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Scope of Study: An attempt has been made in this report to compile information about color and its use in the school shop, which will be of value to industrial arts teachers both in the profession and those in training for it. The report tells of the progress achieved in industry with the proper use of color. It is hoped that this study will be an aid in improving this phase of the industrial arts program. The study includes a brief history of color and something of the general characteristics of color and recent development in industry. Information of a more technical nature has been excluded from this report since the aim of general education is to supply information of a more general nature.

The material for this report was taken from books and publications furnished by manufacturers and distributors of color products.

Conclusions and Summary: Industry has kept pace with scientific discovery. Therefore, changes will have to be made in the school shop that will be in keeping with industry. Providing students with work experiences that will make possible a better understanding of the processes of industry. It is recommended that color dynamics and color conditioning be included in courses taught teachers in industrial arts education and color dynamics and color conditioning be used in all school shops.

ADVISER'S APPROVAL C. L. Hill

COLOR IN THE SCHOOL SHOP

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CHAPTER I

INTRODUCTORY STATEMENT

Prehistoric man used color as a medium of emotional and communicative expression. In ancient times, color played a vital part in religion because it was elevated to the realm of the divine. Since Newton's discovery of the nature of color, nearly three hundred years ago, many books have been written on the physical aspect of color, and there have been some mystical writings on the subject plus many in its connection with art. The psychological aspect of color has generally been neglected; yet it is the psychological factor that is most important in our daily lives. If the purely physical aspects of life were sufficient, human beings would be satisfied with caves or barracks for shelter and with animal skins or sack cloth for clothing. We would not want design in architecture and apparel or expression in the arts.

Because of ignorance of the nature of color, we have much avoidable discomfort in the home, unnecessary irritability, emotional instability, considerable loss in industrial production, and inefficiency in offices and schools.

Purpose of the Study: The purpose of this study is to make industrial arts teachers both in the profession and in training for it aware of the progress industry has made with color dynamics.

It is hoped that this report will be an aid in the improvement of this phase of the industrial arts program. The author also desires that the industrial arts teacher will become more familiar with color dynamics and will realize the emphasis that should be placed upon this phase of the program.

Need of the Study: Many school shops today are functioning under adverse color conditions. The writer in making this study is attempting to acquaint industrial arts teachers with the problem of adequate color in school shops and some of the basic principles involved.

Available Literature: Many books have been written on the subject of color and new phases of color are being expanded every day. Much information may be obtained from periodicals written on the subject.

There is an abundant supply of literature from different commercial companies, and manufacturers, advertising their particular product. Many of these are free and can be secured upon request. Most of the material for this study will be taken from this type of publication.

Requests for Information: Letters requesting all available information on color, its history and use in school shops were mailed to manufacturers and distributors of color products. Replies were received from all but three of those to whom letters were mailed. The greatest amount of information was supplied by three major paint industries, Pittsburgh Plate Glass Company, Pittsburgh 19, Pennsylvania, I. E. DuPont De Nemours and Company, Inc., Wilmington 98, Deleware, and the National Paint, Varnish, and Lacquer Association, Inc., 1500 Rhode Island Avenue N. W., Washington 5, D. C. A number of books and periodicals were consulted in the search for information.

Delimitations: The Study was approached from the viewpoints that instructors might use this information in making their shops a better place to teach industrial arts, and that some form of this study be taught in courses in industrial arts education to those students who plan to teach industrial arts.

Definitions of Terms: The following are definitions of terms common to the color or paint industry. These terms have been used in this report and are selected from books and pamphlets used in the bibliography.

Afterimage: The color that appears after the eye has been stimulated by another color. Looking at a color for about 30 seconds before turning the gaze to a white or neutral surface brings forth an afterimage of the complementary color. This phenomenon is due to the fact that complementary colors are seen by one optic nerve. The eye has an optic nerve for red and green, another nerve for blue and yellow. Mixed colors are seen by co-ordination of the two nerves. (1 page 230)

Chroma: Means the same as tone. It is used to describe the degree of purity or amount of gray content in a color. (1 page 231)

Color: A general term that includes hue, shades, tints and tones. (1 page 231)

Color System: An organized plan of color combinations based on physical, optical and psychological principles. (1 page 321)

Complementary Colors: Colors that are physically, physiologically and psychologically related. Of the complementary colors, one is always a primary color and the other a secondary or a mixture of the two primaries. (1 page 321)

