surface tones which do not reflect any single wavelength of light but rather all of them at once.

Opaque - Having the quality of not permitting light to pass through.

Pigments - Any material or medium used to create the effect of color on a surface.

Polychromatic - When more than one color is combined with other colors.

Primary Colors - Basic colors; the subtractive or pigment primaries are red, yellow, and blue. If all three pigment primaries are superimposed the result is a color gray or neutral.

Prism - A transparent optical instrument; the most common type is usually of glass and is triangular in shape, having two refracting surfaces and making an angle with one another. When sunlight passes through such a prism, the rays are bent twice and separated into the solar spectrum, the visible part of the electromagnetic spectrum.

Receding Colors - Hues that give an illusion of being relatively distant or far from the observer; cool hues in which blue predominates are receding, giving a stimulation sensation.

Secondary Colors - A combination of any two primary colors in equal proportion.

Shade - A deep or dark value of a hue; dimness of illumination; any darkened hue achieved by adding black.

Simultaneous Contrast - The optical effect by which colors are influenced in hue by adjacent colors, each imparting to its neighbor something of its own complement.

Spectral Colors - The band of color produced when a ray of white light is bent (refracted) as by a glass prism.

Spectrum - When a beam of white light is divided through dispersion, as by a glass prism, into its constituent hues or prismatic colors; known as the "solar spectrum." The wave lengths of each color are separated from one another, forming a progressive series of hues.

Split Complementary - Any color scheme or harmony utilizing three colors, one color and the colors to the right and left of its complement.

Subjective Colors - Chosen by the artist without regard to the natural appearance of the object portrayed; having nothing to do with objective reality, but with the expression of the individual artist.

Tint - A pale or light value of a hue; any lightened hue achieved by adding white.

Tone - An intermediate hue; alluding to any color not easily identified as a tint or shade, especially referring to slightly neutralized hues; may be achieved by adding gray to a hue.

Translucent - Having the quality of permitting light to pass, but diffusing it so that objects on the other side cannot be clearly distinguished.

Transparent - Having the quality of permitting light to pass through a substance, so that objects may be clearly seen.

Triadic Colors - Any color scheme or harmony utilizing three colors equally spaced on the color circle.

Value - The characteristic of a color in terms of the amount of light reflected from a surface; the lightness or darkness of a hue.

Vivid - Bright, intense, saturated, pure, as with the colors of the solar spectrum.

Principles of Color. This lecture, the second in a series of background lectures, is entitled "The Elements and Principles of Color Interaction," introduces the novice color student to those factors inherent with various colors as they interact. Because of the content of this lecture, the list of color terms and definitions is given to the student during the previous lecture. This procedure will allow the student time to review those terms appropriate to this lecture. The lecture outlined below presents an introduction and discussion of the dimensions, characteristics, schemes, and attributes of color combinations.

"The Elements and Principles of Color Interaction"

A. The THREE DIMENSIONS of Color.[85]

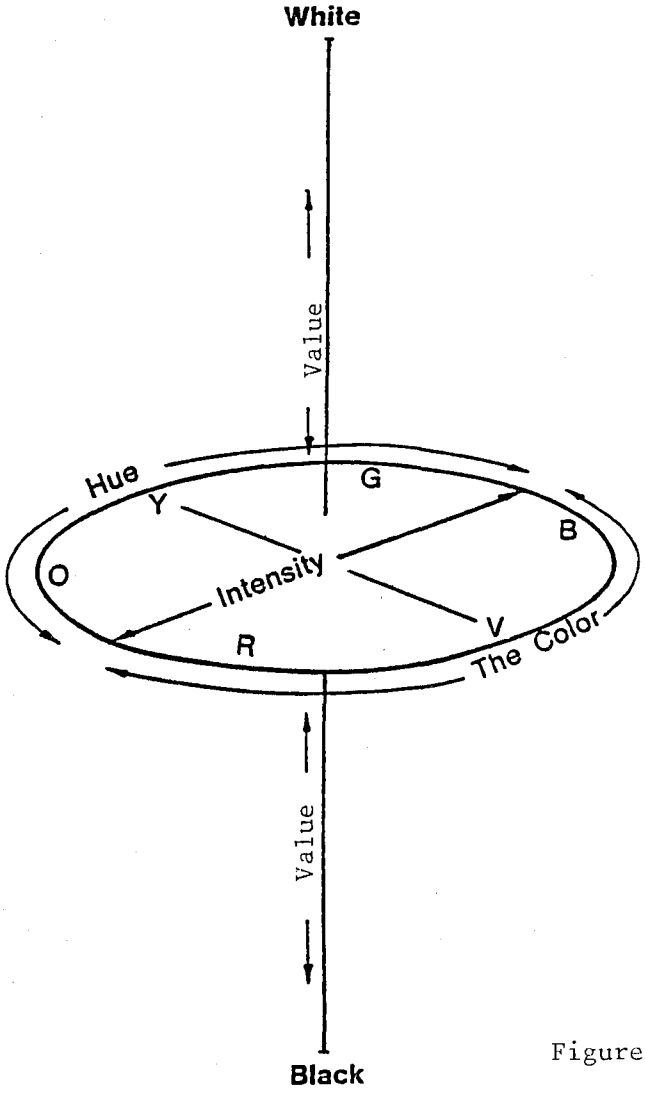

Figure 6.

This diagram demonstrates all three physical properties of color. As the colors move around this solid, they change in hue. When these hues move upward or downward on the solid, they change in value. As all of the colors on the outside move toward the center, they become closer to the neutral values and there is a change in intensity.[86]

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[85] New Munsell Color Tree. Macbeth, A division of Koll-morgan Corporation, 2441 North Calvert Street, Baltimore, Maryland 21218.

[86] Ocvirk, op. cit.

1. HUE: The name of a color; the position of a color in the color circle or within the electromagnetic spectrum.

   a. The PRIMARY (first level) subtractive colors are RED, BLUE and YELLOW.

      1) These pigment subractive primaries are the source of all other pigment colors.

      2) Pigment primaries are called SUBTRACTIVE and are perceived by the absorption of light waves.

      3) Subtractive (pigment) colors are created by the absorption of additive (light) colors.

   b. The SECONDARY (second level) colors are GREEN, ORANGE, and VIOLET, and are created by the equal mixture of two (fully intense) pigment primary colors.

   c. The TERTIARY (third level) colors are YELLOW-ORANGE, RED-ORANGE, RED-VIOLET, BLUE-VIOLET, BLUE-GREEN, and YELLOW-GREEN, and are created by the equal mixture of one (fully intense) pigment primary color and one (fully intense) pigment secondary color.

2. VALUE: The relative lightness (or darkness) of a hue.

   a. Relativity is dependent on the environment or surroundings.

   b. Every subtractive color has a value of its own.

      1) Key = value: High key or low key = high value or low value.

      2) A relationship of value to hue can be made by comparing the lightness (darkness) characteristic to the inherent intensity of the color in question.

   c. The VALUE SCALE (Figure 8, p. 101)

      1) The white-black sequence of a color's value relates directly to its visual attribute of weight.

         a) Relatively light values exhibit relatively light weight.

         b) Relatively dark values exhibit relatively heavy weight.

2) Relative normal values of the primary, secondary, and tertiary hues are indicated below:

	White	
	High light	Yellow
Yellow orange	Light	Yellow Green
Orange	Low light	Green
Red Orange	Medium	Blue green
Red	High dark	Blue
Red violet	Dark	Blue violet
Violet	Low dark	
	Black	

d. The adjustment of the value of a hue can be accomplished by adding white, black, or gray.

1) TINT: Raising a color's value by adding white.

2) SHADE: Lowering a color's value by adding black.

3) TONE: Adjusting a color's value by adding gray.

e. Adjustment of a color's value may be related to the ambiance or mood.

3. INTENSITY: The relative brightness (or dullness) of a hue.

a. Intensity is also called purity, saturation, and/or chroma.

b. Adjusting the intensity of a hue.

1) Physically adding a complementary color or changing the value of a pure hue <u>decreases</u> its intensity.

2) The intensity of a hue cannot be physically increased back to its fullest intensity.

3) An increase in a color's intensity beyond full physical intensity can only occur visually via simultaneous contrast.

c. Complementary mixing produces a COLOR GRAY which is different from a black-white (achromatic) mixed gray.

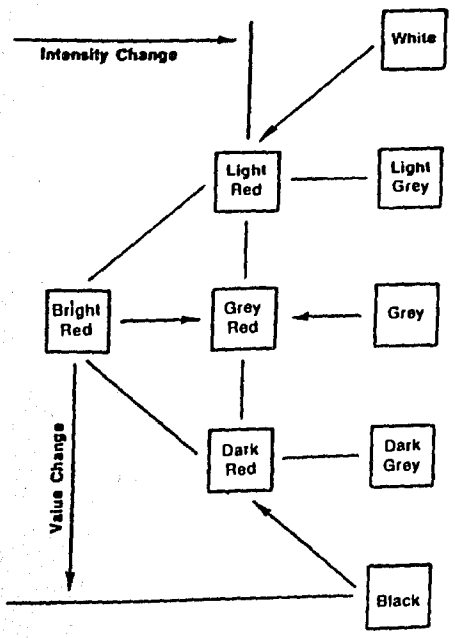

Figure 7.
Scale of Neutrals[87]

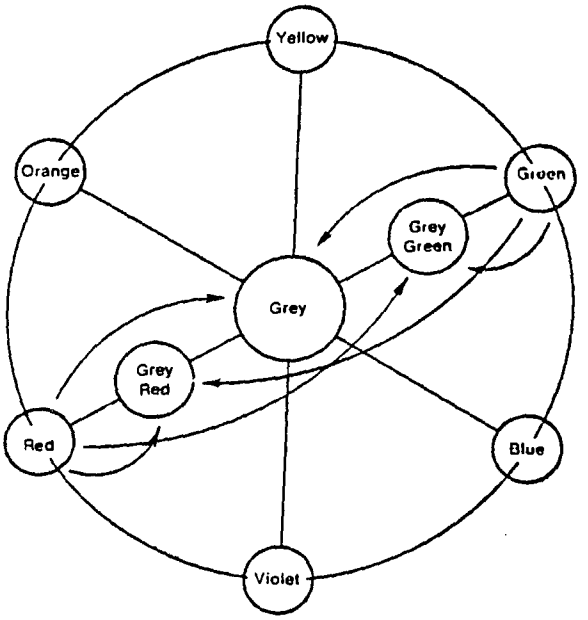

Figure 8.
Scale of Complementaries[87]

B. COLOR SCHEMES or COLOR HARMONIES.

1. Achromatic: Without (pigment) color: black, white, gray.

2. Monochromatic: One color, including all tints and shades.

3. Complementary: Two colors exactly opposite one another on the color circle.

4. Analogous: At least three closely related colors.

5. Triadic: Three colors equally positioned or distant from one another.

6. Split Complement: One hue and the colors on either side of its complement.

7. Double-split Complement: Two colors on either side of a complementary pair.

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[87]Ibid., p. 88.

8. Tetradic: Four colors equally positioned or distant from one another.

C. The FOUR VISUAL ATTRIBUTES of color.

1. Color exhibits physical weight: value

2. Color exhibits temperature: hue relationship with natural and/or psychological associations.

   a. Warm colors advance relative to their environment.

   b. Cool colors recede relative to their environment.

3. Color exhibits size: hue (temperature), value (spreading or von Bezold effect), intensity.

4. Color exhibits spatial movement: hue (temperature), value (spreading or von Bezold effect), intensity.

It should be understood that the addition of a variety of visual aids to the outlines of the previous two lectures will enhance the student's ability to more clearly understand the instruction.

The Value Scale. One of the most useful teaching-learning aids in the color instruction curriculum is the "value scale" (p. 101). This device is to be used to assist the student in determining values and value comparisons of a variety of chromatic hues. Since no hue in the color pack is lighter than white or darker than black, black and white will not be used in the value scale. Construction is accomplished by cutting a one-inch square from each of the sixteen achromatic grays. Successive gray squares are taped adjacent to each other in an ascending (or descending) value order, across the back. Thin transparent tape is recommended so not to create excessive thickness in the value scale, causing shadows. A hole should be punched in the center of each of the sixteen gray squares to assist the student in visualizing

the comparisons of values between various colors and the scale.

The primary method for using the value scale is to have the student establish a light-dark "range" of values directly on a single hue sheet from the color pack. By looking along the common edge of the scale or at the holes in successive gray squares, the student should be able to establish at which point or value the scale edge or hole "disappears". This disappearance occurs because the contrast between chromatic (hue) value and achromatic value is at its least evident relationship, thereby establishing the value of the chromatic hue.

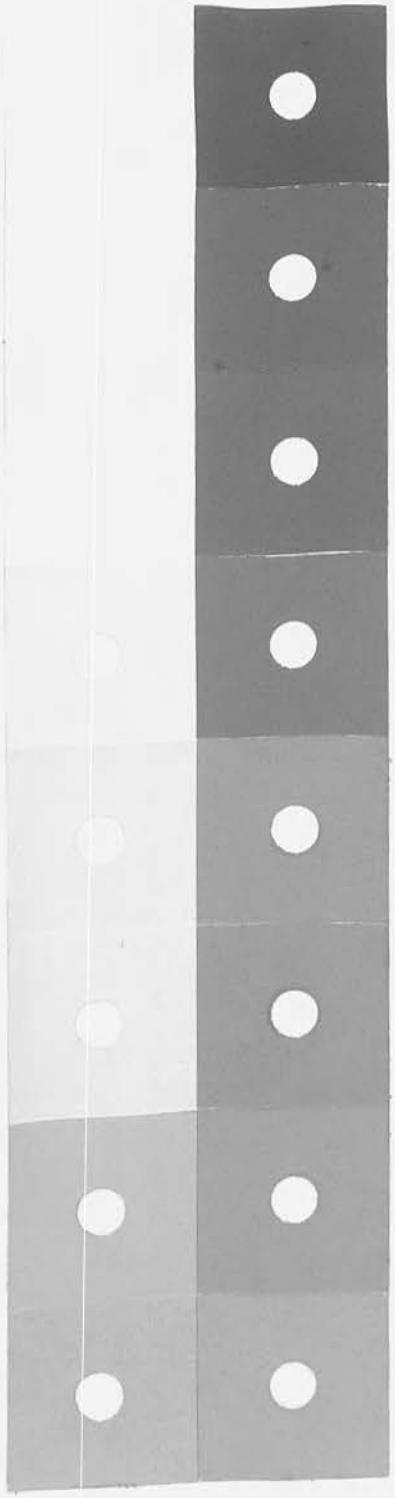

Figure 9. The Value Scale

The Practical Exercises

Exercise One Assignment (Instructor's Outline)

A. Exercise Concept.

1. HUE and VALUE are related to each other because every hue exhibits its own value.

2. Each HUE, including all of its tints and shades, exhibits a relative lightness or darkness.

3. The exercise objectives will demonstrate that various hues exhibit various value levels.

4. Technical aspects of the exercise (handout).

   a. Each student will use all sixteen Color-Pack achromatic grays and sixteen related hues.

   b. Use the value scale to determine the values of a variety of chromatic hues.

      1) Establish a (personal) random pattern of sixteen achromatic grays.

      2) Establish a hue-value pattern with sixteen various chromatics using exact achromatic pattern.

5. During completion a comparison of a variety of chromatic hues to each achromatic value should be made.

   a. Hue-value pattern comparisons can be checked by noting the edge contrast between chromatic hues in the array.

   b. Arrays may be checked by noting similarities between value pattern and hue pattern.

B. Exhibit original and/or color slide examples of a completed exercise.

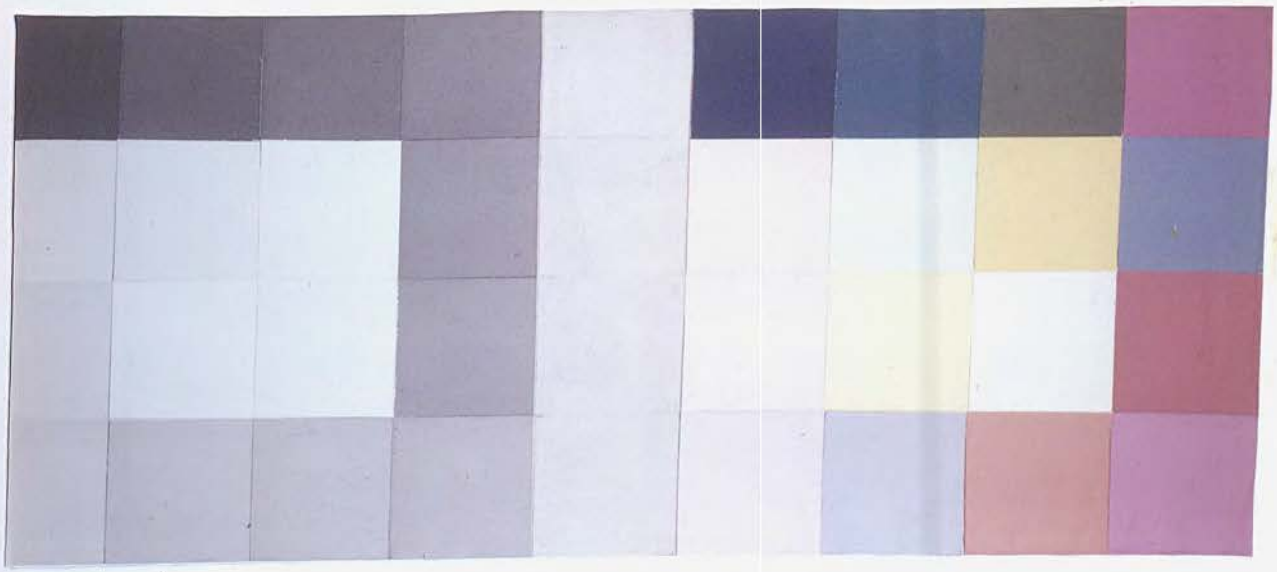

Plate 1. Exercise #1 Completed Project

Exercise One: "The Value of a Hue" (Student Handout)

Exercise Objectives. This exercise has been specifically designed to provide the student with a knowledge and understanding of the relationship of hue and value. Upon completion of this exercise the student will be capable of identifying, distinguishing, relating, discriminating, categorizing, and describing a variety of values within a single color family and/or a similar value range across various hues. The level to which the cognitive and affective behaviors are satisfactorily met will be evaluated through the completion of a practical demonstration comparing an achromatic scale of sixteen values to a scale of sixteen different hues.

Discussion. All sixteen values of gray in the color pack will be selected. Since the primary objective of the exercise is to establish the relationship between a select variety of hues as compared to

a given number of gray values, and because no hue is as dark as black or as light as white, those achromatic values will not be used. Next, select one hue that relates to each of the gray values, establishing sixteen grays and sixteen chromatic hues. The selection of a hue that corresponds to a particular gray value can be most easily accomplished by using the "value scale" constructed earlier. Once all hue and value combinations have been made and checked, physical construction of the exercise may begin. Note that there will be more than one hue that will relate to each gray value, and hue selection may be based on any personal preference. However, more than one hue should be tested for an accurate relationship to the gray standard.

Required Reading. Itten, pp. 37-44; Albers, p. 12; Harlan, p. 112; Libby, pp. 8-16.

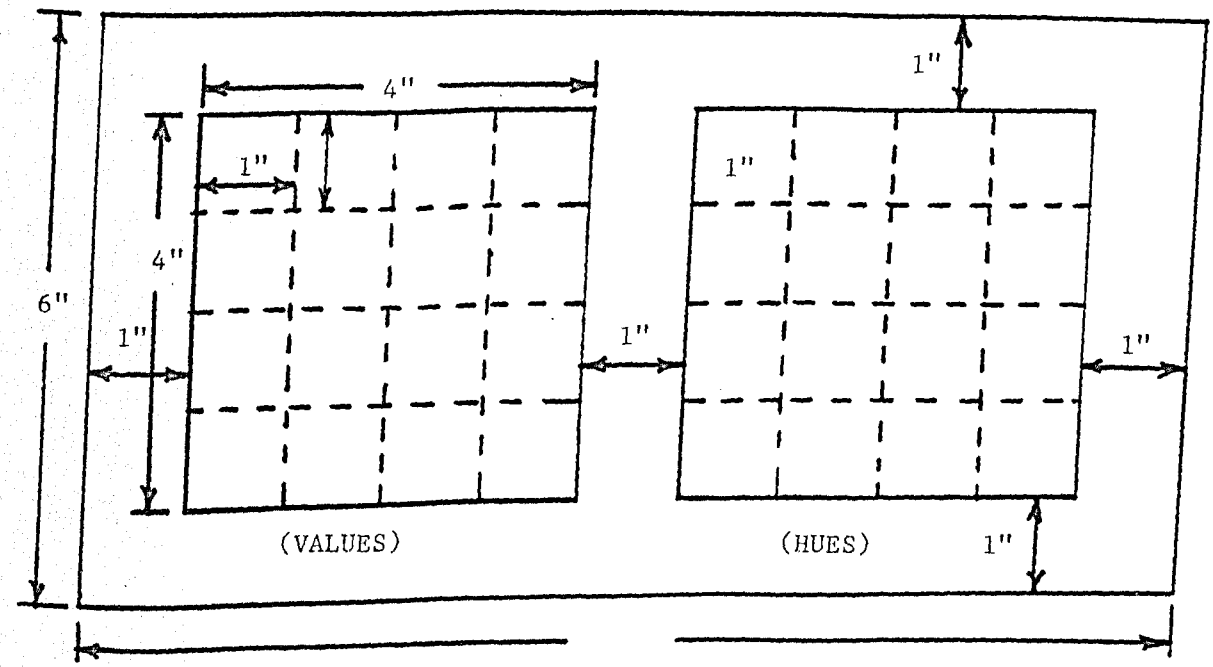

Figure 10. Practical Exercise #1 Construction Diagram

Practical Exercise.

1. Cut one piece of gray mounting board to 6" x 11".

2. Draw two 4" squares, leaving a 1" margin around the top, sides and bottom of each square, and 1" between squares.

3. Divide the square on the left (VALUES) into sixteen 1" squares. In each 1" square, cut and glue a different value gray. The gray value squares may be placed in any pattern desired. Do not allow any space to show between the gray value squares.

4. Divide the square on the right (HUES) into sixteen 1" squares. In each 1" square, cut and glue the tint, shade, or full intensity of a single hue which corresponds to the value and placement of the gray in the square on the left. Note that since the value scale is made up of sixteen different grays, the hue scale will also be made up of sixteen different hues. It is preferable not to select hues from the same family.

5. Place an opaque white paper cover over the exercise in order to prevent damage or marring of the color chips. Place "EXERCISE #1" and your name in the lower left hand corner of the back of the exercise. In the lower left hand corner of the cover, indicate the type of illumination (incandescent, fluorescent, or combination) used in the completion of the exercise.