Contrast Factor: Degree of contrast between colors. A deep shade and a delicate tint have maximum contrast. Complementary hues are also contrasting. (1 page 322)

Cool Colors: Blue and colors in which blue is dominant. (1 page 323)

Hue: A color without black or white. (1 page 323)

Primary Colors: Basic hues that cannot be broken down into component parts. In pigment, the primary hues are green-blue, yellow, and magenta red. In light, the primary hues are violet-blue, green, and orange-red. (1 page 322)

Reflection Factor: The degree of white light that a color reflects. (1 page 322)

Secondary Colors: Colors consisting of two primary hues. The primary colors in pigment are the secondary colors in light. The primary colors in light are the secondary colors in pigment. (1 page 322)

Shade: A hue with black added. (1 page 322)

Specific Identity: A color in which the hue can be recognized instantly is said to have specific identity. A color with much gray content (a tone) does not have specific identity, although it does produce a characteristic psychological effect. (1 page 322)

Spectrum: The band of colors seen when a ray of light is broken up by a prism (or by raindrops as in the rainbow). The hues of the spectrum are popularly called red, orange, yellow, green, blue, and violet. More correctly, the colors should be called magenta red, orange-red, yellow, green, green-blue, and violet-blue. Orange-red, green and violet-blu are the primary colors. The other hues result from merging of the primaries. (1 page 322)

Tint: A hue with white added. (1 page 323)

Tone: A hue with white and black gray added. (1 page 322)

Value: The intensity, lightness or darkness of a color. (1 page 323)

Vibrant Colors: Pure warm hues and pairs of pure complementaries. (1 page 323)

Warm Colors: Red and yellow and colors in which red and yellow hues are dominent. (1 page 323)

Wave Length: Colors travel through space in waves of radiant energy. The waves length is the distance from crest to crest in the waves. Specific colors correspond to definite wave lengths of light. Mixtures of colors are mixtures of wave lengths. (1 page 323)

Coloramics: A summary of some of the problems and suggestions for a constructive plan of operation. It is recognized that all of these changes cannot be made at once but as the years go by, industry will profit by incorporating these ideas on color in its long-range thinking. (19 page 5)

Color Dynamics: Color dynamics is based upon the scientific use of the energy of color. (21 page 4)

Color Conditioning: Psychological reactions, combined with eye easing physical attributes of color are the bases of scientific painting plans. (22 page 2)

Presentation of Study. This study has been approached with the thought in mind of the information contained being included in the subject matter for industrial arts education courses, and in school shops. For that reason, technical information has not been stressed. Since prices fluctuate, they too were not included. The plan of presentation will include four other chapters. Chapter II, The History and Development of Color; Chapter III, The Use of Color; Chapter IV, Color in Industry and in School Shop and the last chapter will be composed of conclusions and summary.

CHAPTER II

HISTORY AND DEVELOPMENT OF COLOR

Color is as old as the human race. Prehistoric man used color. The peoples of ancient civilization employed color in expressing their feelings and ideas. The Chinese, the Hindus, the African natives and the Westerners all used color in decoration to express their emotions and to make their environment more pleasant and inspiring.

The Early History of Color: There is nothing new about using color for enhancing the appearance of interiors of homes and other structures. Man, some 10,000 or more years ago, mixed the charred bones of animals, colored earths and hair with milk, water or the juice of berries to produce a crude paint which he applied to the walls of his cave to make it more livable and possibly to excite the envy of his neighbors. (20 page 5)

> More than five thousand years ago the Egyptians used yellow, blue and green pigments, and an earthen red like our burnt sienna or Venetian red. They had these colors in ink and in paint. (1 page 98)

It is interesting to note that although they developed color to a great degree they had no knowledge of perspective, which is the art of drawing solid objects on a two-dimensional or plane surface so as to produce the appearance of the actual object as viewed from a specific point.

In other words, Egyptians did not know how to portray three dimensions on a two-dimensional surface, but they did know how to express ideas in color.

Orientals still do not bother about perspective. And not until the fifteenth century did European artists begin to introduce perspective into their painting. But no matter what kind of art form a people had, color was a vital part of their art expression.

Light, including its components, is of a physical, physiological, and psycho-physiological nature. Because of this, man from his earliest days must have been cognizant of color.

> Reference to the observance of color is indirectly indicated in the reference made to the rainbow seen by Noah after the emergence from the Ark, and in the "coat of many colors" worn by Joseph to the envy of his brothers. (2 page 1)

The Greek philosophers speculated about color as did the artists and scientists of the Renaissance, but it was not until Sir Isaac Newton, after his return to Cambridge in A.D. 1666, fixed his attention on the phenomenon of the refraction of light through a prism that the modern concept of light and color had its beginning.

Newton's experiment led him to the belief that light instead of being a simple homogeneous substance is made up of a number of rays differing in refrangibility and color. In a paper presented to the Royal Society, of which he had been made a fellow in 1672, Newton presented his theories concerning light which included that of the corpuscular nature of light. An eminent contemporary of Newton, Christian Huygens of Holland, presented a differing theory on light to that of the English scientist. In his, he propounded the undulation theory but because of the tremendous influence of Newton in the field of science, the Huygenian theory was neglected for years, but was subsequently proved correct.

About three hundred years ago, Sir Isaac Newton discovered the phenomenon of the color spectrum by emitting sunlight into a dark room through a hole in the window shutter. He pursued the study of this color phenomenon and proved that white light is compound in nature and that it is composed of all colors. Directing the rays of the white light of the sun through a prism, he created a spectrum, and by refracting these rays through another prism, he in turn produced a white light.

From his several experiments, he discovered further that the color of objects is obtained by selective reflection. When light strikes an object, certain light rays are reflected which gives the color of that object, while all other rays are absorbed. Thus Newton is the father of the increasingly important science of color engineering, but little or no practical application was made of his findings until nearly 130 years after this discovery. Newton's immediate followers did not understand or recognize the natural relation between color and wave length.

In the latter part of the eighteenth century Sir Thomas Young discovered that colors have definite wave lengths. Upon proving that the wave length of red light was longer than that of violet, he paved the way for the discovery of the infra-red ray by Sir William Herschel in 1800, the ultra-violet ray by Edomond Becquerel in 1842, and the X-ray by Professor Roetgen in 1890. All of these rays are invisible, but it was not until 1936 that research technicians adopted the colors of the visible spectrum. That is, color was used as a specific.

Various rooms in hospitals were painted in certain colors to comfort the patients during their convalescent period. This became known as color therapy. Thus, color engineers followed the advice of Newton that "The science of colors becomes a speculation as truly mathematical as any other part of optics."

Thomas Young, the English scientist, presented his famous paper concerning light and color to the Royal Society in the year 1802. The idea of three primary colors was not novel with Young, as both Lambert and Tobias Mayer had advocated Three-primary-color schemes during the eighteenth century, but none of Young's predecessors had grasped the idea that color is a sensation and that the matching of color is a psychological process. It was the great contribution of Young and his successors, notably Helmholtz of Heidelberg, Germany, that color sensation is the result of tri-vision in the human eye and that in normal eyes there are a multitude of nerve receptors which are of three groups or types, each type being sensitive to only one primary color. The fusion of the three primaries takes place within the optical nervous system, and thus the sensation of color becomes a psycho-physiological process.

The Color Wheel. Sir Isaac Newton designed the first color wheel. It was late in the seventeenth century when he took red, orange, yellow, green, blue, indigo and purple and arranged them in a circular form. These were the seven spectrum colors he could see when he looked through a prism of light. They were, incidentally, the same colors you see in a rainbow where the drops of moisture in the air act as millions of tiny prisms.

General color systems, or theories, have been developed to further the understanding and use of color. Among them are the systems developed by Chevreul, Brewster, Lewis Prang, Snow and Froehlich, Walter Sargent, Albert Munsell, and Wilhelm Ostwald.

The two most used systems are the Prang system and the Munsell system. The Prang system is a system which requires twelve colors to complete the spectrum circle and Munsell omitted orange from his system of colors and maintained that only ten colors are required to complete the spectrum circle. The Munsell system is one in which color can actually be measured.

Red, blue and yellow are primary colors and all other colors, with the addition of black and white in some instances, can be produced by properly mixing these primary hues. White and black are "colors" of the highest and lowest values respectively, which possess neither hue nor chroma. Hue is synonymous with color and may be defined as the quality by which we distinguish one color from another. Hue is referred to as the first dimension of color. Value, the second dimension of color, is that quality by which we distinguish a light color from a dark one. Chroma, the third and last dimension of color, is that quality by which we distinguish a strong color from a weak one. Chroma is closely related to value because a strong color becomes weaker as it is lightened or darkened by white or black respectively. Chroma is often referred to as "intensity." A color of its greatest intensity is also of its greatest chroma. All degrees of intensity, or chroma, end in gray, extending from gray to the fullest intensity of that color.