Evaluation. Assignment = 90%; Craftsmanship = 10%.

Exercise One Critique (Instructor's Outline)

A. Exercise objectives:

   1. To learn to "see" (perceive) color.

   2. To evaluate the exercise, to learn from verbal evaluation, to determine the quality of attention to the assignment and craftsmanship, to develop an understanding in order to revise the exercise for resubmission if necessary.

      a. This mastery approach provides for continual revision of the exercise until the concept is understood.

      b. The critique, per se, will not be graded; however, participation in the evaluation process is imperative.

B. Developing a method of criticism.

1. Criticise the exercise, not the personality of a peer.

2. The critique should provide for an expression of positive and/or negative aspects of work.

3. Each student should attempt to learn more about his own presentation from the perception of others, as well as to understand his own approach in relation to other students' solutions.

C. Critique procedures.

1. Submit the exercise at the beginning of the critique period.

2. Upon completion of the critique session the exercise will be submitted as presented for critique to be graded or submitted as presented for critique, initialed by the instructor, returned to the student for revision, then resubmitted at the beginning of the following class period.

   a. Once the exercise is graded and returned to the student, it may be resubmitted as often as necessary until mastery is accomplished.

   b. Exercises not critiqued will be evaluated by the instructor, and graded at the instructor's discretion without provision for resubmission.

3. Caution students that they may run into time problems if they rely on too many resubmissions!

D. Critique notes for Exercise #1.

1. Exercises should be completed early in the period in order for the student to personally evaluate and correct them.

   a. It is important to stand away from the exercise and view it from a distance; mistakes will be more visible.

   b. It is suggested that personal evaluations of the exercise be made in the critique room and under normal critique lighting.

2. Explain the designations of "rows" and "columns" in relation to the exercise format.

3. Explain that "seeing" color is a right brain activity.

    a. Don't confuse lightness (value) with brightness (intensity).

    b. Evaluate the consistency of the pattern; be careful to put hue chips in corresponding value spaces.

        1) The value pattern vs the hue pattern.

        2) Close eyes down (squint); concentrate vision and attention on the exercise.

        3) Explain how to use the "common edge" to evaluate value relationships.

        4) Interaction of color = contrast of values, of light and dark.

4. Explain the difference between a color chip having mechanical (technical) vs visual correctness.

    a. Any color chosen in isolation using the "value scale" may not appear the same when interacting with other colors in the environment.

    b. Don't use the color (hue-value) chart to attempt to locate color combinations because the chart is two-dimensional, there is no intensity scale!

5. Explain the importance of good craftsmanship.

    a. Demonstrate the procedure for cutting, cementing, and trimming color chips.

    b. Demonstrate the method of removing color chips, especially those completely surrounded by other color chips.

Exercise Two Assignment (Instructor's Outline)

A. Exercise concept.

    1. The relationship of HUE and INTENSITY.

        a. As intensity changes by the addition of black, gray, or white, the hue changes in value from its inherent value.

        b. As intensity changes by the addition of the complementary hue, the original hue moves toward a neutral.

2. Because the color pack is two-dimensional, a hue-value scale, the dimension of intensity can only be shown by adjusting the value of a hue.

3. This exercise will demonstrate how hue is affected as intensity changes.

4. Discuss technical aspects of the exercise (handout).

    a. Each student will select one hue family, including the full intensity of the family plus all of its tints and shades.

    b. Set up two arrays of hue-value comparisons by developing a scale from the full intensity outward to the lightest tint and a scale from the full intensity to the appropriate shade.

    c. Note the adjustment of the intensity by using light and dark values.

        1) First the value of the full intensity hue must be determined.

        2) Tint relationships should be established outward from the full intensity toward the corners of the array; toward the lightest value.

        3) Shade relationships (value intervals) should be established outward from the full intensity toward the corners of the array.

            a) If the full intensity is inherently dark the shades will become increasingly lighter.

            b) If the full intensity is inherently light the shades will become increasingly darker.

5. Upon completion of the exercise, a comparison of what happens to various hues as the intensity changes should be noted.

    a. The loss of hue character increases as the intensity decreases.

    b. The increase of the visual intensity of the full intensity hue occurs because of the decreased intensity of the environment.

c. Any perceptible change in the size of the full intensity hue square occurs because the contrast of value and intensity in the environment increases.

B. Exhibit original and/or color slide examples of a completed exercise.

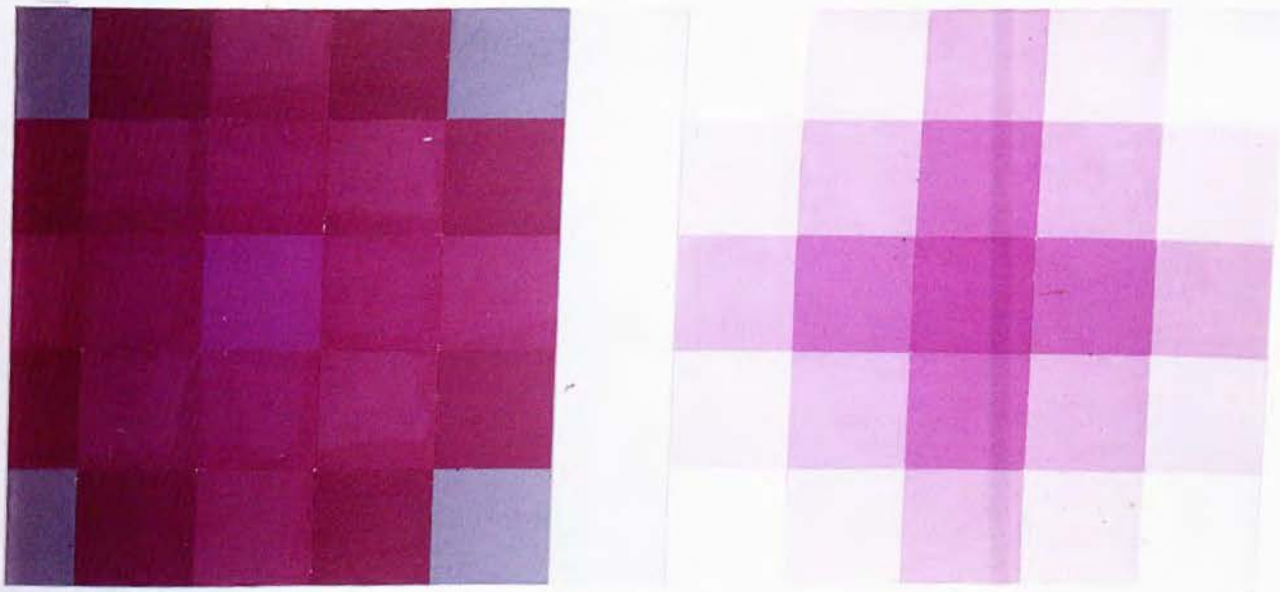

Plate II. Exercise #2 Completed Project

Exercise Two: "The Intensity of a Hue" (Student Handout).

Exercise Objectives. This exercise has been specifically designed to provide the student with a knowledge and understanding of the relationship of hue and intensity. Upon completion of this exercise the student will be capable of identifying, distinguishing, relating, discriminating, categorizing, and describing a variety of intensities within a single color family. The level to which the cognitive and affective behaviors are satisfactorily met will be evaluated via the completion of a practical demonstration comparing the changes of intensity across high and low values within a single hue family.

Discussion. One hue family including all tints and shades will be selected. Since the primary objective of the exercise is to establish the relationship between hue and intensity, and because the color pack is limited to the two dimensions of value and hue, it will be necessary to use hue and value to study the dimension of intensity. (It will become more apparent, beginning with this exercise, that the three dimensions of color are inseparable). Because of material limitations this exercise will require less creativeness than technical ability.

Using the full intensity of the selected hue family and all of its tints, lay the color sheets in order of ascending value, constituting the hue and its intensity variations of the upper half of the value scale. Remember, although values are being used, anytime the purity of a hue is changed, in this case by using white, the intensity is reduced. Using the full intensity of the selected hue family and all of its shades, follow the same procedures as with the tints. Note that because the color pack only includes three levels of shades it will be necessary to select one gray that is related to the value progression of the shades of that family. In selecting the correct gray it is imperative that the value progression be evaluated closely. This can be done by using the "value scale" and noting the steps of value between the full intensity hue and each successive shade. Once the normal progression of values is determined, the proper gray may be selected at a position one step above or below the value of the last shade.

Required Reading. Itten, pp. 55-58; Albers p. 17; Harlan, p. 111; Libby, pp. 8-12, 16-18.

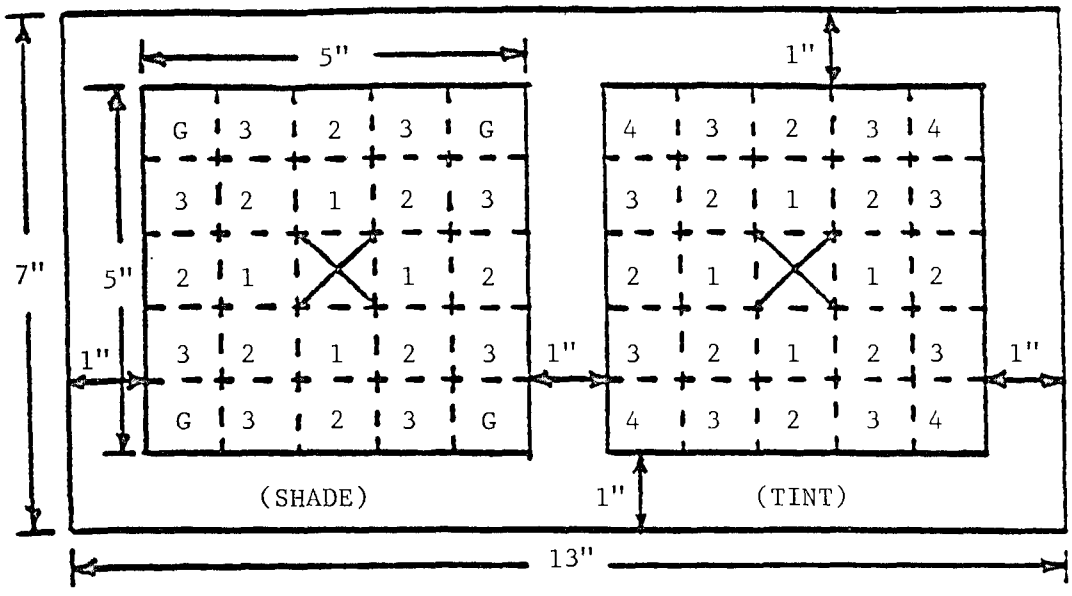

Figure 11. Practical Exercise #2 Construction Diagram

Practical Exercise

1. Cut one piece of gray mounting board to 7" x 13".

2. Draw two 5" squares, leaving a 1" margin around the top, sides, and bottom of each square, and 1" between squares.

3. Divide both squares into twenty-five 1" squares.

4. Cut two 1" squares of the full intensity hue and glue one each in the center of each large square, indicated by the "X".

5. In the square on the right (TINT), cut the appropriate number of each tint into 1" squares and glue each according to the number designation on the diagram: Tint #1 in all squares numbered 1, etc.

6. Follow the same procedure for the left (SHADE) side as in step 5. In the corner squares marked "G", select the correct gray that corresponds to the natural progression in value between the other shades, from the full intensity hue through the corner gray.

7. Place an opaque white paper cover over the exercise in order to prevent damage or marring of the color chips. Place "EXERCISE #2" and your name in the lower left hand corner of the back of the exercise. On the lower left hand corner of the cover indicate the type of illumination used in the completion of the exercise.

Evaluation. Assignment = 50%; Craftsmanship = 50%.

Exercise Two Critique (Instructor's Outline)

A. Exercise objective.

1. Discuss the difficulty in separating intensity from value or hue.

2. Anytime black, white, gray, or the complementary hue is added to any hue, the intensity of the original hue is decreased.

a. Discuss the physical change of intensity by adding the complementary hue.

b. Describe how the color pack is two-dimensional, without an intensity scale, therefore, forcing intensity changes to be made by adjusting the value.

B. Progression of tints and shades in the color pack.

1. Tints follow a well defined progression within the limits of the color pack.

2. Shades present two problems:

a. There are not enough shades to complete this exercise, making it necessary to use gray at the corners.

b. If fourth-level hues are used for this exercise, shades may need to be applied in reverse order because of the addition of white by the manufacturer.

3. The use of gray in the corners of the shade portion of the exercise demonstrates the sequence of values.

a. As intensity changes, value may also change.

b. The desire in this exercise is to end with the appropriate gray in the corners, going through five variations of value change from the full intensity hue in the center of the exercise.

c. Some hues will require that the interval of intensity (value) will vary because the full intensity of a hue starts at a different value level with different hues.

4. In order to determine how much latitude is possible in making a hue more or less intense (using black and/or white) first the value level of the full intensity must be established.

a. Working with the light end of the spectrum (yellow) the value (or intensity) changes are small within the tints but large within the shades because yellow is inherently light.

b. The opposite is true at the dark end of the spectrum (violet).

c. This value change is affected in the same way when mixing complements:

1) Intensity decreases as value gets lighter or darker.

2) Complementary mixing = COLOR GRAY.

d. In order to maintain an original value level when mixing complements, black and white must be added.

C. Intensity = how much of the pigment (coloring agent) exists; how pure, how saturated.

1. BROKEN COLOR = reducing intensity by adding the complement (adjusted by using black, white, or gray).

2. Physical vs Visual adjustment of intensity.

a. Intensity cannot be increased beyond a certain level, never back to its (physically) purest state.

b. We can visually increase the intensity of a hue by adjusting its environment, particularly if we put a complement in the environment.

D. Critique notes for Exercise #2.

1. Discuss intensity, value, and hue of the center square relative to the environment.

2. Discuss the BEZOLD (spreading) EFFECT and its relationship to size change.

3. More intense colors tend to be more active.

4. Color temperature = spatial movement.

Exercise Three Assignment (Instructor's Outline)

A. The Relationship of Colors (Color Relativity).

1. This exercise is a demonstration of how colors affect each other.

2. One hue can be made to appear as two different but related hues by changing the environment hues.

   a. Choose a single hue for the FIGURE HUE, and two different background hues for the GROUND HUES.

3. This exercise will attempt to demonstrate how far apart the figure hue can be moved.

   a. Choose one (figure) hue and put it on two different (ground) hues.

   b. The ground hue(s) will cause the figure hue to take on a specific characteristic appearance which will be changed or be made to take on characteristics of the opposite ground hue.

4. The criteria for selection and analysis of the number of color choices for the figure color is to:

   a. Determine the characteristics of the hue: temperature, complement, value, weight, intensity and size.

   b. Consider how the figure color can be changed; develop contrast in the hue characteristics.

5. Application of the criteria and analysis to the exercise.

   a. Attempt to move the figure color (visually) away from its original position in opposite directions around the color circle.

      1) To make the figure color take on a cool (warm) appearance, place a warm (cool) color in the background.

         a) Application of this process may be made for each one of the characteristics of a hue, i.e., complement, value (weight), intensity, and size.

b) Warm (cool) ground causes figure color change due to simultaneous contrast.

b. Choice of figure hue will establish limits of choice of ground hues to no more than two-thirds (2/3) of the color circle, using the figure color as the center.

c. Description of the setting up of the exercise.

1) Physically define one figure color plus all of its tints and shades.

2) Use the color circle to assist in determining how the figure color may be moved in opposite directions from its original position.

3) Choose two ground colors, plus all tints and shades.

4) Demonstrate how to set up color sheets to check color relatedness.

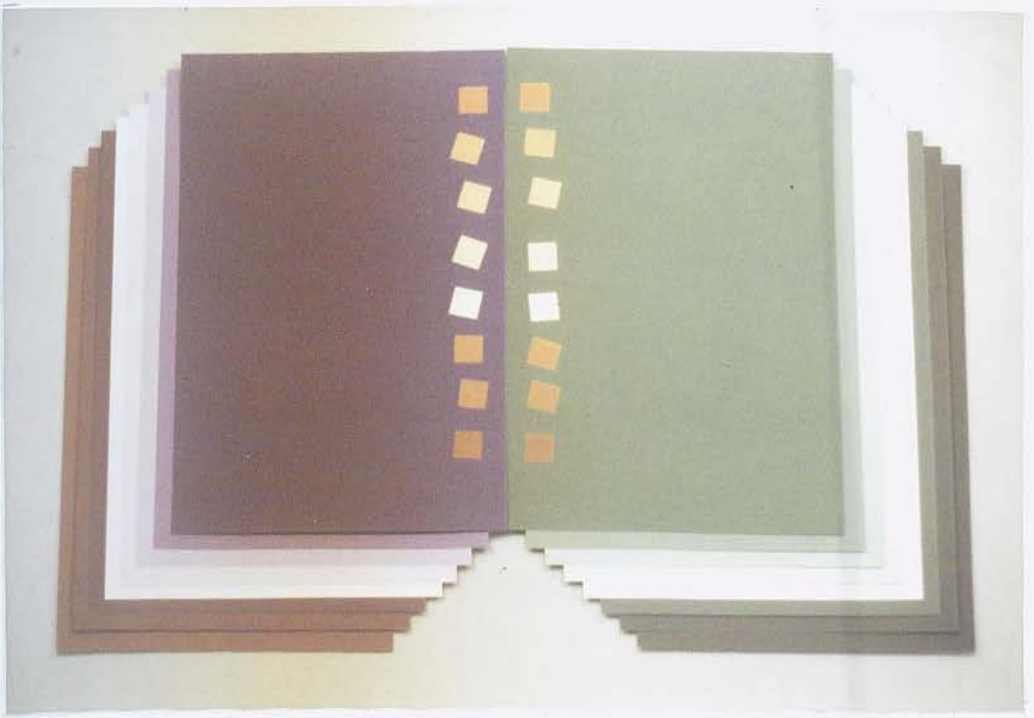

Plate III. Color Interaction Evaluation (Exercise #3)

d. Emphasize that figure colors should be as far apart as possible to appear as different as possible.

6. Demonstrate the cutting and inlaying of colors. (This may be done during the following working class period).

B. Exhibit original and/or color slide examples of completed exercises.

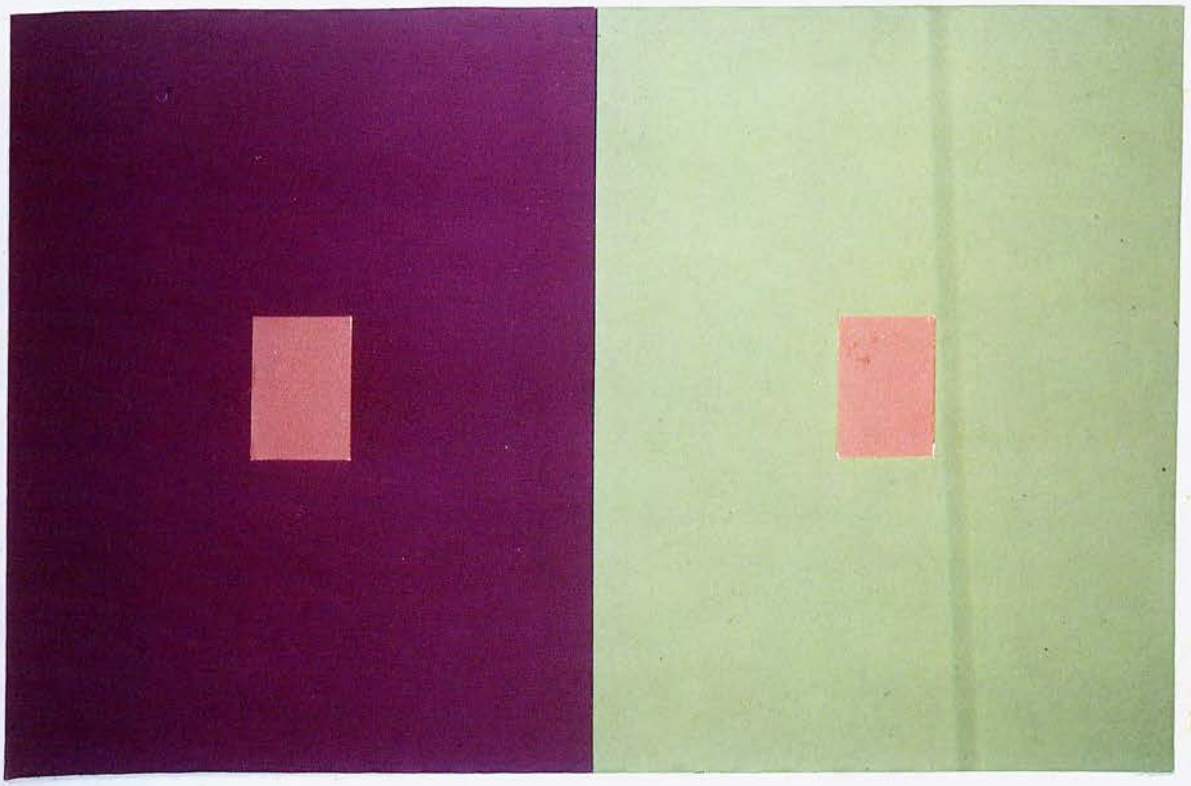

Plate IV. Exercise #3 Completed Project

Exercise Three: The Relativity of Color (Part I) (Student Handout)

Exercise Objectives. This exercise has been specifically designed to provide the student with a knowledge and understanding of how one color affects another. Upon completion of this exercise the student will be capable of identifying, distinguishing, relating, discriminating, categorizing, and describing how a figure color is independently affected

by at least two background colors so that the figure color appears to be changed in the dimensions of hue, value, and intensity, from its original state.

Discussion. It is imperative to remember that an attempt should be made to move the figure color as far right or left of its original position as possible using two different ground colors and the visual effect of simultaneous contrast. Note: the primary reason for a two-sided study is so that a visual comparison can be made. It should not be assumed that more than two colors is ever needed to create visual color change.

One color will be selected (together with all of its tints and shades) that will act as the figure color. The only factor to consider in this choice is that the figure color will establish the limits of possibilities for ground colors. Using the color circle, determine the limits of the choices for ground colors by moving one-third (1/3) to the right and left of the figure color around the color circle. The process of selecting the correct ground and figure colors should begin now. Remember, to this point only a figure color family, and only the outside limits of the ground color families have been chosen. Next, cut two small rectangles from each element of the figure color family. These color "chips" will be placed directly on the element of the ground color family in order to determine which figure-ground combination creates the greatest activity. In choosing figure and ground colors attempt to establish as much color contrast as possible between the ground colors so that the figure color will react with the greatest possible emphasis: TEMPERATURE (warm vs cool), VALUE (light vs dark), and INTENSITY (bright vs dull). The contrast

in adjacent ground colors should provide a maximum color shift in the color.