Discord in harmony affects the eye much the same as musical discord affects the ear. Correct color harmony depends on the proper selection and combination of color. The first color harmony, the complementary, is harmonizing of color by contrast. To create the complementary color harmony, it is necessary to select the hue on the opposite side of the color spectrum circle. Blue may be trimmed with orange, but the painter must remember that since orange is a hot color it should occupy the smaller area. For greater variety and more pleasing results, it is sometimes desirable to select the split complementary harmony, in which blue may be trimmed with the two colors on either side of orange. Still greater variety can be obtained by splitting the complement still further until an equilateral triangle is formed. This triangular harmony is known as the "triad harmony." Using the same complementary colors, for example, blue may be trimmed with yellow or red, the two colors that when mixed make orange. The resultant of these colors, blue, red, and yellow, is gray, which signifies harmony. Harmony by contrast--be it direct complementary, split complementary, or triad--is known to be the loudest of the color harmonies.

With the passing of centuries and growth in population, dwellings and structures of all kinds rapidly increased in number. More and more people are going to use more and more color in and around their homes, offices and apartments. Building owners will use color more freely in the structures they own. To attract and retain high grade employees, the interiors of more and more plants and factories will be color planned. Schools, colleges, hospitals and institutions are using more and more color every time they decorate. The demand for color is not restricted to a few localities. It is world-wide. It is not a temporary demand or a passing fad. Color is here to stay!

Chapter III

THE USE OF COLOR

Color is used for a multitude of purposes in the form of paints. Decorative paints can be supplied in hundreds of hues. Each color has a special purpose, and many years of experimenting have been necessary to develop the right color suitable for the right purpose. Trouble may be caused by using the wrong color. The most important thing is the selection of the right color for the purpose.

The Functional Use of Color: Since all radiant energy travels at the same rate of speed, approximately 186,000 miles per second, and there is the same interval between every two waves, the shorter waves vibrate more often in the same period of time than do the longer waves, and thereby create a different color sensation. Also, invisible waves of varying wave lengths and frequency have been utilized by scientists in the form of infra-red, ultra-violet, x-ray and others for the benefit of mankind. Surely it is reasonable to conclude that all radiant energy, including visible light and the color sensation it produces can be used effectively in a number of ways for the enjoyment of life.

Furthermore, it is a scientifically established fact that every color in the rainbow has its primary association. For every color there is some one thing that is most closely associated with it in the subconscious mind. Thus various colors are given definite functions to perform in the field of color.

Yellow suggests sunlight and warmth. Therefore, it has a cheering and stimulating effect. (18 page 4)

Blue is a cool color, calming and spacious in its effect. If incorrectly used, however, it may be depressing. (18 page 4)

Red is generally associated with danger, fire, excitement. Used with discrimination, its effect can be energizing. Too great a use of it, on the other hand, can cause irritation. (18 page 4)

Green has characteristics of both of its components--blue and yellow. Because of its association with nature and its eye-resting qualities, it has an almost universal appeal. (18 page 4)

Violet has the formality and richness of both red and blue from which it is derived. It has always been associated with royalty and luxury. Its practical uses are limited. (18 page 4)

Orange, being made from red and yellow, possesses attributes of both. It is the brightest and most cheerful of all colors. Tints of orange, such as peach, ivory and buff are among the most adaptable colors and widely used. (1 page 4)

Psychological Effect of Color: The physicist studies in light. The chemist produces pigments. The artist mixes color to produce beautiful designs and pictorial compositions. The physiologist or medical doctor studies the relationship of color to the eyes and other parts of the human body. The psychologist, finally, studies color as it affects the emotional life of man.

All people experience color sensations. Many people, however, completely lack color perception--that is, they are not aware of their color environment and have no conscious reactions to specific colors.

But color sensation affects people who are completely unaware of the presence of color. Often the visual sensation produces a physical reaction. People will feel cold in a blue room and hot in a red room, yet not realize that the color produces the sensation.

Colors are divided into two distinct groups, cool and warm colors. The cool colors are blue and colors predominantly blue. The warm colors are red and colors predominantly red and yellow.

The cool colors have a sedative effect, and being in an environment of cool colors has proved to be very calming to highly nervous people who feel extremely uncomfortable in an environment with an abundance of certain types of red. Some persons become depressed when surrounded by strong blue. Still others react negatively to yellow.

Generally, people surround themselves with diluted colors (tints or tones) of both cool and warm hues, unconsciously seeking a balanced diet of calming and stimulating colors.

We should always differentiate between our sensations of colors and our knowledge of them. Our sensations come through the senses; our knowledge comes through the intellect.

Sensations plus associations result in perceptions. Knowledge comes only after the perceptions have been analyzed and formed into distinct conceptions.

Most experience with color is only on the level of sensation; most people are not conscious of color effects and have no awareness of its influence. However, although color sensation does not always reach the conscious mind, it nevertheless creates an emotional response which is best illustrated by the fact that people feel cold in a blue room and warm in a room with much red.

> Primitive people have very strong emotional response to color, but they are attracted by pure hues only. Delicate tints are washouts to them, and to some they represent weakness. Many savage tribes associate loud colors and noises with manliness and power. (1 page 71)

<u>Children</u> <u>are</u> <u>Like</u> <u>Primitives</u>: They are not attracted by delicate or deep shades. Baby pink may be a thrill for mama but it leaves baby unimpressed. A very hot red may annoy the cultivated sensibilities of the modern mother, but it is a thrill to the two-or three-year-old. Children from the age of one to six are very much intrigued with pure colors. Normal children like red best and blue least. However, it has been observed that children who are emotionally unstable or are given to morbidity choose blue or black as the favorite color. Children who are starved for sunshine prefer yellow, and those in the slum areas where shrubbery is rare are attracted by green.

<u>Color</u> <u>and</u> <u>Mood</u>: We speak of gay colors and somber colors, of colors that depress and colors that give pleasure. We have gone to places that make us feel gloomy, and we have been in others that inspire gaiety. Only few people realize that the color of the room is largely responsible for the mood.

A football coach used color wisely in fitting up his men's dressing rooms. For the room where they lounged and relaxed, he chose a soft restful blue; for the one where "pep Sessions" were held, a stimulating red.

<u>Color</u> <u>and</u> <u>Choice</u>: This is often based on social, cultural and economic factors. You do not always disregard the social element. Your neighbor's opinion often will affect you. The taste of the community may influence your color choice.

Your early upbringing and educational and cultural background are important factors in your choice of color. For example, you may have been taught in childhood that pink is a sissy color or that red is in bad taste.

Color Increases Values: Cost is often the reason for not having the right color in the home. You may feel that you want furniture of blond wood, but you find it too costly; or you may think you should have a few red pieces, but they are priced much higher than the dark brown ones. Thus, for economic reasons your house is furnished in dark brown. Economic incentives also are often responsible for atrocious colors in clothes as well as in the home.

Cold and Warm Light: They have distinct characteristics which can be used effectively for special purposes in restaurants and places of entertainment where the intention is to encourage people to linger, yellow or warm lighting is very effective because it flatters the complexion, creates a sense of coziness, produces the effect of warmth and induces the desire to relax.

During the butter shortage when margarine was served in its natural cold white state, people refused to eat it. But when the margarine was colored to a warm soft yellow, people enjoyed eating it, and most of them did not realize it was margarine until they were told.

What color plate should be used for green salad? This question was asked a number of people. Some said any color, some said white, others said blue, and there were a few who said green. None realized there is a scientific approach to the subject.

The answer is that the plate should be of a color complementary to the green salad--a cool red. This red will make the salad look greener and fresher because complementary colors enhance each other.

But red still does not describe the color fully. The red has to be diluted. Actually it should be a cool pink which expresses delicacy and subtlety.

Designs for food packages should, whenever possible, have a color symbolizing that of food. For example, brown of a specific hue characterizes coffee. For fruit packages, a realistic color photo or painting of the fruit can also be made part of the design.

> For many years a bridge in London was called "suicide bridge." It was painted black. Finally, the bridge was repainted green and the suicides practically ceased. (19 page 10)

Color In School Aid To Education: Once upon a time, "School" meant physical and mental drudgery in poorly lighted and stuffy rooms. Thousands of children march daily into bare, ugly school rooms when they might just as easily be absorbing beauty of surroundings at the same time they absorb knowledge. Modern schoolrooms, however, are intended to provide for our children favorable lighting conditions and a healthier environment in which to study.