According to the diagram (below), neatly stack one ground color family on a flat lighted surface, and place the other ground color family immediately adjacent so that both stacks touch along a common long side. Remember, there is the possibility of using any one of fifteen color families, it is therefore imperative that a systematic evaluation procedure be established. By allowing one stack of ground colors to act as a constant, make a comparison to the other stack of ground colors. The second stack of ground colors may be systematically changed and the effects compared to the figure color "chips" that are resting on the face of both ground color stacks. This procedure of trial-and-error comparisons should be continued until the best possible color combination is reached, only then should the exercise be assembled. Note: It is advisable to make written notes of all figure-ground combinations that appear satisfactory as the comparisons are made, then satisfactory combinations may be re-evaluated and accepted or rejected until the final selection is made.

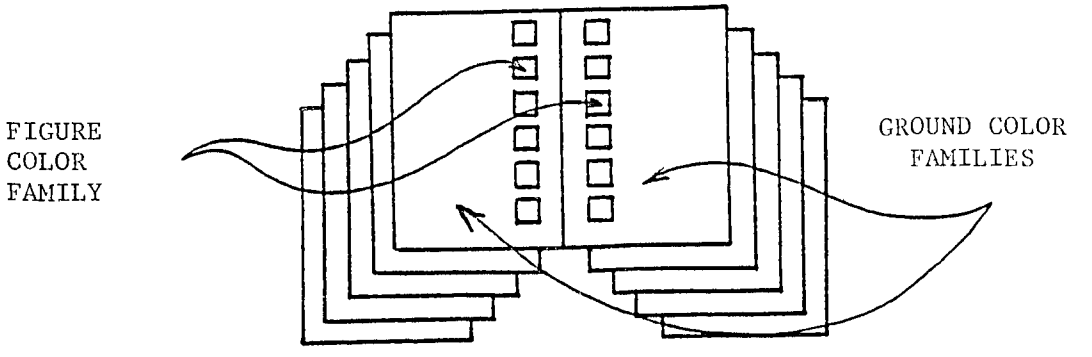

Figure 12. Color Interaction Evaluation (Exercise #3)

Required Reading. Itten, pp. 52-54, 64-65; Albers, pp. 8-11; Harlan, pp. 99-100, 105-106.

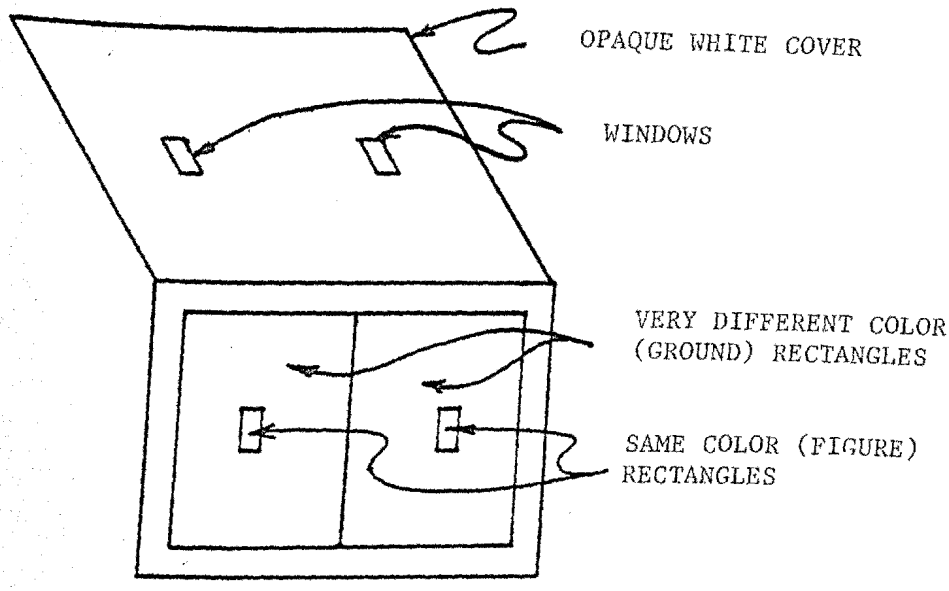

Figure 13. Practical Exercise #3 Construction Diagram

Practical Exercise.

1. Cut one piece of gray mounting board to 6" x 8".
2. Cut one 3" x 4" rectangle from each ground color.
3. Cut two (oversized) 3/4" x 1" rectangles from the figure color.
4. Placing the ground color rectangles color-side down, tape one figure color rectangle (face down) on the center of the back of the ground color and measure and mark a vertical 1/2" x 3/4" rectangle across the figure color rectangle.
5. Cut through both the figure and ground colors from the back, along the 1/2" x 3/4" marks, being careful to cleanly cut the corners as well as the sides of the small rectangle.

6. Upon completion of the (inlay) cutting, turn the ground color rectangle over and remove the small ground color rectangle to expose the figure color rectangle. Tape the figure color into place from the back.

7. Repeat Steps 4-6 for the second ground color.

8. Attach both ground color rectangles immediately adjacent to each other according to the diagram above.

9. Cut one 1/2" x 3/4" rectangular window in the opaque white paper cover to correspond to each figure color rectangle underneath. Note: this will allow for viewing the figure color without the influence of the ground colors. Place "EXERCISE #3", your name, and a diagram, listing the number and location of colors used in completion of the exercise, on the back. On the cover sheet, indicate the type of illumination used in the completion of the exercise.

Evaluation. Assignment = 80% (Hue = 50%, Value = 10%, Intensity = 20%); Craftsmanship = 20%.

Exercise Three Critique (Instructor's Outline)

A. The exercise objective is:

1. To take one figure color and, by changing the ground color that it is on, attempt to change one or all dimensions of the figure color.

   a. The purpose is not just to learn how to make the dimensions of a single color change, but to learn how colors interact.

   b. This exercise helps put together concepts learned in Exercises 1 and 2.

2. To physically adjust one (ground) color, causing a visual adjustment in another (figure) color.

   a. Colors will interact differently, i.e., appear visually changed, as the color relationships are changed.

3. To demonstrate that the concept of color interaction is built on simultaneous contrast.

   a. This contrast emphasizes the fact that there is no such thing as physical color as we know it.

1) Hue: the effects of simultaneous contrast.

2) Value: (physical): more or less light energy reflected; Value (physiological): the contrast of light and dark established in the rods (and cones) on the retina.

a) Size changes are due to value and/or intensity.

3) Intensity: when both colors are of equal intensity, value comparisons become the major consideration.

a) Complementary: vibration occurs as values become more closely related.

b) Analogous: no vibration; one sees the intensities as independent.

c) Contrast of Extension: more of one color will increase the intensity of the other.

b. One must relate value and hue to intensity.

1) One needs to know the three dimensions of each color pair in comparison.

2) The smaller of the two color areas will react with greater volatility.

B. The Exercise.

1. Attempt to understand what happens to a particular color (hue, value, intensity) as the environment is adjusted.

a. Explain simultaneous contrast.

b. Determine what each figure color has "in common" with the ground color.

1) The figure color placed on the ground color will emphasize that factor <u>not</u> held in common; using a common factor to emphasize an uncommon factor.

2) Emphasis of the uncommon factor is accomplished by subtracting the common factor.

c. The relationship of the subtractive process and simultaneous contrast:

1) The common factor of figure and ground is subtracted, emphasizing the uncommon factor.

2) Through simultaneous contrast the dimensions of the ground color emphasize the complementary factors of the figure color.

2. Discuss the relationship of figure to ground via:

a. Size: Value, temperature, and/or intensity contrast.

b. Advancing and receding movement: hue temperature.

3. Application of Exercise #3.

a. Change hue, value, intensity, size, temperature, and movement without physical change; change the environment only!

Exercise Four Assignment (Instructor's Outline)

A. The Subtraction (Absorption) of Color.

1. This exercise is a demonstration of how colors affect each other.

2. Two hues can be made to appear as one hue by changing the environmental hue.

a. Two different hues are chosen for the FIGURE HUES, and two different background hues for the GROUND HUES.

1) All colors will come from within 1/3 of the color circle.

3. This exercise will attempt to demonstrate how close two different figure hues can be moved.

a. Choose two different figure hues and put them on two different ground hues.

b. The ground hue(s) will cause the figure hues to take on a specific characteristic appearance which will be changed or be made to take on the characteristics of the opposite ground hue.

4. Criteria and analysis as related to the number of color choices or possibilities.

a. Choose two colors (hue, value, intensity) for the figure color:

1) Make a comparison with the subtractive process utilizing one figure color as in Exercise #3.

2) Determine the characteristics of both figure hues.

3) Discuss the method used in causing the figure hues to come more closely together; the subtraction of some hue from the figure color by the ground color.

4) Check your choice of figure colors after the final analysis has been determined by reversing the figure colors and placing them on the ground colors.

5. Demonstrate from which families both figure and ground color will come.

   a. Begin by staying within 1/3 of the entire color circle.

   b. Figure colors may be chosen from those color families one color family to the right and left of the center of the 1/3 color circle segment.

   c. If a choice is attempted outside the 1/3 color segment, the ground colors approach a complementary relationship making the choice of the figure colors more difficult.

6. Explain the relationship of this exercise to Exercise #3.

   a. In Exercise #3 an attempt to subtract some of the ground color from the figure color was made in order to make the figure color appear more like the opposite ground color.

   b. In this exercise an attempt will be made to subtract some of the ground color from the figure color to make two different figure colors appear more alike.

   c. It will be more difficult to make the figure colors appear more alike than it was to make them more dissimilar because any contrast in the characteristics of a color will be noted.

7. Application of criteria and analysis to exericse.

a. Attempt to move the figure colors (visually) toward the central position or toward a common direction on the color circle.

b. Describe the setting up of the exercise.

1) Establish (physical) figure colors, plus all tints and shades.

2) Use the color circle to assist in determining how the figure colors may be moved from their original positions toward each other.

3) Choose two ground colors, plus all tints and shades.

4) Demonstrate how to set up the color papers to check color activity.

5) Emphasize that the figure colors should be as close together (appear the same) as possible.

Exercise Four: The Relativity of Color (Part II) (Student Handout)

Exercise Objectives. This exercise, the second in this series, has been specifically designed to provide the student with a knowledge and understanding of how one color affects another. Upon completion of this exercise the student will be capable of identifying, distinguishing, relating, discriminating, categorizing, and describing how two figure colors are independently, yet relatedly, affected by individual background colors so that each figure color appears to be changed in the dimensions of hue, value, and intensity, from its original state toward a common color.

Discussion. It is imperative to remember that an attempt should be made to move each figure color as far to the right or to the left of its original position as possible, toward a common color, using one different ground color for each figure color, and the visual effect of

simultaneous contrast. Note: the primary reason for a two-sided study is only to provide a visual comparison. It should not be assumed that more than two colors is ever needed to create visual color change.

Select two colors, together with all of the tints and shades, that will act as the ground colors. Determine the limits of those choices for ground colors by using only one-third of the color circle. The major factor to consider in this choice is that the ground colors will establish the limits of possibilities for the figure colors. Now, begin choosing the correct figure colors. Determine the center point between the two ground colors. From this point move to the right and left toward the ground color limits. What should begin to occur is that the common factor in each figure color will be subtracted by its respective ground color so that each figure color will begin to take on more of the appearance of a single color. Now, cut two small rectangles from each element of both figure color families. These color chips will be placed directly on each element of the respective ground color family in order to determine which figure-ground combination creates the greatest activity.

According to the diagram below, neatly stack one ground color family on a flat and well lighted surface, and place the other ground color family immediately adjacent so that both stacks touch along a common long side. Remember, there is the possibility of using any one of eight color families; therefore, it is imperative that a systematic evaluation procedure be established. By allowing one stack of ground colors to act as a constant, i.e., not changing, use one ground color

as a comparison to the other stack of ground colors. The second stack of ground colors may be systematically changed and the effects compared to the figure color chips that are resting on the face of both ground color stacks. This procedure of trial-and-error comparisons should be continued until the best possible color combination is reached; only then should the exercise be assembled. Note: it is advisable to make written notes of all figure-ground combinations that appear satisfactory as the comparisons are made, then satisfactory combinations may be re-evaluated and accepted or rejected until the final selection is made.

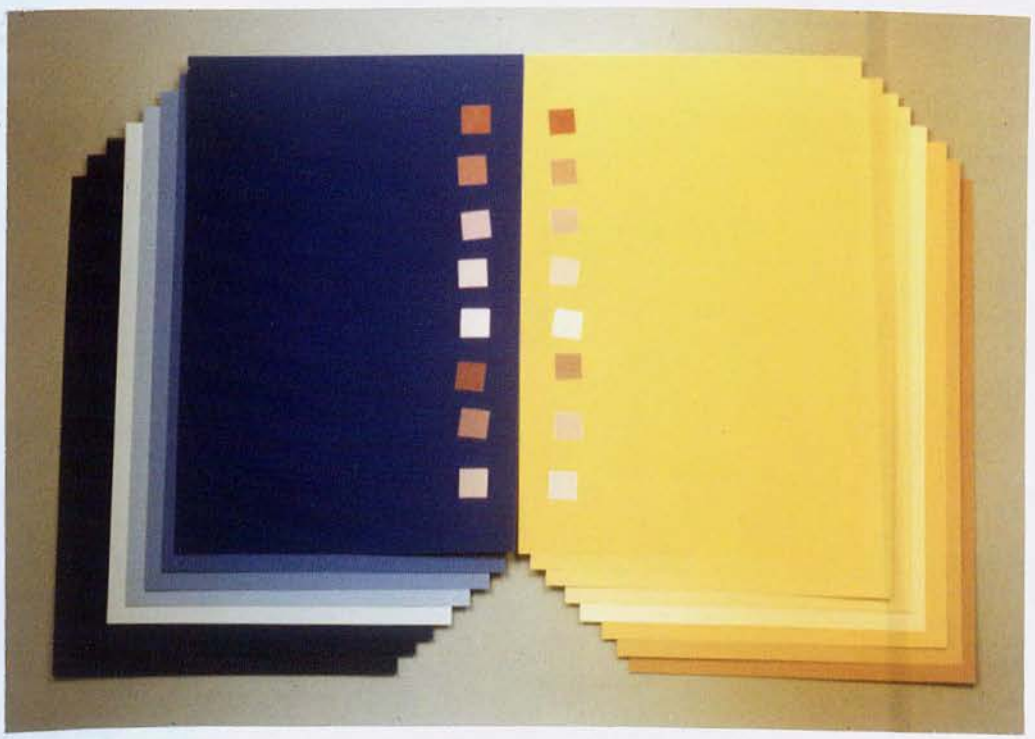

Plate V. Color Interaction Evaluation (Exercise #4)

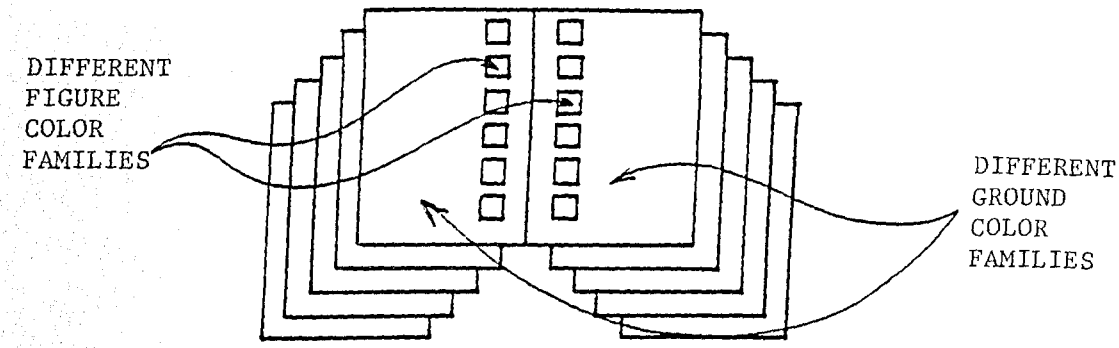

Figure 14. Color Interaction Evaluation (Exercise #4)

Required Reading. Itten, pp. 52-54, 64-65; Albers, pp. 20-21; Harlan, pp. 99-100, 105-106.

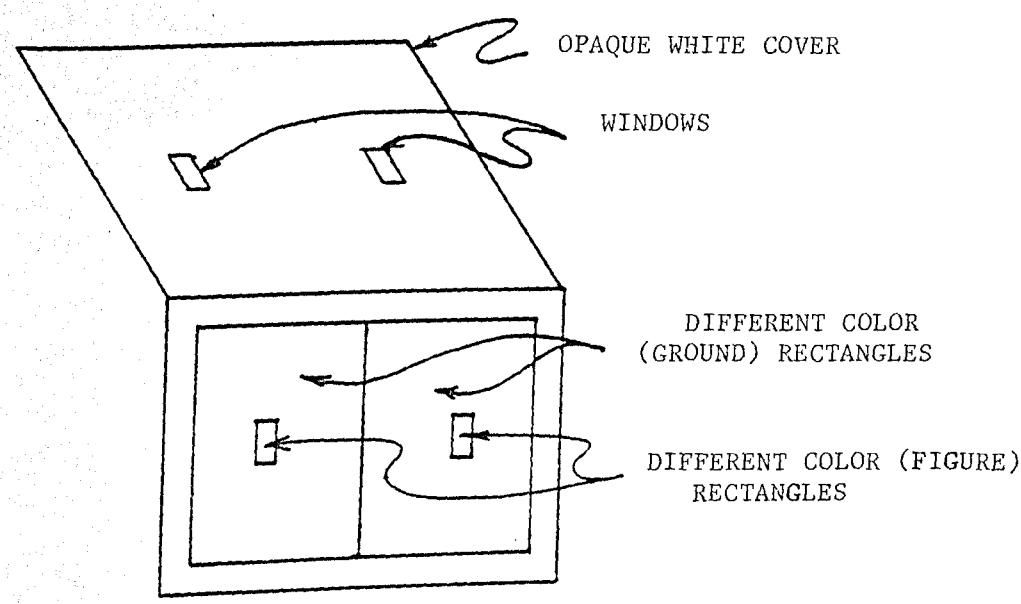

Figure 15. Practical Exercise #4 Construction Design

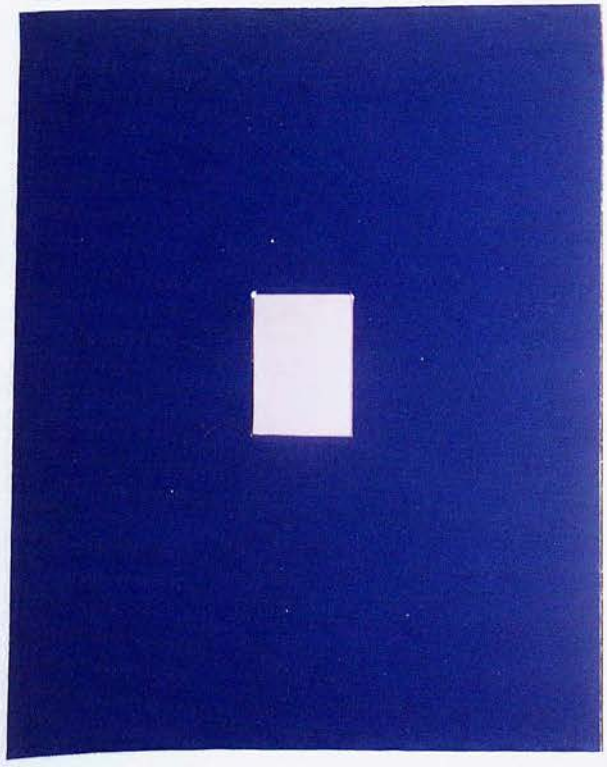

Plate VI. Exercise #4 Completed Project

Practical Exercise

1. Cut one piece of gray mounting board to 6½" x 8".

2. Cut one 3" x 4" rectangle from each ground color.

3. Cut two (oversized) 3/4" x 1" rectangles from each figure color.

4. Placing the ground color rectangles color-side down, tape each figure color rectangle (face down) on the center of the back of the respective ground color, measure and mark a vertical 1/2" x 3/4" rectangle across the figure color rectangle.

5. Cut through both the figure and ground colors from the back, along the 1/2" x 3/4" marks, being careful to cleanly cut the corners as well as the sides of the small rectangles.

6. Upon completion of the (inlay) cutting, turn the ground color rectangles over and remove the small ground color rectangles to expose each small figure color rectangle. Tape the figure colors into place from the back.

7. Repeat Steps 4-6 for the second figure-ground color combinations.

8. Attach both ground color rectangles immediately adjacent to each other according to the diagram above.

9. In the opaque white paper cover to be placed over the exercise, cut one 1/4" x 1/2" rectangular window corresponding to each figure color rectangle underneath. Note: this will allow for viewing the figure color without the influence of the ground colors. Place "Exercise #4", your name, and a diagram, listing the number and location of colors used in completion of the exercise on the back. On the cover indicate the type of illumination used.

Evaluation. Assignment = 80% (Hue = 50%, Value = 10%, Intensity = 20%); Craftsmanship = 20%.

Exercise Four Critique (Instructor's Outline)

A. Exercise Objective:

1. To take two figure colors and by changing the ground colors that they are on, attempt to change one or all dimensions of the figure colors, making the two figure colors appear as the same color.

    a. This exercise is an extension of Exercise #3; extending the discovery of how colors interact.

    b. This exercise helps to relate concepts learned in Exercises #1, 2, and 3.

2. To physically adjust two ground colors, forcing a visual adjustment in the related figure colors, bringing them into a visual relationship on all dimensions.

    a. Colors will interact differently, i.e., appear visually changed, as the color relationships are changed.

3. To demonstrate that the entire concept of color interaction is built on simultaneous contrast.

    a. This contrast emphasizes the fact that there is no such thing as physical color as we know it.

        1) Hue: the effects of simultaneous contrast.

2) Value (physical): more or less light energy reflected; Value (physiological): the contrast of light and dark established in the rods (and cones) on the retina.

a) Size changes are due to value and/or intensity.

3) Intensity: when both colors are of equal intensity, value comparisons become the major consideration.

a) Analogous: no vibration; one sees the intensities as independent.

b) Contrast of Extension: more of one color will increase the intensity.

b. One must relate value and hue to intensity.

1) One needs to know the three dimensions of each color pair in comparison.

2) The smaller of the two color areas will react with greater volatility.

B. The exercise.

1. Attempt to understand what happens to a particular color (hue, value, intensity) as the ground or environmental color is adjusted.

a. Explain simultaneous contrast.

b. Determine what subtractive adjustment is necessary in one figure color using the ground color to cause the figure color to become visually equal to a second figure color.

1) Adjustment of the ground color is just as important as the adjustment of the figure color and may cause a visual change in the figure color.

c. Determine the common denominator between the two ground and the two figure colors.

1) Hue contrast is determined by causing a larger color area (the ground) to interact with the smaller color area (the figure) causing an emphasis or contrast of anything <u>not</u> common to the ground color.

a) Each figure color has its own common denominator (color relationship) with the ground color on which it rests.

b) Each figure color has a hue factor in common with the other figure color.

c) Identical visual appearance of figure colors to each other is caused by the subtraction of the "common" factor between each figure color and its respective ground.

2) Intensity contrast is determined by causing the quality of the intensity of one (ground) color to emphasize the opposite quality of another (figure) color.

3) Value contrast is determined by causing the light-dark characteristic of one (ground) color to emphasize the opposite characteristic in another (figure) color.

2. Discuss the relationship of figure to ground.

3. Application of Exercise #4.

a. Change, hue, value, intensity, size, temperature, and movement, without physical change; change the environment only!

Exercise Five Assignment (Instructor's Outline)

A. The Illusion of Transparence

1. This exercise will begin the development of the manipulation of color illusions beyond the basic changes of hue, value and intensity.

a. This exercise is the first in a two-part series of exercises on transparent color illusion.

b. This exercise uses color principles or concepts to create illusions.

2. Development of an illusion of transparency using opaque colors.

a. Discuss characteristic differences in the way the light source effects what is seen as transparent.

1) Two opaque surfaces (directly related to this exercise): color reflection; a visual illusion.

2) One opaque and one transparent surface: physical transparence.

3) Two transparent surfaces: physical transparence.

b. Compare the three dimensions of both of the opaque colors used in the visual illusion.

1) Define PARENT and DESCENDANT colors.

a) The PARENT color is that color or those colors from which the descendant color appears to derive its characteristics.

b) The DESCENDANT color is that resultant color created by a mixture of two parent colors.

2) Illustrate the illusion of transparence by overlapping (and inlaying) two opaque colors.

c. Develop an understanding of the DESCENDANT color.

1) DESCENDANT color dimensions (characteristics) must be between the dimensions of both PARENT colors.

a) The color papers are based on a hue-value scale which is two-dimensional, excluding intensity; therefore, the color-scale should not be used mathematically to determine parent-descendent pairings.

b) Descendant colors should be determined visually; subjectively, not objectively.

c) Complementary pairings may not be possible with color papers because of hue-value limitations.

d. Physically demonstrate the establishment of the PARENT-DESCENDANT color test using three opaque color papers.

1) It is not necessary to be concerned with which parent color appears to be above or below the other parent color in creating the descendant color.

2) Provide a demonstration and explanation of the physical cutting and inlaying of three opaque colors to create the illusion of transparence.

B. Exhibit original and/or color slide examples of a completed exercise.

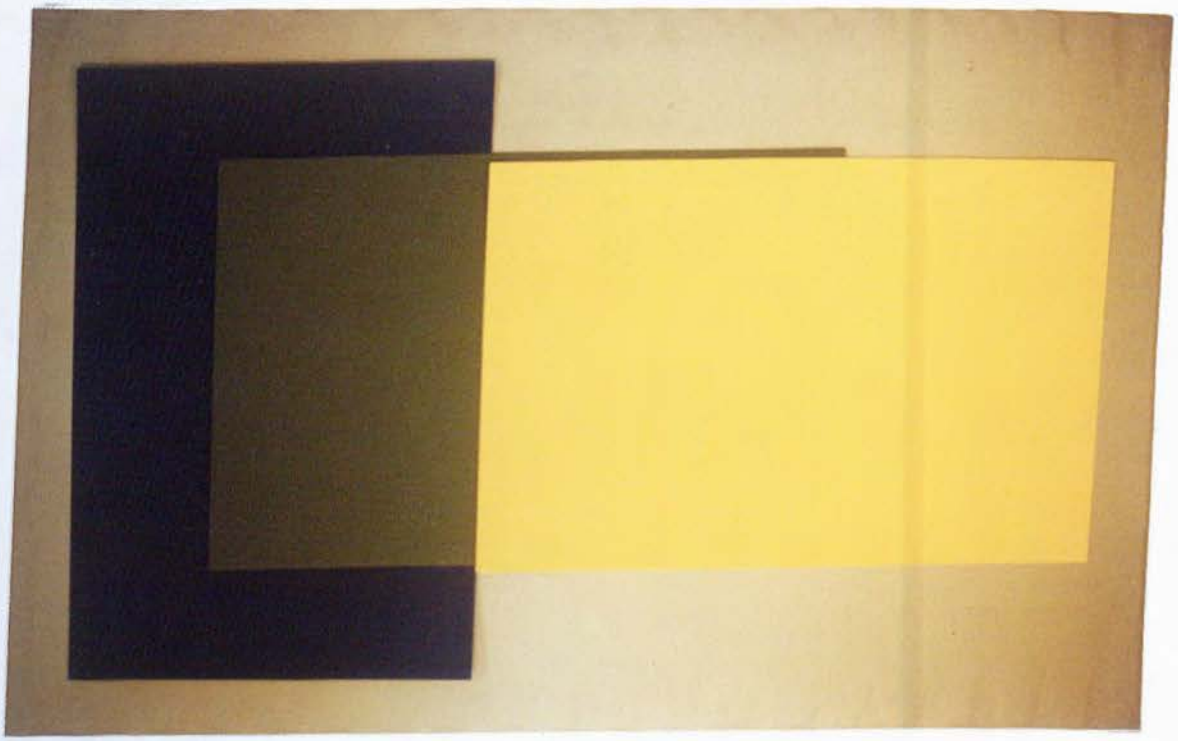

Plate VII. Transparent Illusion Evaluation (Exercise #5)

Plate VIII. Exercise #5 Completed Project

Exercise Five: The Illusion of Transparence (Student Handout)

Exercise Objectives. This exercise has been specifically designed to assist the student in gaining a knowledge and understanding of how two parent colors may be physically mixed together to create a third descendant color, and how that descendant color may cause either parent color to appear transparent. By developing an understanding of the relationship of each dimensions of color exhibited by the parent color, the student will develop the ability to create the illusion of transparence by utilizing the concepts of color interaction and overlapping planes.

Discussion. In beginning this exercise on the illusion of color transparence, it is initially important that a complete understanding of the relationship of the color dimension between parent colors is made. A study of this relationship should be made with each set of parent colors by comparing each dimension (hue, value, intensity) to determine the characteristic of the color dimensions of the descendant color. To establish a procedure for testing the relationship of various parent color pairings, use the graphic example below. At this time it is not necessary to be concerned with the quality of the descendant color dimension other than that it exhibits some characteristic relationship between parent color.

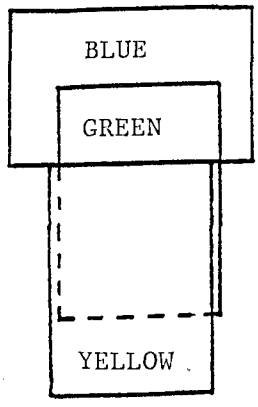

Figure 16. Transparent Illusion Evaluation

In determining the descendant color from two parent colors, first choose two colors that will act as "parents" (BLUE and YELLOW). Align the two parent colors so that one is horizontal (BLUE) and the second (YELLOW) is placed vertically, adjacent to and centered on the bottom edge of the top parent color. Now, determine the relationship of the characteristic dimensions of the parent colors and choose a descendant color. Place the descendant color (GREEN) underneath the vertical parent color (YELLOW) so that it sticks out above this parent color and overlaps the top parent color (BLUE). The illusion that is created by establishing this visual test should produce an appearance that allows either parent color to become transparent when it overlaps the other parent color. If the color relationships are correct and strong enough, the realization that three opaque colors are used should

disappear.

Required Reading. Itten, pp. 19-22, 29-31, 64-65; Albers, pp. 24-26; Birren, p. 55.

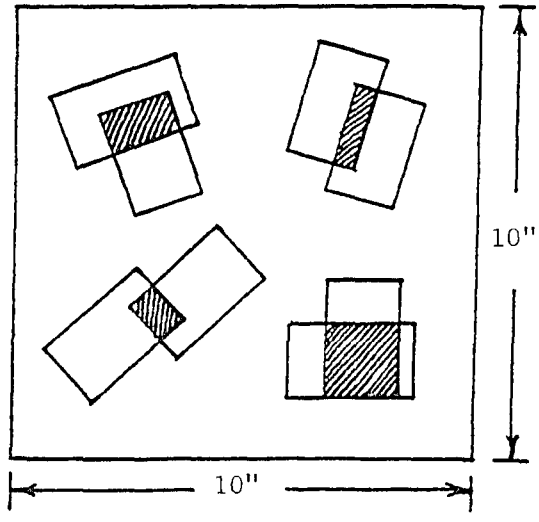

Figure 17. Practical Exercise #5 Construction Diagram

Practical Exercise

1. Select at least four (4) combinations of parent-descendant color relationships.

2. Arrange, cut, and inlay, in any configuration, each combination of parent-descendant colors so that two (2) 2" x 3" rectangles exhibiting the illusion of overlapping and transparence will be created. (The area of overlap will also exhibit the illusion of transparence).

3. Cut one (1) piece of gray mounting board to 10" x 10".

4. Arrange and rubber cement the four parent-descendant color combinations, in any configuration, to the gray mounting board.

5. Cover the entire exercise with an opaque white cover sheet. Place your name and the exercise number in the lower left hand corner of the back, and note the type of illumination used in constructing the exercise in the lower left hand corner of the cover sheet.

Evaluation. Assignment = 70%; Craftsmanship = 30%.

Exercise Five Critique (Instructor's Outline)

A. Exercise objectives.

1. To use three opaque color surfaces to create the visual illusion of transparence.

2. To understand that the visual illusion of transparence using opaque colors is a special case of transparence.

   a. The perception of which parent color is seen as above or below is not important for this exercise.

   b. All three dimensions of both parent colors must be taken into consideration when choosing the descendant color.

      1) The descendant color must be an average or a combination of the dimensions of the two parents.

      2) Discuss parent-descendant relationships of hue, value, and intensity.

      3) Discuss why special cases of hue combinations cannot be created by using the color papers.

         a) Two secondary colors can be physically mixed to create an unintense color within a primary family, but that unintense primary descendant will not be available within the materials for this class.

         b) The color pack will not allow a full extent of complementary mixing.

         c) The student can determine the make-up of the descendant hue by analyzing the primary hue make-up of each parent.

3. Reiterate the lighting-surface relationships or conditions of transparence as illusion vs fact.

   a. Two opaque surfaces creating an illusion.

   b. One opaque and one transparent surface creating a reality.

   c. Two transparent surfaces creating a reality.

B. Verbal group critique of the exercise.

Mid-Course Examination (Appendix C)

The objective of the examination is to provide an additional means of evaluating the individual student's cognitive abilities, beyond evaluating the caliber of cognitive involvement with the practical exercises. Questions for the mid-course written examination are derived from out-of-class readings, lectures, demonstrations, and practical color exercises. The examination includes objective elements in the form of matching and sentence completion questions, as well as subjective or essay-type questions. Appendix C (pp.209-215) provides a sample of the mid-course written examination and an answer key.

Exercise Six Assignment (Instructor's Outline)

A. Transparence and Space Illusion.

1. This is the second in a series of two practical exercises demonstrating the illusion that light rays of one color plane are transmitted through and combined with light rays of a second color plane creating a color common to the characteristics of both color planes.

2. The objective of this exercise is to demonstrate the creation of a dimension of space between colors exhibiting characteristic transparence.

a. Space is created by simple overlapping.

b. Space is also created through an illusion of transparence.

1) The relationships of hue, value and intensity between two opaque parent colors must cause the descendant color dimensions to be placed between the two parent colors.

2) To create the illusion of space using transparent colors the descendant color must exhibit more of the characteristics of one parent than of the other parent.

B. The exercise.

1. Begin with three opaque parent colors and arrange their descendants in such a manner as to cause each parent color to be perceived as lying on a separate plane.

   a. With the interaction of two parents creating a descendant, one parent must dominate.

   b. One parent and the descendant from the other two parents are responsible for the creation of a descendant made up of a combination of three colors.

2. Exhibit original and/or color slide examples of completed exercises.

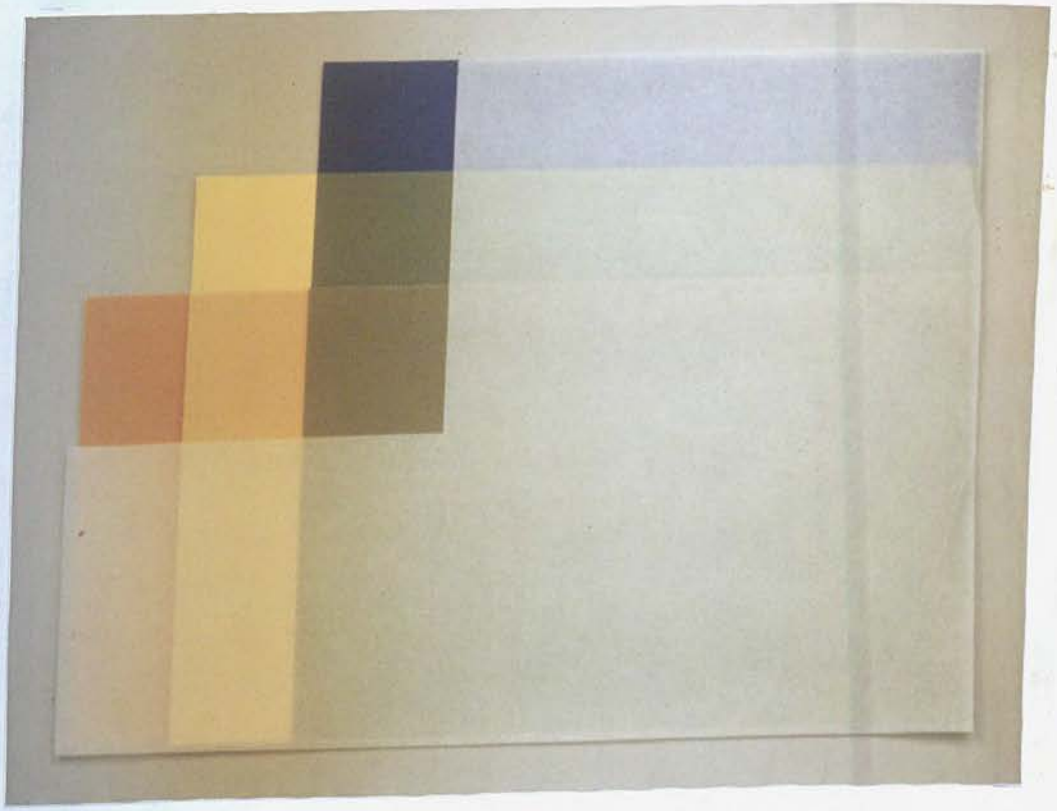

Plate IX. Transparent Illusion Evaluation (Exercise #6)

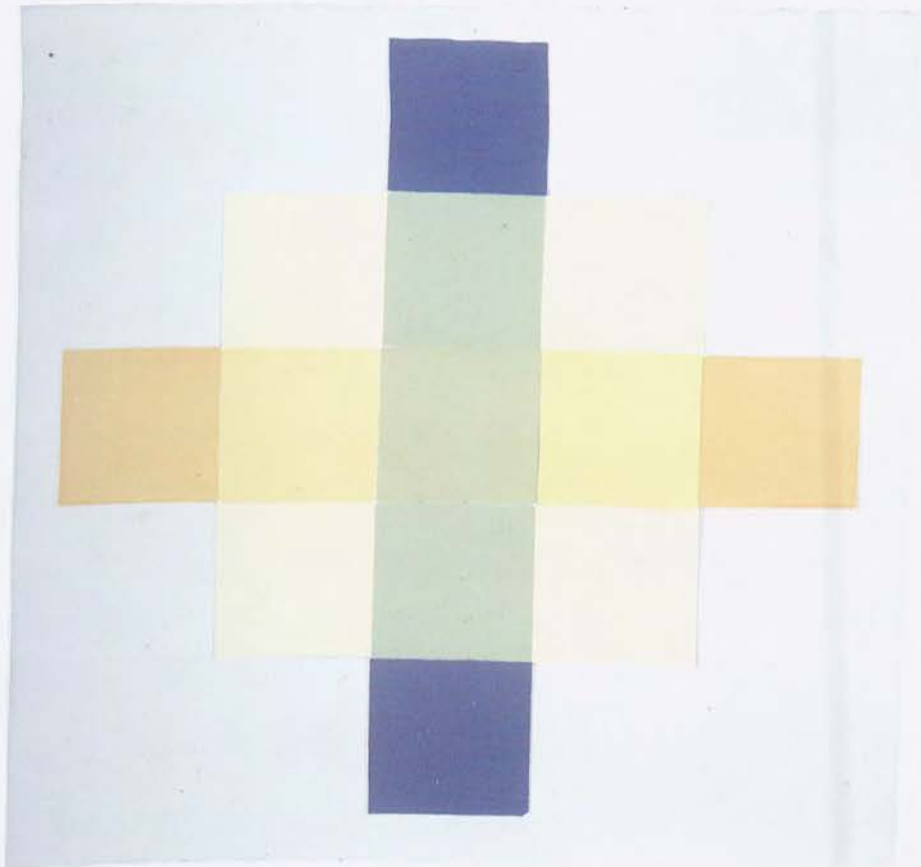

Plate X. Exercise #6 Completed Project

Exercise Six: Transparence and Space Illusion (Student Handout)

Exercise Objectives. This exercise has been specifically designed to assist the student in expanding the knowledge and understanding gained in the previous exercise on transparence by developing a secondary illusion of spatial placement. By concentrating on the spatial illusion, the student will gain the ability to analyze the interaction of the three dimensions of two or three colors, producing an appearance of three layers of color.

Discussion. In beginning this exercise it is important to remember that when using opaque papers to create the illusion of trans-

parence, several factors should be considered. First, the descendant color may be neither lighter nor darker in value, nor more or less intense than either one of the parent hues. Second, predominance of one parent color in the descendant is directly dependent on the proportion in which the parent colors are mixed. Third, only when one color appears to hover above another is the illusion of SPACE produced. When developing the illusion of transparence for those areas involving only two colors, the main thing to remember is that one parent must dominate. When developing the illusion of transparence for that section involving the interaction of three colors, the center position for this project, it is imperative to remember that the color interaction is produced by one parent and one descendant color.

Required Reading. Itten, pp. 19-22, 29-31, 64-65; Albers, pp. 24-26; Birren, p. 55 (Color Perception in Art).

Graphic Example. The space illusion should appear to move toward or away from the viewer, using one base color and two color overlays. A variety of six separate colors will be needed to complete the exercise.

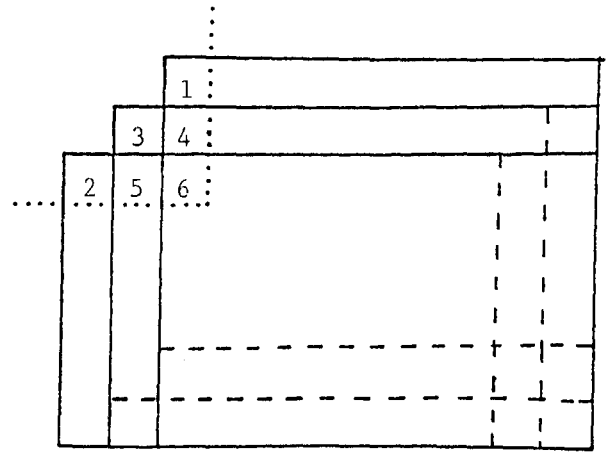

Figure 18.
Transparent Illusion Evaluation

1) Select three parent colors. Each of these should differ in all three color dimensions to give as much color variation as possible. These three parent colors will be placed in the sections marked 1, 2, and 3, on the diagram above.

2) Determine two parent-descendant combinations. Parents 1 and 3 will create the descendant for placement in position 4. Parents 2 and 3 will create 5.

3) To determine the color quality for position 6, use one parent and one descendant combination, e.g., 2 and 4 create 6, or 1 and 5 create 6.

Practical Exercise. Number symbols have been used in the diagram below (and in the Graphic Example) only to designate placement and should not be considered as mathematical in nature.

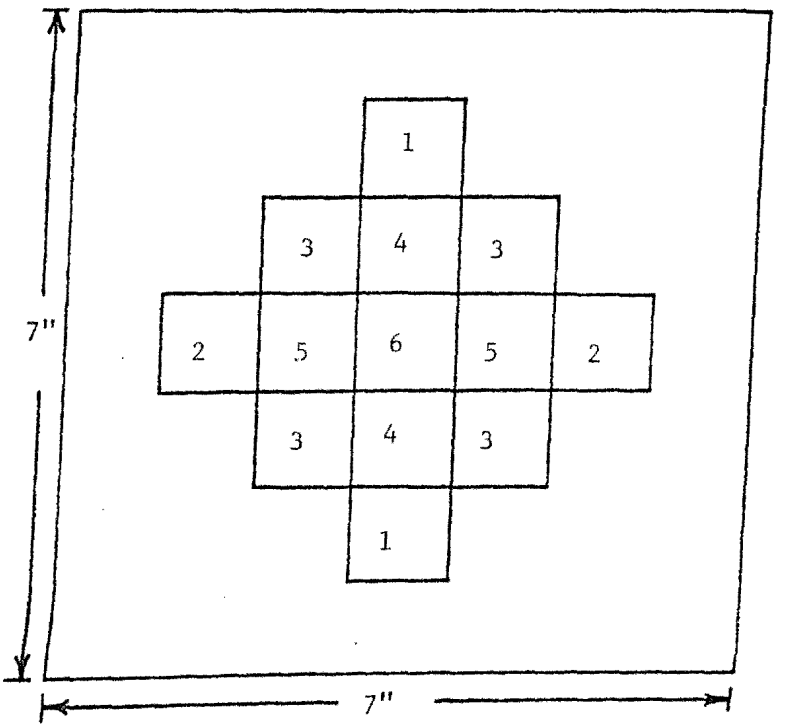

Figure 19. Practical Exercise #6 Construction Diagram

1. Cut one piece of gray mounting board to 7" x 7".

2. Once the color combinations have been determined, cut each color into 1" squares and glue them adjacent to each other in the numbered positions that correspond to their order of descent.

3. Cover the entire exercise with an opaque white cover sheet. Place your name and the exercise number in the lower left hand corner of the back, and note the type of illumination used in the construction of the exercise on the lower left hand corner of the cover sheet. Note the order of descent on the cover sheet.

Evaluation. Assignment = 80%; Craftsmanship = 20%.

Exercise Six Critique (Instructor's Outline)

A. Exercise objectives:

1. To consider independently and collectively the characteristics or properties of hue, value, and intensity of each opaque parent color to create the descendant color characteristic.

a. The illusion of transparence is created by the common characteristics of the two parent colors.