The primary consideration in color planning for schools is to create the best environment for learning. The colors used in schools must be as inviting and stimulating as the modern methods of teaching; however, the decor must not draw attention away from the teaching, but supplement and embellish it. The color must be bright and cheerful, but not garish; it must be light, but not glaring; it must be varied, but harmonious.

There are several color stylings used in classrooms in schools. In selecting the color with which to work, consider the light reflective value of colors.

Color to be used in classrooms should have reflectance value of between 50% and 70%. Within this range are such colors as pink, yellow, pine-frost green, spray blue, and the intermix shell white is used almost without exception for the ceilings.

After determining the colors, next consider the exposure of the room. In rooms having a cool (north or east) exposure, the use of warm colors such as pink, yellow, and peach should be used. In rooms having a warm (south or west) exposure, use cool colors such as green, aqua, and gray. This achieves a feeling of color balance in each room.

It is better to be guided in color recommendations solely by room size, architectural design, exposure, and function, than be guided by the likes and dislikes of a teacher.

Consideration must be given to permanent fixtures, and color selected for ceilings and walls must harmonize with the colors of these permanent fixtures. In classrooms, the fixtures would be such things as floors, the furniture and woodwork and chalkboards. Other permanent fixtures would include such things as tile dadoes appearing in washrooms or shower rooms, toilet partitions used in toilet rooms, lockers appearing in locker rooms and corridors. Therefore, any fixture or part of the room or furnishing which is not to be painted or replaced must be considered in the selection of colors for that room.

Another factor to be considered is the function of a room. In many cases this overshadows the importance of exposure. Several examples of this are as follows: in a cafeteria or lunch room a color conducive to good appetites should be used such as peach. In a gymnasium where a great deal of physical exertion takes place, a cool color such as aqua or green is most satisfactory. This principle could also be applied to metal and wood shops and typing rooms. A neutral gray should be used in art rooms so as not to detract from the colors being studied and used. Yellow has been found most satisfactory for use in chemical labs as it shows the least amount of discoloring from chemical fumes. These are just a few examples of considering the function of a room with relation to the colors to be used in the room.

The use of dadoes or wainscoting in classrooms is rapidly becoming out-dated. They were originally used for practicality as the lower areas of the wall most often became soiled. Today, with highly washable wall paint, a wall can be spot washed easily and therefore the need of the dado is gone.

When all of these considerations are united in color styling a school, the best possible environment for learning has been created.

All human beings are consciously or unconsciously influenced by pleasant surroundings. In a pleasant environment it is natural to be in high spirits and have a friendly attitude. If color produces these in the home, office, school, and factory, this will be a better world in which to live.

Chapter IV

COLOR IN INDUSTRY AND IN SCHOOL SHOP

Vocational rooms or industrial arts shops in a school are not unlike those in industry. Machines and other equipment found in these shops are also found in industrial plants. Here in classes, students are familiarized with the operation of the various machine tools and working conditions and fitted ready for their place in our industrial world.

Coloramics. At long last industry has awakened to the fact that colorful horizons can improve the efficiency of the industrial worker. Color appeal will do much to increase production and do away with irritability and inefficiency.

For years, the new industrial society has been giving considerable thought to time and motion studies, safety, general health and welfare of the worker and other items of like nature....but has neglected the most useful and complex of all senses, vision. It has been estimated by experts that through vision the worker receives eighty per cent of his knowledge of the world, and this means within the re-engineered plant, too. Such things as white walls, near-black walls, dirty gray ceilings, dirty gray or black machines, dark colored inspection tables, dull colorless floors and bad and improper lighting can and will contribute to body fatigue. This history of modern industry abounds with examples of color objectives that have contributed definitely to fewer injuries, less absenteeism, better quality of production and, in general, good industrial relations between employer and employee.

Coloramic is a summary of some of the problems for a constructive plan of operation. It is recognized that all of these changes cannot be made at once but, as the years go by, industry will profit by incorporating these ideas on color in its long range thinking.