2. To establish a dominant parent color to demonstrate a spatial characteristic.

a. The color dimensions of the descendant must be more closely related to one parent color than to the other parent color.

b. The value of the dominant parent will be the most noticeable dimension in relating the descendant to the dominant parent.

c. The descendant color will determine the spatial placement of the two parent colors.

3. To evaluate both parent-parent-descendant pairings and then the parent-descendant-descendant relationship to determine which opaque parent color lies on which of three planes.

B. Verbal group critique of the exericse.

Exercise Seven Assignment (Instructor's Outline)

A. Color Interval and Transformation.

1. Define INTERVAL and TRANSFORMATION.

a. The establishment of two levels of value = the interval.

1) The interval is that common value distance at which colors within one family relate to colors within another family.

2) Every color family utilized for this exercise will be represented at both the high and the low values.

b. Within the same family, colors may tend to loose their hue characteristic because the value and intensity have been varied.

1) Value changes always cause the intensity to decrease.

2) Intensity changes will cause the value to change either up or down except when complementaries of equal value or a color and an achromatic gray of the same value are combined.

c. The characteristic changes that occur in the hue and the intensity of related color families established by the value interval = the transformation.

2. The exercise.

a. Choose four color families, beginning with a tetradic scheme and moving toward color families that will allow for high and low values to be related.

1) Do not be concerned with intensities in construction of the exercise as the color package is established on a hue-value basis.

2) Align the chosen color family choices along two value levels so that they appear to have the same value across high and low value levels.

3) Both high and low values must be from the same color family.

b. Complementary colors should not be juxtaposed as they may create visual movements that will cause a lessening of the effects of the transformation.

B. Exhibit original and/or color slide examples of a completed exercise.

Exercise Seven: Color Interval and Transformation
(Student Handout)

Exercise Objectives. This exercise has been specifically designed to assist the student in expanding the knowledge and understanding gained in the previous exercises, developing comprehension of the relationship between a constant color dimension and two variable color dimensions. By allowing the dimension of value to act as the constant on two levels, and hue and intensity to act as the variables, the student will construct a model and demonstrate the changes in hue-intensity characteristics as the value is held constant on the high and low levels.

Discussion. This exercise is not meant to present a pleasing appearance, but should be approached as a study aiming at the distinct understanding of PARALLEL INTERVALS. In beginning this exercise it is important to understand that the dimension of value will be established as a constant on two levels, high (light) and low (dark), and that a tetradic color scheme will be used as a starting point in the establishment of hue. Each hue, regardless of its intensity, will be used at both value levels, so it is important to choose hues that will relate to each other at both value levels. Choosing four hues that relate at two different value levels demonstrates what happens to the characteristics of hue and intensity when a color moves from one value to another. Because of the difference between colors, known as the interval, various dissimilar and sometimes significant changes occur, known as the transformation, when colors are changed along one or two of their dimensions.

Required Reading. Itten, pp. 79-82; Harlan, pp. 97-99, 100-103, 109-110.

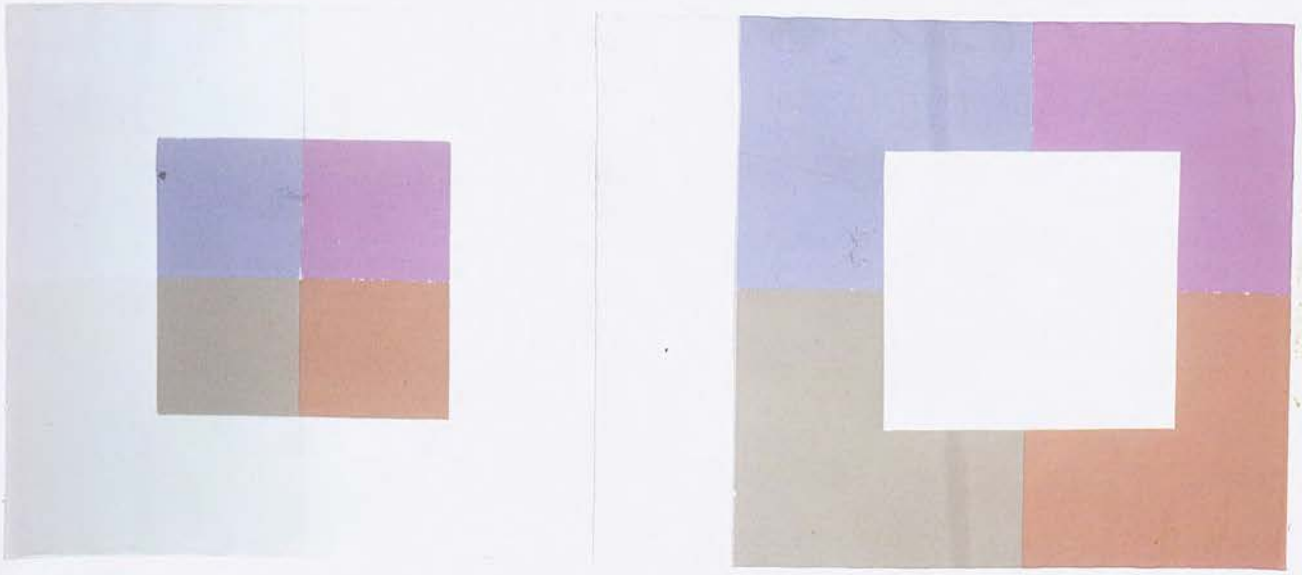

Plate XI. Exercise #7 Completed Project

Practical Exercise

1. Choose a tetradic color scheme in which all light value colors are the same value, and all dark value colors are also equal in value.

2. Once the selection process is complete, cut a 2" x 2" square of each color. You should have eight squares, one of each light value and one of each dark value for each hue.

3. Tape the light value squares together along the back so that they form a 4" x 4" square with a different color in each quadrant. Repeat the process for the dark value colors. Make sure that the color squares coincide across both value models.

4. Either on the front or back of one of the models, place a dot in the center of each hue quadrant. Connect the dots so that they form a 2" x 2" square with the central axis coinciding with the 4" x 4" square.

5. Place the "marked" four-hue square on top of the unmarked four-hue square. Make sure that the light and dark value of each hue coincides between the two squares.

6. Carefully cut through both four-hue squares at the same time, along the line designating the 2" x 2" square.

7. Transpose and tape in place the inner 2" x 2" square from each larger square so that one PROOF exhibits a light value center with a dark value frame, and the other proof is a dark value center with a light value frame.

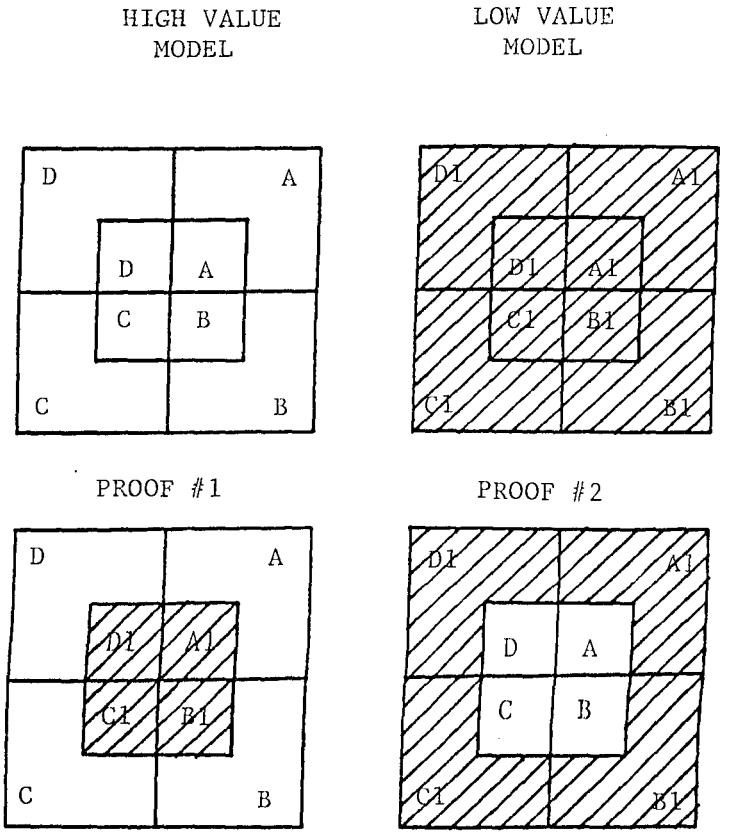

Figure 20. Practical Exercise #7 Construction Diagram

Proof. The only way in which the two groups can be compared easily and accurately is to superimpose one group on the other.

Evaluation. Assignment = 70%; Craftsmanship = 30%.

Exercise Seven Critique (Instructor's Outline)

A. Exercise Objectives

1. To choose four different color families that will coincide on two value levels.

   a. Albers does a similar exercise using two hues across four different value levels.[88]

   b. This exercise may also be accomplished by holding the intensities of specified colors constant.

2. To determine what happens to a color if moved from its original state.

   a. The hue characteristic will tend to be maintained within a given color family when black is added to the original hue, except in those hues which include yellow, and when white is added to the original hue.

   b. The intensity characteristic will be maintained only if all hues are presented at the same purity level; the intensity characteristic changes as the value changes.

   c. As the value characteristic is maintained, hue characteristics may be changed and intensity characteristics will be changed.

   d. If the value characteristic is held constant on one or more levels, as in this exercise, a transformation in hue and intensity will occur.

3. To establish a consistency of change, the interval, between related hues and their intensities.

   a. Determine if each hue and/or each intensity changes to the same degree as it moves from one value to the other.

B. Verbal group critique of the exercise.

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[88]Albers, loc. cit, pp. 34-36.

Exercise Eight Assignment (Instructor's Outline)

A. Color Quantity and Harmony: The Contrast of Extension.

1. The objective of this exercise is to develop an understanding of how the amount of color used in a composition exhibits a visual (psychological) aesthetic balance.

a. Balance can be either symmetrical and/or asymmetrical.

1) Symmetrical: comparative color quantities used are in accordance with the objective (mathematical) formula for physical balance.

2) Asymmetrical: comparative color quantities used are based on the aesthetic or intuitive judgment of the individual.

2. The objective formula is based on empirical studies which assign a given area (quantity) to each pairing of complementary colors.

a. The assigned area is based on the aesthetic (psychological) factors affecting the color combination: hue (temperature), value (weight, spreading), and intensity.

b. Every color naturally exhibits a given space, based on its dimensions, in relation to colors in its environment.

c. In order to bring any complementary pairing into balance, it is necessary to adjust their respective amounts.

d. The complementary pairing ratio equals the quantity of each pair needed to achieve visual (symmetrical) balance:

1) 1/4 yellow : 3/4 violet

2) 1/3 orange : 2/3 blue

3) 1/2 red : 1/2 green

3. The Exercise.

a. The choice of complementary pairings at their fullest intensity allows for the simplest approach to the exercise, a hue-value comparison, without

becoming involved in how a change in the intensity will cause a change in the color quantity.

b. A common ratio will be established by using six full intensity (primary and secondary) colors of different comparative ratios.

c. One must establish visual ratios, then establish a common denominator, multiply the ratio by 1/3, and eliminate the denominator to establish full intensity amounts for each color to be used in the thirty-six squares of this exercise.

	Red	Orange	Yellow	Green	Blue	Violet
1)	1/2	1/3	1/4	1/2	2/3	3/4
2)	6/12	4/12	3/12	6/12	8/12	9/12
3)	6/36	4/36	3/36	6/36	8/36	9/36
4)	6	4	3	6	8	9

d. By dividing a square into 36 equal parts and using the given proportions of each color, a random arrangement will establish a symmetrical design.

e. Create an asymmetrical balanced design by using all six original full intensity colors so that their individual and/or related quantities are <u>not</u> symmetrically balanced.

f. Make a comparison of a symmetrical and an asymmetrical color-balanced design to see what kind of interest is created by each design.

1) Become aware that interesting color designs can be created by either a symmetrical or an asymmetrical color design.

B. Exhibit original and/or color slide examples of a completed exercise.

<u>Exercise Eight: Color Quantity and Harmony</u> (Student Handout)

<u>Exercise Objectives</u>. This exercise has been specifically designed to provide the student with a knowledge and understanding of the relationship between psychological aesthetic color weights and

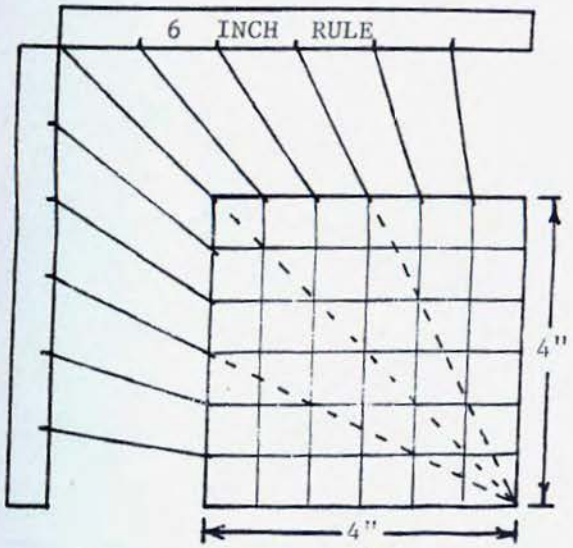
the amount of color needed to achieve color balance. Upon completion of this exercise the student will be capable of identifying, distinguishing, relating, discriminating, and describing those characteristics necessary for the development of compositions with symmetrical and asymmetrical color balance.

Discussion. Select all primary and secondary full intensity hues. In order to simplify this exercise, which by the process of hue selection can become quite complex, you will use only six colors, although any number beyond two may be used. Since the colors have in effect been preselected, you should concentrate on understanding the characteristics of the three complementary pairings. It is imperative that you develop an understanding of the spatial characteristics that each pairing exhibits so that you can completely comprehend how and/or why one color requires or demands more physical space than other colors in its environment. The most important element in determining the physical aspects of color quantity is to understand the measurement proportions of each complementary pairing. These proportions have been previously calculated and will be discussed in greater detail in class. Since absolute balance or harmony is only one type of composition, you will first produce a symmetrically balanced color design according to an objective formula, and second you will create an asymmetrically balanced color design of your own.

Required Reading. Albers, pp. 72-74; Harlan, pp. 111-112; Itten, pp. 59-63.

Graphic Example.

1. Cut one piece of gray mounting board to 6" x 11". On the board draw two 4" x 4" squares with one-inch margins at the top, bottom, and in between.



2. Divide both squares into thirty-six (36) equal squares. The method for this division is shown in the figure on the left.

Figure 21.

Measurement Diagram

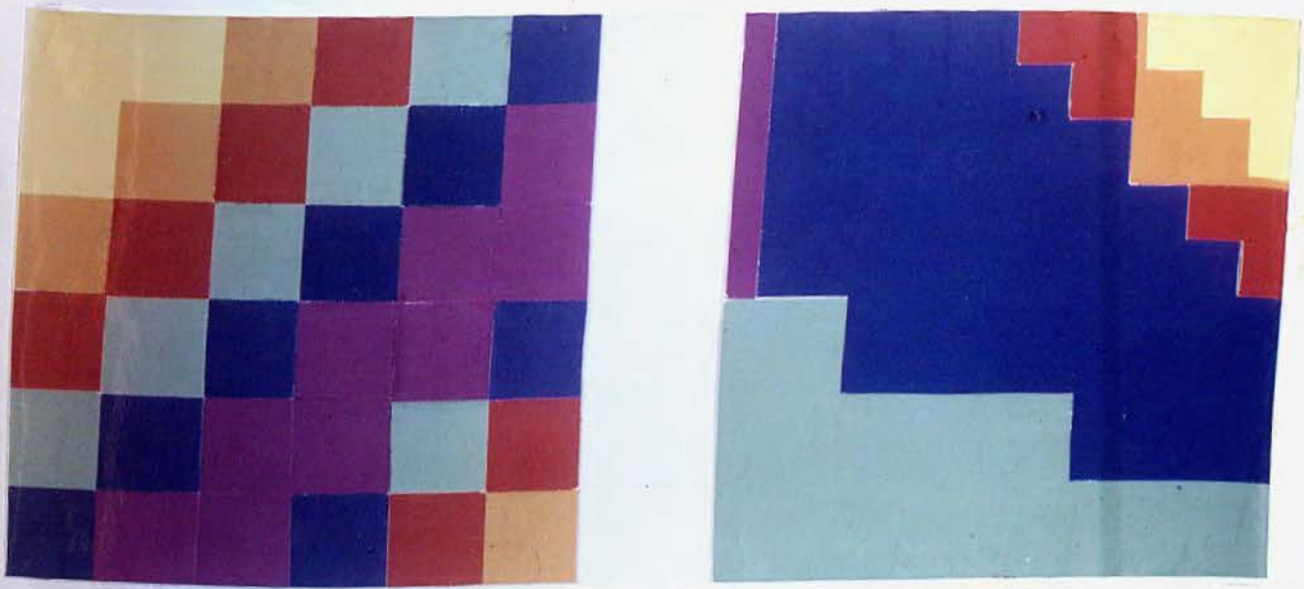


Plate XII. Exercise #8 Completed Project

Practical Exercises

1. The left square will be designated the Symmetrical and will represent the mathematically balanced portion of this exercise. In this square place the proper amount of each color, in relationship to its complement, in any configuration that you desire.

2. In the right-hand square, designated as the Asymmetrical, you will create an aesthetically balanced design using the six full intensity primary and secondary colors. This design does not need to be divided into equal parts as long as the design remains on the vertical-horizontal.

3. Cover the entire exercise with one sheet of opaque white paper. Place your name and Exercise #8 in the lower left hand corner of the back of the exercise, and the source of illumination in the lower left hand corner of the cover.

4. In addition to the exercise itself, provide at least a 300 word written statement regarding the aesthetic relationship between color designs that you attempted to create. Attach your statement to the back of the exercise with rubber cement.

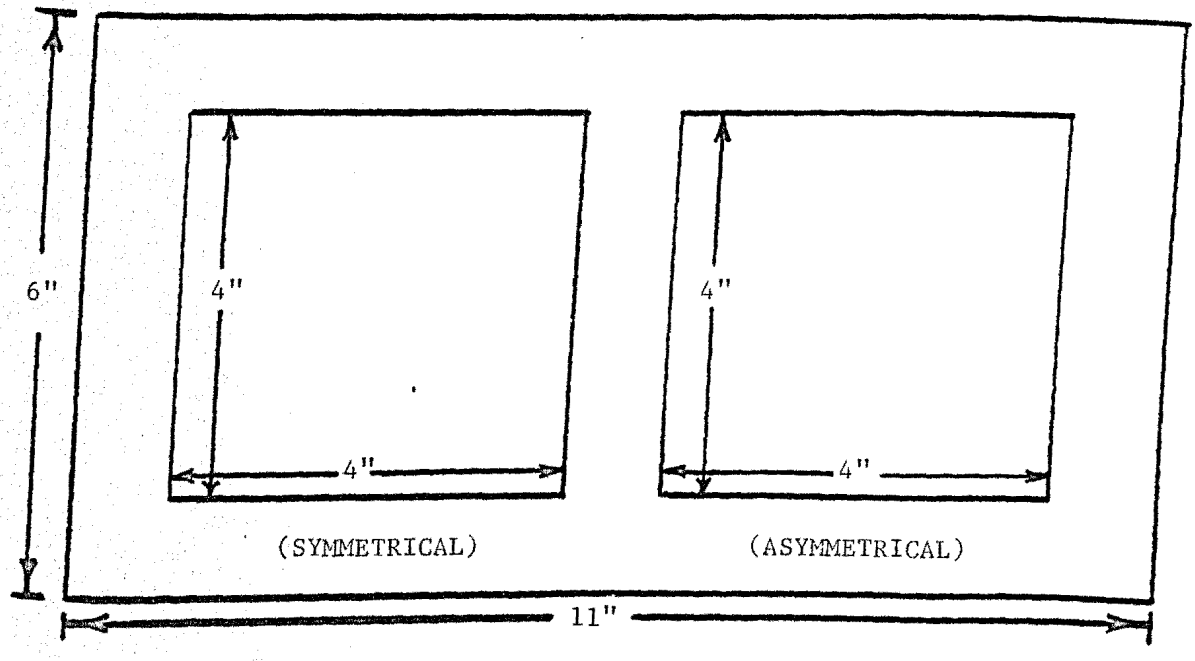


Figure 22. Practical Exercise #8 Construction Diagram

Evaluation. Assignment = 70% (Exercise = 60%, Paper = 10%); Craftsmanship = 30%.

Exercise Eight Critique (Instructor's Outline)

A. Exercise objectives.

1. To learn how to use the attributes of color to determine color quantity (area) in creating symmetrically and asymmetrically balanced color compositions.

a. Complementary colors of equal intensity will appear to balance by weight given a relationship of space that they occupy.

1) Use less of a lighter value to acquire balance due to the spreading effect.

2) Use less of a warmer hue to acquire balance due to the advancing effect.

b. Understand how symmetrically and asymmetrically balanced compositions are different.

2. To understand that area change is necessary when no other dimension can be manipulated because a given hue at a given intensity has a given value; therefore, the only way dominance can be diminished and balance restored is by changing the area.

a. The quantity (area) of a color is changed in order to control color dominance in the composition.

b. Reasons for balancing a color harmony are:

1) To create a desired psychological effect.

2) To manipulate harmonies to create compositional (aesthetic) interest.

c. Adjustments are necessary to make colors look balanced.

1) Because complementary pairings are opposite in a given hue-value relationship, the only way to relate their respective color dominance is to change their quantities.

2) Balance is psychological because of our sociocultural relationship to the attributes of individual colors.

d. If color quantity is made larger or smaller than its objective area, then it will become dominant.

1) If yellow takes up less area when related to violet than the normal ratio of 1:3, the yellow will appear more dominant.

2) Dominance is determined by the contrast of color dimensions and attributes.

B. Conduct a verbal group critique of the exercise.

Exercise Nine Assignment (Instructor's Outline)

A. Color Relativity: Spatial Balance.

1. The exercise objective is to relate the information gained in Exercise #8 to color balance (contrast of extension), creating a composition in which no color is dominant.

2. The practical exercise.

a. Any number of colors may be used, but no fewer than four.

b. Any relationship of colors may be used as a repetitive or non-repetitive pattern.

c. Any amount of a color may be used, but must be interrelated to all other colors.

d. Any color may dominate in any portion of the composition but must be balanced elsewhere in the composition by other color attributes.

e. Color quantities should be developed intuitively; color quantities produced by using objective measurements may stifle creativity.

f. Achromatics may not be used.

g. The dimensions of each color must be related, i.e., the interactions of colors must be considered.

1) Hue: temperature/space (advancing, receding).

2) Value: size (spreading effect), weight.

3) Intensity: spatial movement.

B. Exhibit Original and/or color slide examples of a completed exercise.

Exercise Nine: Color Relativity (Spatial Balance) (Student Handout)

Exercise Objectives. This exercise has been specifically designed to allow the student to continue to explore the concepts of the relatedness and/or interactions of colors. Upon completion of this exercise, the student will be capable of assimilating and synthesizing all previous information learned relative to color interaction in the development of a color composition in which no one color will be dominant.

Discussion. The most important facts to remember in the development of this exercise are that this exercise will require the recall of all previous information learned in exercises one through eight. It is especially important to recall information relative to the dimensions and attributes of individual colors and their relationships. No matter how many colors are chosen for this exercise, no one color may be dominant! Balance should be evaluated on a basis of hue (temperature, space), value (size, weight), and intensity (space).

In development of this exercise a choice of at least four different colors should be made. An expansion of color choices may be made by using any number of tints and/or shades from each color family. All colors will be presented as adjacent verticle strips with no space between colors. Achromatics will not be used. The color pattern may be either repetitive or non-repetitive (random).

Required Reading. Review all readings of value and intensity; review all readings on "Contrast of Extension" (Exercise #8).

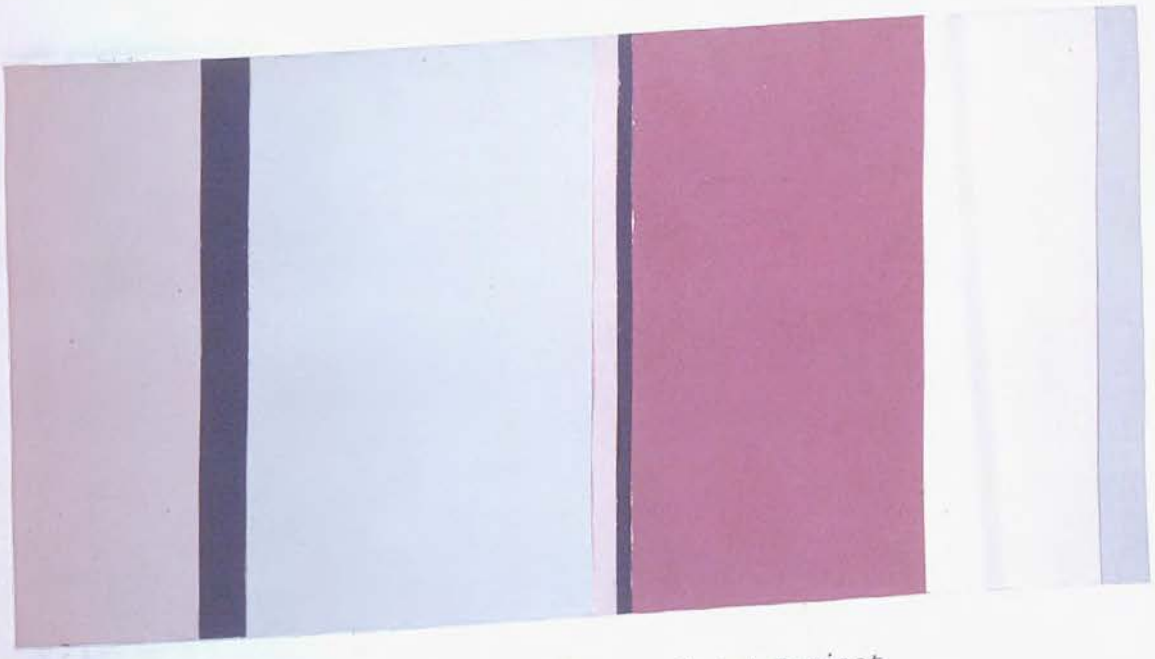


Plate XIII. Exercise #9 Completed Project

Practical Exercise.

1. Choose at least four different chromatic colors.

2. Experiment with the sequential arrangement and area of the chosen colors so that no one color is dominant.

3. When a successful sequential arrangement and area of color has been determined, vertical strips should be cut and taped together from the back or cemented directly to the mounting board.

4. Cut one piece of gray mounting board to 5" x 8".

5. On the mounting board, draw a 3" x 6" rectangle in which the color strips will be cemented. (Refer to the diagram on the next page).

6. In addition to the exercise itself, provide at least a 300 word written statement regarding the spatial balance that you attempted to create in the exercise. Attach the written statement to the back of the exercise.

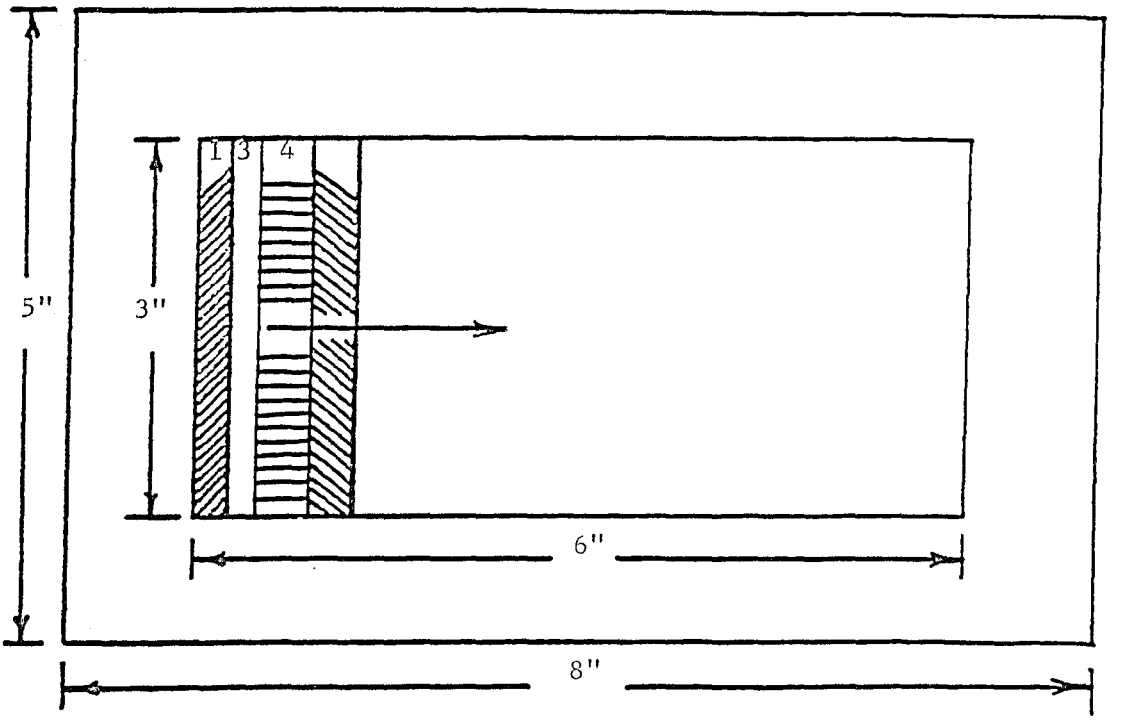


Figure 23. Practical Exercise #9 Construction Diagram

7. Cover the completed exercise with one piece of opaque white paper. In the lower left hand corner of the cover sheet note the type of illumination used in the development of the composition. In the lower left hand corner of the back of the exercise place your name and "Exercise #9".

Evaluation. Assignment = 70% (Paper = 10%, Exercise = 60%); Craftsmanship = 30%.

Exercise Nine Critique (Instructor's Outline)

A. Exercise Objective:

1. To create a color composition in which no color is to be dominant.

a. Reiterate the relatedness of two or more colors.

1) Relate the adjustment of hue, value and intensity to the color environment.

2) Discuss the illusion of overlapping and/or transparence given color adjacency.

3) Discuss color interval and transformation related to all three color dimensions.

4) Discuss contrast of extension and the attributes of color balance: temperature, space, weight, and size.

b. Discuss the fact that the more colors there are in the composition, the more complex will be the considerations of relatedness.

c. Emphasize that the use of vertical strips moves the study of color relativity as far from recognizable objects as is possible.

d. Discuss some of the considerations needed to assure that one color does not become dominant.

1) *Color value: contrast of extension, weight.*

2) Color hue: temperature.

3) Color intensity: spatial movement.

e. Reiterate that all of the colors of the exercise are related, first to adjacent colors, and second to all other colors of the composition.

B. Conduct a verbal group critique of the exercise.

Exercise Ten Assignment (Instructor's Outline)

A. Personal Color Expression: Free Study #1.

1. The exercise objective is to use all of the information gathered in previous exercises to put together a non-objective pictorial reference of a specific theme.

a. Use color as a non-objective element to define a single theme that will be familiar to the class as a group.

b. The color design may include diagonals and/or curved edges.

1) Do not allow the edges between colors to be descriptive of an object or symbol.

2) The direction of the edge will automatically describe spatial movement, but should not describe an object.

3) Edges describing spatial movement may be straight and/or curvilinear.

a) The edges of color areas will be perceived before the color is perceived.

b) The student must attend to describing the color of the design before defining the edges of the color shapes.

c. The design may include any combination of chromatic and/or achromatic colors.

d. The design must use the total format space.

e. To assist in the choice of color, the student must write a narrative of the theme before making the color choices.

f. The choice of a theme should be primarily concerned with the description of a psychological response.

B. Exhibit original and/or color slide examples of completed exercise.

Exercise Ten: Personal Color Expression (Free Study #1) (Student Handout)

Exercise Objectives. This exercise has been specifically designed to allow the student to synthesize all previous color learning by making a personal expressive statement through the creation of a non-objective color theme.

Discussion. In developing the non-objective color theme, the student should be aware that no recognizable image should be created. The theme should describe, in color, the student's personal definition;

color should be chosen for its own sake and not be related in any way to a descriptive shape. Any combination of hues, values, and intensities may be used. Black, white and gray may be used but may not constitute the total composition. Color areas may exhibit any shape or indicated movement. Any linear design configuration may be used and the entire compositional space must be used.

Before beginning the practical portion of the exercise, write a 300-word paper describing the process followed and the reasons by which the final color choices were made. Explain how and why the colors were chosen, and what personal significance the color choices have as related to the exercise theme.

Required Reading. Itten, pp. 19-22, 72-78; Harlan pp. 119-131; and all color exercise handouts.

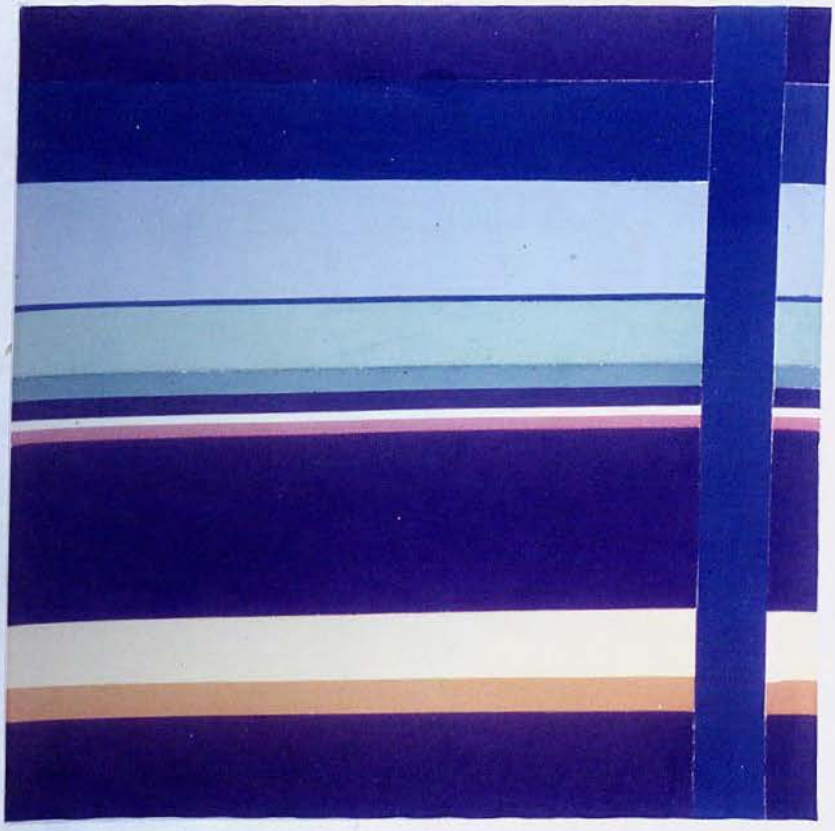


Plate XIV. Exercise #10 Completed Project

Practical Exercise.

1. Cut one piece of gray mounting board to 8" x 8".

2. Inside the 8" square, draw a 6" square, leaving a 1" margin between the 6" square and the edge of the mounting board. The 6" square will define the format size and shape of the thematic color design.

3. Inlay any color combinations in any configuration, according to the theme, within the 6" square.

4. Cover the entire exercise with one sheet of opaque white paper. Note, in the lower left hand corner of the cover sheet, the type of illumination used in completion of the exercise. Place your name and "Exercise #10" in the lower left hand corner of the back of the exercise.

5. In addition to the exercise itself, provide a written statement of at least 300 words regarding the reasons for the color choices that you used in the creation of the design. Cement the written statement to the back of the exercise.

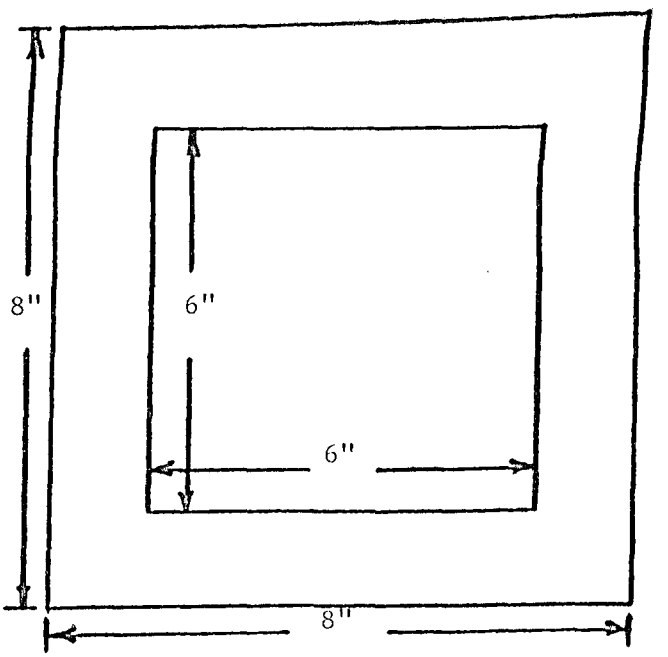


Figure 24. Practical Exercise #10 Construction Diagram.

Evaluation. Assignment = 70% (Color design = 60%, paper = 10%); Craftsmanship = 30%.

Exercise Ten Critique Statement. Because of the nature of Exercise #10, the criticism period is one which must be presented without a single premeditated objective. Because the exercise asks the student to use any and/or all of the color information gained in previous exercises and handouts, and because the student brings to the design of the exercise more personal expression than before, the critique will be more intuitively oriented. The critique must be conducted so that all members of the class will have an opportunity to verbally and overtly evaluate the color design before the student artist is identified. This approach will allow for a discussion, without aesthetic or personality bias, of how the general observer might perceive the presentation. It also allows the student to critique a personal work developed along a common theme, using color terminology. Only after a brief period of evaluation and constructive criticism should the student designer be identified and be provided the opportunity to describe the presentation.

As the first of two personal color expression designs, the instructor has a better opportunity to evaluate the student's cognitive and affective behaviors more thoroughly than in previous classes. Regarding cognitive behaviors, this exercise provides for the instructor's evaluation of a student's comprehension of color principles by judging his ability to apply, analyze, and synthesize prior learning in the creation of a personal color statement. This exercise also allows for the instructor's appraisal of a student's ability to logically and adequately judge the work of his peers as well as his own

creation. While the importance of the affective behaviors should not be diminished, it should be understood that because the student has previously completed nine exercises, the instructor's evaluation of the student's aesthetic abilities may not be greatly enhanced by the completion of this exercise.

Exercise Eleven Assignment (Instructor's Outline)

A. Personal Color Expression: Free Study #2.

1. The exercise objective is to use all of the information gathered in previous classes to create a non-objective color self- or personality-portrait.

a. Define your own person or personality by using a non-objective color composition.

b. The color design may include diagonal and/or curved edges.

1) Do not allow the edges between colors to be descriptive of any particular anatomical feature.

2) Edges of spatial movement may be straight and/or curvilinear.

a) The direction of the edge will automatically describe spatial movement but should not describe anatomical feature.

b) The edges of color areas will be perceived before the color is perceived.

c) The student must attend to describing the color of the design before defining the edges of the color shapes.

c. The design may include any combination of chromatic and/or achromatic colors.

d. The design must consider, but not necessarily use, the total format space.

2. Exhibit original and/or color slide examples of completed exercises.

Exercise Eleven: Personal Color Expression (Free Study #2) (Student Handout)

Exercise Objectives. This exercise has been specifically designed to allow the student to synthesize all previous color learning by making a personal expressive statement through the creation of a non-objective color self-portrait.

Discussion. In developing the non-objective color self-portrait, the student should be aware that a recognizable image should not be created. The non-objective linear design and the objective color design should emphasize the student's personality. Colors should be chosen to represent the individual student's feelings and/or moods. Any combination of color dimensions and attributes may be used. Achromatics may be used, but may not constitute the total composition. Color areas may exhibit any shape or indicated movement, and any linear design configuration may be utilized as long as it does not describe an anatomical feature.

Before beginning the practical portion of the exercise, write a paper of at least 300 words describing the process followed in making your color choices. Explain how and why the colors were chosen and what personal significance the colors have to your personality.

Required Reading. All previous color exercise handouts.

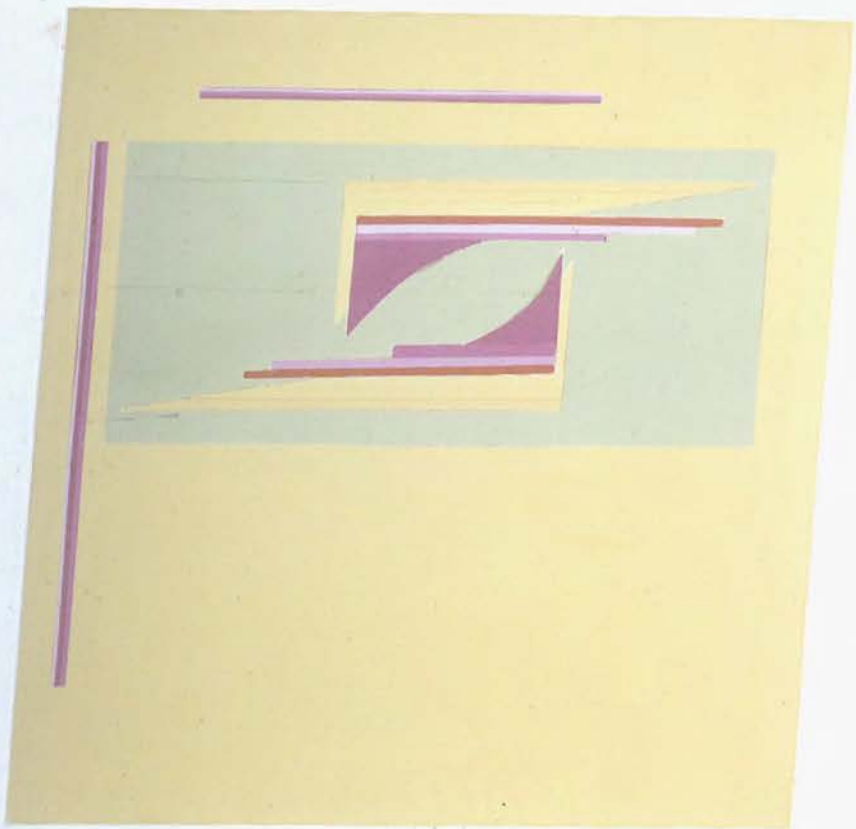


Plate XV. Exercise #11 Completed Project

Practical Exercise

1. Cut one piece of gray mounting board to 8" x 8".

2. Inside the 8" square, draw a 6" square, leaving a 1" margin between the 6" square and the edge of the mounting board. The 6" square will define the format size and shape of the self-portrait design.

3. Inlay any color combinations in any configuration within the 6" square.

4. In addition to the exercise itself, provide a written statement of at least 300 words regarding the reasons for the color choices that you used in the creation of the design. Cement the written statement to the back of the exercise.

5. Cover the entire exercise with one sheet of opaque white paper. In the lower left hand corner of the cover sheet, note the type of illumination used in completion of the exercise. Place your name and "Exercise #11" in the lower left hand corner of the back of the exercise.

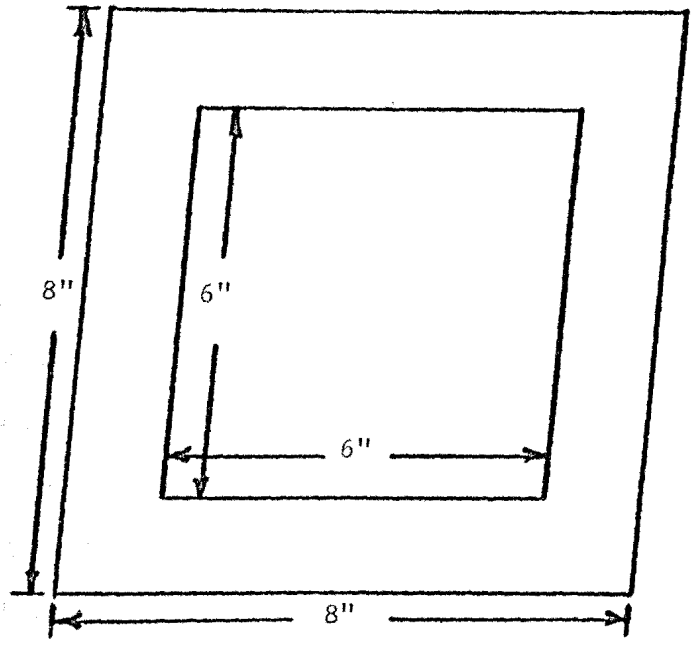


Figure 25. Practical Exercise #11 Construction Diagram

Evaluation. Assignment = 70% (Color design = 60%, paper = 10%); Craftsmanship = 30%.

Exercise Eleven Critique Statement. Because of the nature of Exercise #11, the criticism period is one which may be presented with discussion centering around the use of color as a psychological element. It should be noted that because color is a complex element with which to be involved, and because the instructor may have little background in color psychology, the criticism may be approached from

the manner in which the individual student has used color to describe his own personality. As in Exercise #10, the critique will be subjective and should be conducted so that all members of the class have an opportunity to openly evaluate the color design before the student artist is identified. During a brief period of constructive criticism and evaluation, the class might try to identify the personality or personality-type of the individual as related to the exercise. After this brief discussion the student should identify himself and explain his reasons for the specific color design. It is recommended that each student attempt to work individually on this exercise, allowing none of his peers to see his design, and submitting his work to the instructor prior to the criticism period. This anonymity may help to assure a more unbiased critique. It is recommended that the critique itself should be conducted so that each color design is presented and discussed individually to direct attention toward this final exercise.