When a beam of sunlight shines through a prism, the rays are split up into the hues of the rainbow. The 130 million nerves or rods, of the eye are sensitive to black and white and are spread over the retina. The cones, in the center of the eye, see the colors. The question has often been asked...."Why do you see colors better in daylight?" The central nerves and cones of the eye are active under bright light but inactive at night in dim light. In dim light the rods are most active. It is hard to believe, but some scientists state the human eye can see 100 million different colors, transmitting images to the brain. The eye itself can last 130 years, provided corrective measures are taken. Wrong colors, as well as ill health, are the big destroyers. They must be eliminated from inside our industrial walls. Much has been done on the health side, but little achievement has been made by either large or small businesses on a constructive color program. Isn't it therefore, essential that every effort be made to help in prolonging the useful life of one of our most precious possessions?

The functions of color are many, extending from camouflage by subtle binding to acclamation by sharp contrast. Coloramics applies these functions to accomplish a fourfold objective:

1. To promote better employee relations.
2. To improve efficiency of operations and reduce accidents.
3. To maintain quality of product.
4. To increase the longevity of the eye.

<u>Color Dynamics</u>. Color dynamics is based upon the scientific use of the energy in color.

It is a well-established fact that color affects and influences human beings of all ages. Scientific tests have shown that some colors stimulate and excite. Others soothe and relax. Still others create fatigue, depression and irritation.

Only a small percentage of all radiant energy contributes to the sensation of visible color. The exact color sensation created depends upon the wave length of the light and its corresponding rate or frequency of vibration. It is desirable to secure variety throughout the school being decorated by the choice and placement of colors. The avoidance of monotony is a rule of color dynamics and the use of more than one wall color is often advocated. Some areas call for stimulating colors while calm, soothing colors are more appropriate in other places.

In classrooms devoted to certain subjects it is highly important to secure and retain the attention of the pupils where the instruction is being given. Color dynamics meets this problem with a functional application known as a focal wall. The focal wall is painted a darker or lighter value of the color used on the other three walls, or a contrasting color--one which will focus the attention of the student on that part of the room, and, at the same time, not be conducive to eye strain.

A darker color is most often used for establishing the focal wall, since a slightly darker value is usually more restful than the lighter colors surrounding it. In this case the same color may be repeated on the lower portion of the outer three walls, where there is a dado or wainscot. An important consideration should be the atmosphere in which a teacher works. They should never be forced to look into strong light. Wherever possible a wall painted in an eye-rest color should face the teacher. In cases where a focal color is used on the front wall, the same color should be used on the opposite wall for this purpose, provided the teacher faces it often.

Color For Floors and Aisles: Under certain circumstances, the under portion of products being fabricated requires more illumination. An example is an airplane wing where good visibility is essential below as well as above. Similar conditions prevail in the fabrication of all large objects which cannot be turned readily for better observation. The remedy is to increase the reflectivity of the floors, thus gaining the benefits of proper light diffusion to the under side of the product being worked on. (21 page 23)

Consider a blue gray or pewter gray. To achieve any efficiency, floors should reflect 20 to 30 per cent of the light that strikes them.

Aisle markings give one a choice of colors. These markings are to denote zones and should be clearly defined. Suggested colors are brilliant yellow, white, red, bright blue, deep blue, orange and black. Much depends on the floor color. Orange is popular.

Color for Walls and Ceilings: All other things being equal, almost everyone feels a bit more lighthearted on a sunny day than when the skies are overcast. Yet many factories use colors on walls and ceilings which give the impression of a perpetually cloudy day. Cheering up such an interior is extremely simple, with colors that suggest sunlight.

> In factories where the temperature must necessarily be high, cool colors act as mental and emotional stabilizers. On the other hand, warm colors are used where low temperatures must be maintained. (21 page 18)

Certain walls stand directly in front of machines. They are constantly in the worker's field of vision and are glanced at frequently in the course of the day. If the machine is dark and the wall light, the eye has to make a quick adjustment. The energy required to make this adjustment a few times is slight, but multiply it by several hundred during the course of the day and you have a very common source of eyestrain. For this reason, eye-rest surface should have approximately the same general value of color as the one the worker sees when he is concentrating on his work. Furthermore, the human eye that has seen an excess of one color compensates by seeing the complementary shade of that color when the glance shifts to any light colored surface. For instance, a worker on a red plastic will see green for a few seconds when he looks up at a white wall. This produces a slight feeling of mental confusion which may gradually impair his efficiency. The logical way to eliminate this difficulty is to paint the wall the complementary hue of the red plastic, namely green.

This is the most natural relief to the eye that has seen red.

White or buff is the best color for ceilings. White is important to assure light reflection and to reduce shadows. On walls, use sea mist green or pale blues or mellow grays.