As in Exercise #10, the instructor should use this variation of the normal criticism period to more closely evaluate the cognitive aspects of each student's response to the exercise. As well as being able to better analyze cognitive behavior, the instructor should be capable of making some final evaluative discriminations regarding the student's affective response toward this more complex solution to color design.

Conclusion

Chapter Four is intended to provide the user of the color instruction curriculum with a logical presentation of cognitive

background information in the form of lectures and demonstrations, and with a method for demonstrating that understanding through a series of practical exercises. The background information provides the student with a knowledge of the history of color, the physical origins of color and how color interacts within its environment, how one responds to and/or interprets color physiologically, and some psychological implications of color.

Through a sequence of practical exercises, the student is asked to analyze specific dimensions and attributes of color; to apply appropriate principles relating to those dimensions and attributes; and to synthesize that knowledge, understanding, analysis, and application to provide a solution to a specific principle of color. Within each exercise and throughout the instruction, the student is required to critically evaluate his own work, as well as that of his peers, through the use of group critiques.

Chapter 5

SUMMARY

Chapter five summarizes the problem of this work, the survey of current literature, the findings of the survey of post-secondary color instruction curriculums, and the curriculum developed for the instruction of subtractive color learning.

Description of the Problem

The objective of this work was the development of an educational curriculum in subtractive color learning for the post-secondary level, when the search for a visually and verbally complete instructional guide for training in human color discrimination could not be located. As a result of the literature search, this curriculum was derived from the basic course color curriculum constructed and taught by Johannes Itten and Josef Albers at the Bauhaus in Germany during the 1920's. Until now, there has been no published evidence that the Itten-Albers curriculum has been critically analyzed for contemporary use at the post-secondary level.

Current Literature and Research in Color Instruction

A search of the current literature and empirical research for help in developing the curriculum revealed that no comprehensive guide for the instructor in color instruction existed, and that current texts on subtractive color learning were not presented in a curricular fashion. Literature related specifically to curriculum development in higher education - art was found lacking in substance and number, and few citations existed prior to the early 1970's. In

their theories of aesthetics, authorities on art instruction in higher education have generally devoted themselves to the development of cognitive requirements and activities necessary in visual learning. Of these activities, a "hands-on" relationship to art instruction was espoused to encourage the student to develop an analytical outlook through creative work. In order to provide a value base for a hands-on aesthetic experience, art curriculum developer-reformers have said that the artist, as a role model, must move from the studio to the classroom to act as the catalyst for educational change, educating an entire population and extending credence to art as also possessing a cognitive element.

Most texts on color instruction included a variety of general facts about subtractive color. While each author presented subtractive color in a personal style, none presented color principles in the form of a comprehensive hands-on series of cognitive curriculum experiences. Empirical research limited to subtractive color was not found within the find arts; however, a variety of articles relating to specific subtractive color elements were cited from various sciences and the humanities. Of the texts and research cited, none were presented as a curriculum guide capable of being used effectively and/or efficiently by the art instructor, or of being understood clearly and/or easily by the student.

Because of the scarcity of current literature and research a survey instrument was constructed to question select institutions of higher education about their methods of instruction of the principles of subtractive color in order to determine current practice.

The literature search found no consistency in the viewpoints concerning the methodologies of presenting color, and thus curricular design is a formidable task. This may cause the educator to be ill-prepared to successfully construct or adequately conduct instruction in color learning, and the result may be students in post-secondary art education improperly prepared to deal cognitively and/or practically with the complexity of color.

Institutions including subtractive color courses, separate from other studio art courses, did so because this method of presentation was the most practical for the complexity of the topic. A separate presentation was also justified because of the importance placed on color by the general art faculty. Students interested in learning about color principles came from a variety of disciplines, and were generally first scheduled into the color course as freshmen. A majority of programs used the color system (and text) of Johannes Itten and/or Josef Albers. Those programs more closely related to commercial art used the Munsell system, and a small proportion of programs used "departmental" systems. Instruction of color principles was accomplished generally through practical exercises, with other instruction being provided through lectures, demonstrations, audio-visual presentations and criticisms. Since none of those institutions providing separate color learning instruction used a published curriculum guide, instructors found it necessary to develop programs based on their own experiences and interests.

The Color Instruction Curriculum

By synthesizing the related literature in post-secondary

curriculum development - art with that in color texts, empirical research, and the survey of methods of color instruction, a color instruction curriculum was developed. The intent of the subtractive color curriculum is to provide the instructor with guidance in developing a coherent curriculum, which will enhance the student's ability to apply his color perception and judgment in a more systematic and informed way.

The color curriculum has been developed as a guide for the instructor of a foundation-level course in subtractive color principles at the post-secondary level. The curriculum possesses a content which is notably objective, progressing through a sequence of practical exercises which call for increasingly subjective responses on the part of the student. The intention of this curriculum is to commence instruction in a highly structured manner causing the student to be confronted by factual information before moving to more subjective responses and broad applications. The curriculum is meant to be presented in a mastery fashion, allowing the student to present for criticism the solution to a sequenced practical exercise, reworking the solution based on the results of the critique, and then submitting the solution for an interim or final grade. Because the major function of the curriculum is to cause the student to learn to discriminate and make application of subtractive color relatedness, the student should be permitted to resubmit solutions graded on an interim basis as frequently as desired so that he will master each particular segment of the course.

The content and sequencing of the curriculum provides the

student with a variety of cognitive and practical experiences. The general organization of the curriculum uses a series of lectures, demonstrations, and practical exercises in the presentation of subtractive color principles. The curriculum includes a series of background lectures in color history, the physical properties of light, i.e., its relationship to the reflective surface and the eye-brain receptor system, and the principles of color dimension, harmony, and illusion. Following these introductory lectures, a series of five practical exercises is presented to develop an understanding of basic color principles. These exercises utilize the three dimensions of color: hue, value, and intensity, by emphasizing one or a combination of these dimensions within each exercise. A mid-course written examination is provided as a means of evaluating a student's understanding of those principles discussed and practiced in the first five exercises. The next six exercises involve a more complex approach to the uses of color principles while continuing to be based on the same color dimensions as the first five exercises. Prior to each exercise a lecture explains the aesthetic and technical considerations of the particular experience. One-to-one criticism is scheduled during the execution of the practical exercise, with a group (peer) critique scheduled upon completion of each exercise.

The curriculum provides both the instructor and the student with an organized guide for color learning. For the instructor, the curriculum provides background information and a sequence of practical exercises which increase in complexity and culminate in

exercises demonstrating the student's comprehension of color principles and color relatedness. Background information provided by the curriculum and presented by the instructor prior to beginning the practical exercises allows for a fundamental understanding of color history, physics, physiology, and illusion. At the same time these lectures allow the instructor to make comprehensive presentations concerning those elements affecting color perception.

The practical exercises allow the instructor to present specific facts about color and allow for a depth of study unattainable in more traditional art studio experiences. The mid-course written examination allows the instructor to evaluate the student's cognitive comprehension for the first five practical exercises. The second phase of six practical exercises allows the instructor to present more complex exercises that reflect the personal aesthetic considerations of the student.

For the student, the color curriculum provides a foundation of subtractive color principles. Because the curriculum deals with color principles exclusively, the student is presented with more information than is generally available in other studio courses and is provided with a strong base for generalizing his learning outside the classroom.

Conclusions

It is evident that authors of color texts have written from postures which present personal approaches or represent universal theories of subtractive color, but do not present color curriculums.

Since the Itten-Albers course was introduced, only Sargent has presented a credible color instruction curriculum. Unfortunately both of these are incomplete, the former lacking coherent verbalization, the latter lacking visual examples. It is therefore the conclusion of this author that a complete and coherent instrument for subtractive color instruction at the post-secondary level was needed, and thus the contribution of this dissertation is the critical analysis of the Itten-Albers color course culminating in the development of this curriculum in subtractive color learning.

Implications

This work suggests that because subtractive color curriculums are not extant in higher education - art, the individual who desires to teach color must first learn the principles in a fragmented manner. If the instructor is compelled to develop a background in color principles from a variety of sources which may not be consistent, then the development of a curriculum of instruction may be filled with incongruities. With curriculums based on inconsistencies, recipients of instruction will receive information that is incomplete, leading to learning difficulties in the student's aesthetic education.

Those who are inconsistently trained as curriculum designers will develop flawed programs which will result in students being improperly educated and ill-prepared to use their training. The implication is that the use of the prescribed series of lectures, practical exercises and critique outlines, and the mid-course written

examination, will afford the instructor a consistent and coherent curriculum for the instruction of subtractive color principles. Instruction using this prescriptive curriculum and the practical exercise handouts will afford the student a logical progression of learning experiences, allowing him to generalize his color training.

Limitations

Several limitations of this work suggest areas for future study to test the completeness and efficiency of the curriculum. First, although the mid-course written examination has undergone changes during the development of the curriculum, a statistical item analysis has not been done on the effectiveness of individual questions. Second, while the student's cognitive development is evaluated for the first half of the course, there is no written final examination to do likewise upon completion of the course. And third, while the curriculum was developed, presented, evaluated and revised within a single liberal arts institution, it needs to be presented in other classroom settings to evaluate both the effectiveness of the curriculum as a whole and the efficiency of the sequencing of the practical exercises.

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APPENDIX A

THE SURVEY OF POST-SECONDARY COLOR INSTRUCTION

A search of the literature revealed that no color curriculum guide existed, therefore in order to establish a basis for the development of a course, selected institutions were surveyed for subtractive color instruction methodologies and content. A pilot survey instrument was distributed to selected four-year post-secondary institutions in Maryland. Pages 185-187 of this appendix indicate, respectively, the survey cover letter, the pilot survey instrument, and the percentages of positive responses to the color course pilot survey.

In order to determine if and to what extent the results of the pilot survey could be generalized, the pilot survey was revised and the first color instruction survey was designed. The cover letter used for the pilot survey was also used for the first color instruction survey. The first color instruction survey instrument, responses of states by total and percent, and the percentages of positive responses to the first color instruction survey, are exhibited on pages 188-191, respectively.

In order to determine more specific information regarding the cognitive and practical instruction of the principles of color as a specific course curriculum, response data from the first color instruction survey was used to establish the population and question areas for the development of a second color instruction survey instrument. The population used for the second color instruction survey was the total of affirmative responses (142) from the first color instruction survey.

Pages 192-203 present a copy of the second color instruction

survey, together with the findings of the second survey as averages and percentages where objective responses resulted, and as narrative paraphrases where responses were subjective. A total of 27 institutions (individuals) responded affirmatively to the second color instruction survey.

SALISBURY STATE COLLEGE
DEPARTMENT OF ART
(301) 546-3261, ext. 443
SALISBURY, MARYLAND

Dear Colleague:

I am writing this letter to ask your assistance in surveying present academic instruction in the area of color theory.

During the past several years I have become increasingly interested in the various methods in which color is taught in academic institutions. In particular, I am interested in the manner of teaching the history, systems, physics, physiology, and psychology of color to college students.

The specific problem with which I am presently dealing is a question of curriculum development and implementation. I began some time ago to search a variety of published literature, texts and empirical research, in the hope of obtaining necessary information by which to develop a specific course dealing with color theory. What I hoped to find was a curriculum-type guide by which both art and non-art students could deal with subtractive color elements and principles. What I found was a variety of methods of discussing color, but none which were fashioned for use in a post-secondary setting. My reason for this survey therefore, is to attempt to determine how and by whom color is taught in colleges, universities, and institutes.

Although this survey cannot answer all of the questions that may have been posed above, it can assist me in determining some vital statistical data with regard to who teaches color courses, how and how often they are taught, and their relative success.

The attached survey should take no more than three minutes to complete. After completion, please place the survey in the self-addressed, pre-stamped envelope and mail. Let me thank you in advance for your kind assistance and assure you that I will return the results of this survey if you so desire.

Very sincerely,

Kent N. Kimmel

COLOR COURSE SURVEY

A. Does your department presently teach a specific course in color theory?

YES ☐ NO ☐ If "YES", please complete questions 1 through 10.

(Please estimate if specific information is not readily available).

1. The course has been taught for:

   1-3 years ☐ 4-6 years ☐ 7-9 years ☐ More than 10 years ☐

2. The course is offered: Less than once yearly ☐ Once yearly ☐

   Twice yearly ☐ More than twice yearly ☐

3. The format for course instruction is:

   Bauhaus ☐ Departmental ☐ Modular ☐ Munsell ☐

   Other _____

4. The curriculum structure of the course is:

   Lecture ☐ Studio ☐ Combination ☐

5. The faculty structure in teaching the course is:

   Individual ☐ Team ☐ Alternating ☐ Block ☐

   Other _____

6. The course is required of all majors. YES ☐ NO ☐

7. The course is taught as an elective. YES ☐ NO ☐

8. Average student enrollment is: Less than 10/year ☐

   11-20/year ☐ 21-30/year ☐ 31-40/year ☐ More than 40/year ☐

9. Is the course successful? YES ☐ NO ☐

10. Does your department plan to continue teaching the course?

    YES ☐ NO ☐

B. If you answered "NO" to question A, does your department plan to teach a color theory course in the future?

YES ☐ NO ☐ If "NO" please complete questions B.1 and B.2

1. Color theory is taught in some <u>other</u> studio area: YES ☐ NO ☐

   If "YES", please indicate which area.

   Design ☐ Painting ☐ Commercial Art ☐ Other _____

2. Color theory is taught in some other <u>academic</u> discipline:

   If "YES", please indicate which discipline.

   Applied Design ☐ Psychology ☐ Physics ☐ Other _____

C. I would greatly appreciate any additional comments that you feel have been omitted from this survey and/or comments on the survey itself.

_____

_____

D. Please return the results of this study. ☐

Name _____

Title _____

Institution _____

Address _____

_____

Percentages of Positive Responses to the
Color Course Pilot Survey

Survey Questions		N	Percent YES
A. Does your department presently teach a specific course in color theory?		16	18.8
1. The course has been taught for:	1-3 years	3	0.0
	4-6 years		33.3
	7-9 years		33.3
	more than 10 years		33.3
2. The course is offered:	less than once yearly	3	0.0
	once yearly		0.0
	twice yearly		66.7
	more than twice yearly		33.3
3. The format for course instruction is:	Bauhaus	3	100.0
	Departmental		66.7
	Modular		33.3
	Munsell		33.3
4. The curriculum structure of the course is:	Lecture (only)	3	0.0
	Studio (only)		0.0
	Combination		100.0
5. The faculty structure in teaching the course is:	Individual	3	66.7
	Team		0.0
	Alternating		33.3
	Block		0.0
6. The course is required of all majors?		3	33.3
7. The course is taught as an elective?		3	100.0
8. Average student enrollment is:	less than 10 per year	3	0.0
	11-20 per year		0.0
	21-30 per year		33.3
	31-40 per year		33.3
	more than 40 per year		33.3
9. Is the course successful?		3	100.0
10. Does your department plan to continue teaching the course?		3	100.0
B. If you answered "NO" to question A., does your department plan to teach a color theory course in the future?		15	6.2
1. Color theory is taught in some <u>other</u> studio area:	Design	16	87.5
	Painting		62.5
	Commercial Art		25.0
	Other		18.8
2. Color theory is taught in some other <u>academic</u> discipline:	Applied Design	16	12.5
	Psychology		18.8
	Physics		6.2
	Other		0.0

COLOR INSTRUCTION SURVEY

A. Does your department currently teach a specific course in the elements and principles of subtractive color processes?

YES ☐ NO ☐

If "YES", please complete question 1 through 10 below. If "NO", please complete question B. All respondents should answer questions C thru F (Please estimate if specific information is not readily available).

1. The course has been taught for:

1-3 years ☐ 4-6 years ☐ 7-9 years ☐ More than 10 years ☐

2. The course is offered:

Once yearly ☐ Twice yearly ☐ More than twice yearly ☐

3. The curriculum structure of the course is:

Bauhaus ☐ Departmental ☐ Modular ☐ Munsell ☐ Other _____

4. The format for course instruction is:

Lecture (only) ☐ Studio (only) ☐ Combination ☐

5. The faculty structure in teaching the course is:

Individual ☐ Team ☐ Alternating ☐ Block ☐ Other _____

6. The course is required of all majors. YES ☐ NO ☐

7. The course is taught as an elective. YES ☐ NO ☐

8. Average student enrollment is: Less than 10/year ☐

11-20/year ☐ 21-30/year ☐ 31-40/year ☐ More than 40/year ☐

9. Is the course successful? YES ☐ NO ☐

10. Does your department plan to continue teaching the course? YES ☐ NO ☐

B. If you answered "NO" to question A., does your department plan to teach a color theory course in the future?

YES ☐ NO ☐

C. Is color theory (also) taught in some other studio area? If so, please indicate.

Design ☐ Painting ☐ Commercial Art ☐ Other _____

D. Is color theory (also) taught in some other academic discipline? If so, please indicate which discipline.

Applied Design ☐ Psychology ☐ Physics ☐ Other _____

E. I would greatly appreciate any additional comments on omissions from this survey, the survey itself, and/or additional information about your present instructional program

_____

_____

F. I am interested in the results of this survey. Please send a copy to me. ☐

Name _____

Title _____

Institution _____

Street _____

City/State/Zip _____

Responses of States by Total and Percent
to the First Color Instruction Survey

States Surveyed	Total Surveys Submitted	Total Surveys Returned	Total % Surveys Returned	Tot. Pos. Surveys Received	% Positive Surveys Returned
Alabama	28	15	53.6	3	20.0
Connecticut	28	16	57.1	11	68.8
Delaware	3	2	66.7	0	0.0
District of Columbia	11	3	27.3	0	0.0
Florida	29	10	34.5	1	10.0
Georgia	40	18	45.0	5	27.8
Illinois	86	42	48.8	12	28.6
Indiana	47	27	57.4	2	7.4
Kentucky	29	15	51.7	4	26.7
Maine	22	7	31.8	2	28.6
Maryland	26	16	61.5	3	18.8
Massachusetts	69	32	46.4	14	43.8
Michigan	53	23	43.4	12	52.2

Responses of States by Total and Percent
to the First Color Instruction Survey

States Surveyed	Total Surveys Submitted	Total Surveys Returned	Total % Surveys Returned	Tot. Pos. Surveys Received	% Positive Surveys Returned
Mississippi	20	9	45.0	2	22.2
New Hampshire	21	6	28.6	3	50.0
New Jersey	40	9	22.5	5	55.6
New York	196	67	34.2	19	28.4
North Carolina	45	24	53.3	6	25.0
Ohio	58	20	34.5	5	25.0
Pennsylvania	94	53	56.4	13	24.5
Rhode Island	14	5	35.7	4	80.0
South Carolina	28	18	64.3	5	27.8
Tennessee	44	19	43.2	2	10.5
Vermont	17	8	47.0	3	37.5
Virginia	35	27	77.1	4	14.8
West Virginia	17	4	23.5	2	50.0
TOTAL RESPONSES	1100	495		142	

Percentages of Positive Responses to the
First Color Instruction Survey

Survey Questions		N	Percent YES
A. Does your department currently teach a specific course in the elements and principles of subtractive color processes?		495	28.7
1. The course has been taught for:	1-3 years	142	31.3
	4-6 years		20.8
	7-9 years		12.5
	more than 10 years		32.6
2. The course is offered:	less than once yearly	142	7.6
	once yearly		44.4
	twice yearly		34.7
	more than twice yearly		11.8
3. The curriculum structure of the course is:	Bauhaus	142	51.4
	Departmental		29.9
	Modular		7.6
	Munsell		30.6
4. The format for course instruction is:	Lecture (only)	142	0.0
	Studio (only)		18.8
	Combination		79.9
5. The faculty structure in teaching the course is:	Individual	142	88.9
	Team		5.6
	Alternating		5.6
	Block		0.7
6. The course is required of all majors?		142	59.7
7. The course is taught as an elective?		142	60.4
8. Average student enrollment is:	less than 10 per year	142	11.8
	11-20 per year		29.9
	21-30 per year		20.1
	31-40 per year		11.8
	more than 40 per year		25.0
9. Is the course successful?		142	93.8
10. Does your department plan to continue teaching the course?		142	95.8
B. Does your department plan to teach a color theory course in the future?		353	9.3
C. Is color theory (also) taught in some other studio area?	Design	495	51.6
	Painting		41.1
	Commercial Art		10.7
	Other		13.2
D. Is color theory (also) taught in some other academic discipline?	Applied Design	495	4.5
	Psychology		9.7
	Physics		9.7
	Other		5.7

IN-DEPTH SURVEY IN COLOR INSTRUCTION

This in-depth survey of art schools, colleges and universities is being conducted to extend existing information concerning programs in color instruction. Since you responded to an earlier demographic survey, you are being asked to provide an expansion of that information by answering the questions below. If color is no longer taught as a separate course, please note in the comments section on page 8. Please return the questionnaire in the enclosed envelope. Your prompt attention will be greatly appreciated. Thank you.

I. DEMOGRAPHY - Does the name of the color instructor and the address and zip code of the institution correctly appear at the right? If not, please make the necessary corrections. Thank you.

1. Please estimate the size of your institution and your department. (Please use full-time equivalent student numbers).

   5712 FTE Students in Institution 287 FTE Students in Department

2. Check the instructional period used at your institution.

QUARTER	TRIMESTER	SEMESTER	OTHER
3	1	21	2
11.1%	3.70%	77.78%	7.41%

II. CURRICULUM

1. Briefly explain why your institution has chosen to teach color as a separate course.

   a) Essential component to larger studio program, b) Essential to visual arts, c) subject area complicated enough to justify separation, d) more efficient, e) more efficient cognitive and affective learning.

2. Is color presently taught in more than one separate course in the department?

   YES 7 26% NO 20 74%

   YES - Most provide only one advanced course in the form of a practical application course or as a seminar.

   NO - No responses.

a. Should color be taught in more than one course, e.g., relating to the physical and psychological, and one relating to design?

YES [12.5] 50% NO [12.5] 50%

YES - Because few instructors have a full command of all aspects of color; to enhance unique media characteristics. NO - Impractical, most programs not large enough, too dependent on interest and skills of faculty.

3. How long has/have the course(s) been taught at your institution? (Please use "instructional period" units from I.2. above)

Beginning = ten-plus years; Advanced = twelve-plus years

a. Briefly describe the factors responsible for course longevity.

1. Importance placed on color instruction by the general art faculty, 2) Importance of strong color background for students, 3) Develops a common language, 4) Flexible nature of color.

4. How often is/are the course(s) taught? (Please use "instructional period" units from I.2. above)

Instructional Period		Institutions
Quarter:	Less than one time per quarter	2
	One time per quarter	0
	More than one time per quarter	1
Trimester:	Less than one time per trimester	1
	One time per trimester	0
	More than one time per trimester	0
Semester:	Less than one time per semester	13
	One time per semester	7
	More than one time per semester	1
Other:		2

5. How many credits are awarded for successful completion of the course(s)?

Credits per Instructional Period	Institutions
One credit	0
Two credits	2
Three credits	17
Four credits	6
Other	2

6. Please estimate what portion of an average class is composed of majors and non-majors.

58.4% MAJORS 4.6% NON-MAJORS

a. Please list the disciplines from which non-majors come.

Major Area:	Specific Discipline	Discipline %	Area %	N
Social Sciences	Psychology	66.7	22.6	8
	Soc/Social Work	25.0		3
	History	8.3		1
		100.0		12
Professionals:	Bus/Accounting	36.4	20.3	4
	Engineering	27.3		3
	Architecture	18.2		2
	Nursing	18.2		2
		100.0		11
Liberal Arts:	Comm/Theatre	66.7	17.0	6
	General	22.2		2
	Journalism	11.1		1
		100.0		9
Physical and Mathematical Sciences:	Chem/Physics	44.4	17.0	4
	Biology	11.1		1
	Geography	11.1		1
	Mathematics	11.1		1
	Med. Illus.	11.1		1
	Natural Sci.	11.1		1
		100.0		9
Education:	Ele/Secondary	50.0	15.1	4
	Art	25.0		2
	Industrial	12.5		1
	Technical	12.5		1
		100.0		8
Human Resources:	Fashion Illus.	25.0	7.5	1
	Home Economics	25.0		1
	Interior Design	25.0		1
	Textile Design	25.0		1
		100.0		4

6. b. Briefly describe the factors responsible for course population.

1) Required for art majors, 2) Interesting, popular, challenging, an important prerequisite; relevant; enhanced by cooperation of faculty who realize course importance.

7. Should color be taught separately for majors and non-majors?

YES [18.5%] NO [81.5%]

YES - Because color information is so broad and specialized,

NO - Impractical, institution and department size and mission cause course segregation to be academically unsound.

8. Briefly describe how the instruction of color as a separate course has/has not eliminated or reduced the problems of teaching color in other studio areas.

a) Make instruction of color easier in other areas, b) Two areas of question regarding information transfer are student carry-over and faculty utilization.

9. Does the curriculum make available workshops in color?

	(N) % YES	(N) % NO	(N) % No Resp.
For majors	(5) 18.5	(20) 74.1	(2) 7.4
For non-majors	(3) 11.1	(20) 74.1	(4) 14.8

If YES, briefly describe staff, content, frequency of offering, level and type of workshop, and reasons for offering. A copy of the workshop program would be greatly appreciated.

Accomplished through "internal" lecture-demonstration-application.

III. INSTRUCTION

1. When are students first scheduled to experience color instruction?

FRESHMAN [50%] SOPHOMORE [31.5%] JUNIOR [0%]

SENIOR [0 %] OTHER [14.8%] any time.

2. Please list the color system(s) which is/are used in your color instruction, e.g., Bauhaus (Albers), Modular, Munsell, etc.

a) 35% Bauhaus (Itten-Albers), b) 21.7% Munsell, c) 15% use a "departmental" or eclectic system.

a. Briefly explain the reason for your choice(s) of color system(s) for instruction.

1) The Bauhaus system avoids "prettiness", generates interest and understanding of basic theories, organizes theory in a practical manner, 2) Munsell utilized by commercial curriculums, provides comprehensive theory; basic superior contents provide completeness, 3) All systems closed and limiting, requiring input from a variety of sources.

3. Please estimate the portion of your instruction which is:

18.8% LECTURE 8.8% DEMONSTRATION 6.8% AUDIO-VISUAL

46.7% PRACTICAL EXPERIENCE (Class work), 19.0% CRITICISM

a. Briefly explain the basis for LECTURES, e.g., sequence in class presentation, relation to theory and/or practical experience, etc.

Able to explain topics for discussion and process thoroughly; utilized early to define color history, physiology, physics, psychology, and perception theories; included in and explaining practical problems.

b. Briefly explain the basis for DEMONSTRATIONS, e.g., use of materials, effects of varied lighting, etc.

Photographic examples illustrating color principles; use of colored papers under various lighting conditions to demonstrate light reflection; examples of previous student and notable artist's works; pigment mixtures; mechanical optical mixtures, and craftsmanship skills.

c. Please list by name and/or type any films, film strips, slides, visual cards, etc., that are used in your color instruction.

1) "Homemade" visuals developed from a variety of reproduced filmstrips, slides from texts, color-aid paper examples, painted examples of color principles; 2) Albers' and Jacobson's portfolios, the "Language of Color" and Pavey filmstrips.

d. Please enclose a copy of the color course syllabus and any additional written material that is normally provided to the student. NO RESPONSES!

1) Please explain to what extent "craftsmanship" (mechanical skill) is stressed in color instruction.

a) 9 responded to stressing craftsmanship highly,

b) 8 responded to limiting the stress on craftsmanship to individual needs, or a stress on perception and process.

e. Is criticism of practical color exercises conducted?

YES [6] Please explain. NO [?]

17 responded as to having varying degrees of criticism throughout instruction and to differing degrees, most use final group critiques, some use peer evaluations during production with instructor evaluation as the final authority.

4. Please check those elements of instruction which include presentations defining additive and/or subtractive color processes.

Elements	Additive		Subtractive	
	(#) % YES	(#) % NO	(#) % YES	(#) % NO
Lecture	(21) 77.8	(6) 22.2	(20) 74.1	(7) 25.9
Demonstration	(15) 55.6	(12) 44.4	(17) 63.0	(10) 37.0
Audio Visuals	(11) 40.7	(16) 59.3	(15) 55.6	(12) 44.4
Prac. Exer's.	(13) 48.1	(14) 51.9	(18) 66.7	(9) 33.3

5. Please estimate what portion of color instruction includes discussion in:

Area	Percent	N
Color History	17.9	20
Color Psychology	16.2	18
Color Physics	9.8	17
Color Physiology	14.5	18

6. Please list the TEXT(S) used for color instruction and check if required (in student's possession) or used for reference (in the institution or department library).

	# Inst's. Reporting	
Abbreviated Bibliography	Required	Reference
Albers, Interaction of Color (1976)	3	7
Arnheim, Art and the Visual Perception ('67)	0	1
Art Today (Periodical)	0	1

Abbreviated Bibliography	# Inst's. Reporting	
	Required	Reference
Birren, Color Perception (1976)	0	1
_____, Principles of Color (1969)	0	2
Eastlake (ed.), Goethe's Theory of Color	0	2
Evans, Introduction to Color	0	1
Gauldene, Art Through the Ages	0	1
Gerritsen, Theory and Practice of Color	0	1
Gregory, The Eye and the Brain (1968)	1	1
Harlan, Color Interaction	1	0
_____, Vision and Invention (1970)	0	1
Hartley, How to Beautify the Home with Color	0	1
Hellman, The Art and Science of Color	0	1
Hoehberg, Perception (1978)	0	1
Itten, The Art of Color (1973)	0	6
_____, Color Symbolism	1	0
Judd, Color	0	1
Krause, The Nature of Art	1	0
Libby, Color and the Structural Sense ('74)	1	0
Mayer, Painters Handbook	0	1
Merrill, An Introduction to Color	1	0
Ostwald, The Color Primer (1969)	0	1
Rainwater, Light and Color (1971)	0	1
Scientific American (Periodical)	0	1

6. a. Please list the strengths and/or weaknesses of the text(s) listed.

Strengths of Itten and Albers texts note sufficient inclusions and visuals; Birren, Eastlake, Hartley, Merrill, Ostwald, and Gregory also noted as good texts. Notable weaknesses in all texts are that they are presented from a single viewpoint, include too few practical exercises, are too complicated for basic presentation, or are outdated.

7. Please estimate what portion of color instruction emphasizes:

36% THEORY (knowing-recognizing), 64% PRACTICE (using-doing)

8. Please check and briefly describe the instructional approach used in color class(s).

[15] FOR KNOWLEDGE ALONE (exclusive of other studio areas)

Syllabus structured for use of information exclusive of any future aesthetic studies; sensitize to color properties; provide capability for intelligent discussion.

[14] DIRECTLY RELATED TO OTHER STUDIO COURSES. Presentation of color work from other classes; specific relation to painting, graphics, sculpture and history.

[8] RELATED TO AREAS OUTSIDE THE TRADITIONAL STUDIO, AS WELL AS STUDIO AREAS.

Utilized for use in commercial and industrial areas.

a. Is the course designed to provide a transition into other studio areas?

YES [20] 74.1% NO [2] 0.7%

Affirmative responses indicate color as a prerequisite to any and all studio courses utilizing color, as a forerunner for specific courses in painting and commercial graphics.

b. Is the course designed to provide a transition into non-studio areas?

YES [8] Please explain. NO [?]

Course design assists in generally organizing non-studio work by developing an ability to understand and retain theoretical concerns; extremely beneficial for art history which generally lacks discussion of design fundamentals and/or color theory.

IV. INSTRUCTIONAL STAFF

1. Is a trained instructor necessary for color instruction?

YES [25] NO [0]

Because the technicality, complexity, and ephemerial quality of color demands adequate instructional training. Inadequate training could precipitate harmful training.

2. Briefly describe the qualifications of the instructor(s) presently teaching color at your institution.

Advanced post-secondary degrees, longevity of instruction in theoretical and pragmatic problems, special interests.

3. Has your institution ever advertised for and/or hired a specialist to teach color?

YES [5] 18.5% NO [22] 81.5%

YES - College Art Association of America. NO - Vacancies filled through graduates and general correspondence.

4. Does the color curriculum use guest lecturers?

YES [11] 40.7% NO [16] 59.3%

Yes - From within the institution; either inside or outside the department.

V. INSTRUCTIONAL EVALUATION - (Please expand any responses in the comments section on page 8).

1. Are students evaluated prior to instruction for color discrimination?

YES [5] 18.5% NO [21] 81.5%

YES - Evaluate males especially, student use of color before class, student-teacher consultations before class. One institution used the Farnsworth-Munsell Test.

2. Briefly explain what method of evaluation is used to determine a student's progress during the course.

Most instructors make sujbective judgments; commenting and grading of practical exercises, craftsmanship, class attendance and participation, and written examinations.

3. Briefly explain on what criteria the student is given a final course grade.

Collective evaluation of exercises, improvement, verbal responses during class and critiques, class attendance.

4. Are students evaluated upon completion of color instruction for changes in color discrimination?

YES [5] 18.5% NO [21] 77.8%

YES - Subjective evaluations of student's practical exercises, verbal presentations, written and visual examinations. One institution utilized the Farnsworth-Munsell Test.

5. Is the student's final color discrimination evaluation correlated to discrimination information gathered prior to the course?

YES [5] 18.5% NO [22] 81.5%

One affirmative response has the student bring a color example together with a written description upon commencement of the class, the same example is re-described at the end of the course.

6. Are students given the opportunity to evaluate the instructor and/or the course content?

INSTRUCTOR:	YES	22	81.5%	NO	4	14.8%
CONTENT:	YES	16	59.2%	NO	7	25.9%

7. Have elements of the color curriculum changes as a result of student evaluations?

YES [11] 40.7% NO [12] 44.4%

YES - Expanded use of media and techniques in color experimentation, fewer "finished" exercises and more experimentation, more emphasis on visual products.

8. Is any follow-up (survey) made regarding effects of color instruction on former students?

YES [3] 11.1% NO [22] 81.5%

One response noted a general institutional alumni poll indicated that the color course is notable.

APPENDIX B

COLOR HISTORY BIBLIOGRAPHY

Textbooks

Ralph Fabri, Color: A Complete Guide for Artists (New York: Watson-Guptill Publications, 1967), pp. 15-21.

This brief background entitled, "Color in History" offers understanding and valuable information to everyone who uses color in one way or another. Fabri discusses the earliest uses of color by the ancient world's cultures and in the aesthetic periods through Post-Impressionism.

Faber Birren, Color and Human Response (New York: Van Nostrand Reinhold Co., 1979), pp. 1-11.

In chapter one, "The Historical Background," Birren explains that ancient man had more than an aesthetic attitude toward the spectrum, discussing primitive man's color symbolic relationships to the elements and quarters of the world, his religious and astrological beliefs. Ending the chapter, Birren discusses the role of color, both symbolic and practical, in the culture of human life.

Faber Birren, Color Psychology and Color Therapy (New York: University Books, Inc., 1961), pp. 3-51.

Chapter one explains early mystical, supernatural and astrological uses of color beyond the sensuous delight of a variety of occidental and oriental cultures; chapter two, states how ancient philosophers and alchemists used color as a prime element in the dispensing of knowledge and remedies. The occult superstitions and practices of color therapy are discussed in chapter three; chapter four describes the concept of man as the possessor of spiritual energies manifested through color.

Wilhelm Ostwald, The Color Primer, ed. Faber Birren (New York: Van Nostrand Reinhold Co., 1969).

Wilhelm Ostwald's Die Farbenfibel (The Color Primer) is one of the most successful books on color ever published. This is the first English translation and complete reprinting of the original 1916 German edition.

Faber Birren, Principles of Color (New York: Van Nostrand Reinhold Co., 1969), pp. 9-25.

A history of color organization theories from Newton's revelation around 1660 through those of LeBlon, Harris, Schiffermuller, Goethe, Chevreul, Blanc, Hayter, von Helmholtz, Maxwell, Rood, von Bezold, Jacobs, Munsell, Hering, Ostwald, to Birren's own structural theory.

Faber Birren, Color Perception in Art (New York: Van Nostrand Reinhold, 1976), pp. 8-17.

A review of the major color schools and movements of the nineteenth and twentieth centuries, noting the accomplishments of individual artists who typified and were innovators in their own eras.

Robert M. Boynton, Human Color Vision (New York: Holt, Reinholt and Winston, 1979), pp. 1-24.

Boynton discusses color concepts of the Greek civilization, theories of the middle ages, seventeenth century observations and experimentations, including Newton's breakthrough and Helmholtz's trichromacy theory; opponent-color theory, the CIE system, and Land's color experiments.

Frans Gerritsen, Theory and Practice of Color (New York: Van Nostrand Reinhold Co., 1975), pp. 13-18.

A discussion of the varied historical concepts of how we see light and color, from psychical phenomenon of the Neo-Platonic philosophers to the latest empirical discoveries of color-vision research.

Ogden N. Rood, Modern Chromatics (American ed., New York: Van Nostrand Reinhold Co., 1973).

The entirety of this text deals with the underlying facts upon which a great deal of color expression in modern art depends. The volume is divided into three parts; an introduction covering Rood's life by Faber Birren, Birren's contemporary cross-referenced notes of Rood's original work, and a facsimile reproduction of Rood's original writing.

Color Slide Series

Faber Birren, The Vision of Color: Series A (Van Nostrand Reinhold Co., 1972).

A review of basic color theory is presented, including a description of old and modern color circles and color systems; traditional principles of color harmony and the visual illusions relating to simultaneous contrast, after-image, and fundamentals of Op-Art.

Faber Birren, The Vision of Color: Series B (Van Nostrand Reinhold Co., 1972).

This text is a supplement to Series A, carrying on the art of color into new and more advanced territory, including a presentation of color effects based on the perceptual responses of lustrousness, iridescence, luminosity, and transparency.

Color Film-Strip/Audio-Cassette Series

Donald Pavey, et. al, Pavonis Color Series (New York: Sheikh Publications, Inc., 1970).

The Language of Color (New York: Visual Publications, 1976).

APPENDIX C

MID-COURSE WRITTEN EXAMINATION AND ANSWER KEY

Written Examination Questions.

A. Matching: Make the letter of the definition at the right correspond to the number adjacent to the color term on the left. Some lettered answered may be used more than one time, some not at all. (One point each).

1. Achromatic	A. Hue purity
2. Analogous Colors	B. Opposite hues
3. Chroma	C. Single hue scheme
4. Color Gray	D. Blackened hue
5. Complementaries	E. Relative lightness/darkness
6. Hue	F. Devoid of color
7. Intensity	G. Grayed hue
8. Polychromatic	H. Whitened hue
9. Saturation	I. Complementary mixing
10. Simultaneous Contrast	J. Variety of hues
11. Shade	K. Color name
12. Tint	L. Closely related hues
13. Tone	M. Adjacent hue influence
14. Value	N. Reverse mixing

B. Completion: Complete the list of sentences by providing the necessary term(s) or word(s).

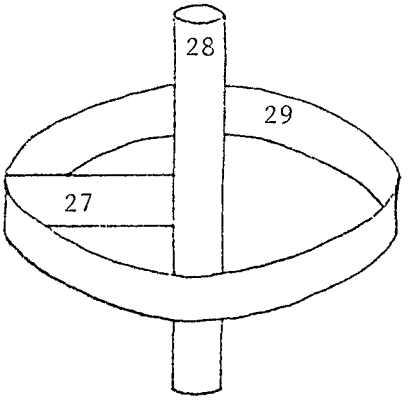
15-20. List six of the eight COLOR HARMONIES or COLOR SCHEMES. (Three points each).

21. The entire band of colors that become visible when white light is split into its component parts is called the _____. (One point)

22-25. Since color is a sensation in the brain and does not exist in the outside world, name the four factors that effect what is called "color". (Two points each)

26. The surface of light sensitive nerve endings on the inside back of the eye that converts the light that falls upon it into nerve impulses is called the _____. (One point)

27-29. List the three major COLOR DIMENSIONS, each distinguished by a separate dimension in the diagram below. (Three points each)



C. 30. Diagram: Draw a color wheel. List and arrange, in natural value order, all PRIMARY, SECONDARY, and TERTIARY hues only.

D. True/False - Short answer: Place a (T) or (F) adjacent to the number of the statement and explain the reason for your answer. (Three points each)

31. The artist must be concerned with pigment quality and surface texture. Why or why not?

32. Most people have a good ability to remember specific colors. Why or why not?

33. The factual identification of color is the same as sensitive seeing. Why or why not?

34. The light source may effect the way in which a color is seen. Why or why not?

E. Short Essay: Using a brief paragraph form, answer the following questions. (Five points each)

35. Name the additive primary colors and explain why they are known as "additive".

36. Name the light-sensitive receptors in the eye and explain their function.

37. Name the subtractive primary colors and explain why they are known as "subtractive".

38. Explain how colors are created by passing white light through a glass prism.

39. Explain the relationship between additive and subtractive color.

F. Discussion: Discuss in essay form the four aspects of color listed below. (Five points each)

40. Discuss how color exhibits physical weight.

41. Discuss how color exhibits temperature.

42. Discuss how color exhibits size differences.

43. Discuss how color exhibits spatial movement.

G. Extra Credit Essay: This question may be attempted only if all other questions have been completed. (Twenty points)

44. Discuss the process of color interaction called "simultaneous contrast". What elements, with regard to surface and receptor, must be taken into consideration?

Mid-Course Examination Answer Key

A. Matching: 1. F 2. L 3. A 4. I 5. B
6. K 7. A 8. J 9. A 10. M
11. D 12. H 13. G 14. E

B. Completion:
15. Achromatic
16. Monochromatic
17. Complementary
18. Analogous
19. Triadic (Tetradic)
20. Split Complement (Double Split Complement)
21. (Visible) spectrum
22. Light source
23. Atmosphere
24. (Reflective) surface
25. (Eye-Brain) Receptor
26. Retina
27. Intensity
28. Value
29. Hue

C. Diagram: (Evaluated Visually)

D. True/False:
31. T - The opacity and grain of the pigment, and the tooth of the surface will effect the manner in which the spectrum is reflected.
32. F - Because of the abundance of commercially produced colors, and because of the multitude of variations of natural colors, no one is capable of mentally "seeing" a specific color.
33. F - Factual identification of color can only be accomplished by a mechanical instrument such as a spectrophotometer. Sensitive seeing is accomplished by the individual, especially those trained in color perception.
34. T - Since the perceived color is principally dependent on the type of light that is reflected from a surface, the type or color of the light source will definitely effect the way in which a color is seen.

E. Short Essay:

35. The additive primary colors are red, green, and blue. These colors are called additive because, as irreducible elements of light, when combined or added together, produce white light.

36. The light sensitive receptors in the eye are the rods and the cones. The rods are sensitive to the light and dark characteristics of the visible spectrum. The cones are sensitive to the chromatic characteristics of the visible spectrum.

37. The subtractive primary colors are red, blue and yellow. These colors are called subtractive because they are tangible and they absorb elements of the visible spectrum; they absorb light energy, reflecting only that spectral frequency which relates to the chemical composition of the reflective surface.

38. When white light is passed through a glass prism, it goes from the less dense medium of air to the more dense medium of glass, and back into the air. When this physical energy passes from one density to another, its components parts (frequencies of the light) are refracted or bent, causing the light to be seen as separate color bands.

39. Additive colors are derived from a light source, subtractive colors are created by the absorption and reflection of the various frequencies of the light source. Therefore, an additive color source is necessary for a subtractive color to exist.

F. Discussion:

40. Value is the characteristic that defines color weight. Light value colors are perceived as less weighty, dark value colors as heavier.

41. Hue is the characteristic that defines color temperature. Natural and psychological (sociocultural) relationships cause perceptions which allow warm colors to advance and cool colors to recede.

42. Hue temperature and intensity, perceived as advancing and receding, and the attribute of value known as the von Bezold effect, which allows that light colors tend to occupy more space than dark colors, all demonstrate how color exhibits size differences.

43. Color value attributes of physical weight and the von Bezold effect cause colors to appear to move in space, either up and down, or as larger and smaller, respectively. Hue temperature and intensity are the attributes that define color movement as advancing and receding. Warm and intense colors advance, while cool and unintense colors tend to recede.

G. Extra Credit: When (white) light is reflected from a surface, a specific color quality is recorded on the retina of the eye and perceived mentally in the brain. The chemical makeup of the retina is increasingly depleted the longer the light energy falls on the same spot of the retina. If or as the eye is shifted, the light energy is moved from the position on which it was falling, allowing the retinal chemical to be regenerated. During the regeneration process, lasting a very short time, the eye-brain "sees" the complement of the original colored surface, thereby changing the original color by allowing the complement to visually "wash" over the physically reflected color. As an example: if a red circle is stared at and then the eye is moved to the side, and focused on a white surface, the complement of red as a green circle will be perceived. Therefore, if red and blue rectangles are placed adjacent to each other, red will cause the blue to appear slightly blue-green, and conversely, blue will cause the red to be perceived as red-orange. As adjacent colors approach a complementary paring the effects of simultaneous contrast, or adjacent hue influence, cause a vibration along the common boundary.