<u>Color in Overhead Cranes and Factory Trucks</u>: The center section of overhead cranes could be painted with alternate stripes of brilliant yellow and black which would be sufficient to promptly locate the crane, whereas the other portions could be painted in a harmonious color to blend with the background. It is not necessary to paint the entire crane a brilliant yellow, for it may prove too distracting.

> The automotive equipment should be painted in colors with high visibility to warn workers of their approach. Factory trucks can be painted either red, a brilliant yellow or orange, striped in black on both front and rear. (19 page 19)

Movable bins used to collect or distribute material should also be treated with colors that shout for attention. The inside of the bin should be given a contrasting color which makes it easy to see just how much material is in the bin.

<u>Color Applied to Machines</u>: The critical or operating parts of the machine should be given a color that comes quickly to the eye, a color that pops up in strong contrast to the stationary or non-critical parts of the machine. This is known as focal color. It focuses the worker's attention exactly where it should be--arrests his eyes and reduces the unnecessary travel which is bound to occur when the whole machine is a monotone in machine gray. Eye travel throughout the working day is a common cause of fatigue.

While the critical part of the machine must come forward, the non-critical parts must drop back. The widely used machine gray does this to some extent, but is in itself a somewhat depressing morale lowering color. After careful study, the Pittsburgh laboratories have developed a receding color called vesta green for the body of the machine. No other color has such a relaxing effect on the human eye as green, yet it does not act as a depressant. The widespread use of green by nature in forests and fields is the perfect proof of this point.

Vesta green is recommended for the body of most machines. Occasional exceptions occur to this rule. In plants engaged in food preparation it may be advisable to use white to give a more sanitary appearance.

> In as much as there are so many various types of machines, it is impossible to cover in detail what should be done in using colors for each individual machine. (19 page 21)

Paint the electric control push button box for starting and stopping machines a brilliant red or blue. Moving parts and parts used for operating the machine might be painted orange.

Stock Boxes and Work Benches: Within the past years it has been found that small stock boxes, if painted green or yellow, will seem lighter to handle. Some plants have now repainted all their small stock containers to take full advantage of this discovery. Large stock receptacles present another problem. It is recommended that these continue to be painted yellow or orange with black stripes for contrast.

Considerable thought has been given to assembly lines and work benches or tables within recent years. Here again, the size of the articles and the color must be blended in such a way to eliminate afterimage and eye fatigue. Each case will present a different problem, but remember to avoid irritating clashes.

Color For Safety: Traditionally, certain colors have certain meaning. White has always stood for purity and cleanliness, red for fire, green for safety, yellow for caution. It seems logical to assume that color can be profitably used as a means of improving safety conditions everywhere.

> In 1944, DuPont, in cooperation with the noted color expert, Faber Birren, devised a standardized safety color code, which was approved by the National Safety Council. (22 page 18)

The widespread use of the code is testimony to its soundness in principle and efficiency in practice. The DuPont Safety Color Code is an integral part of the color plan worked out to reduce accident rates, cut time losses and improve human well being.

Yellow, a high visibility color, should be used as a band when marking busy aisles, moving objects. When used in combination with black, as parallel bars, yellow and black identify moving objects that create hazards of striking against, stumbling over, or falling into. (21 page 17)

Orange, combining the vitality and intensity of red with the high visibility of yellow to produce a color which has more attention value than any other color, should indicate dangerous parts or areas. Machine guards or moving parts that extend into aisles would be tipped or banded with orange. Crushing or cutting edges should be identified by an orange stripe, and the interior of electrical switch-boxes, doors, and emergency switches on machines should also be painted in brilliant orange. (21 page 26)

Red, the physical color associated with fire, should be used to identify the location of fire fighting equipment. (21 page 26) When marking columns where fire extinguishers are located, band the columns near the ceiling and the floor as well as the extinguisher location. The floor should also be painted red, 12 inches from each side of the column. The use of red bands near the ceiling, identifying fire fighting equipment, makes for easy location from any part of the shop floor.

Blue is suggested as a caution color. Blue tags or flags should be used to warn against moving equipment on which work is being done. Blue discs can also be hung on machine controls when the machine is down for repairs. These discs or flags should be lettered out of order.

Green, always associated with safety and medical practice, should be used to identify safety equipment and its location. The write cross and a green background identifies cabinets containing first-aid material. Entrance to first-aid rooms should be prominently identified by a white cross against a green background or edged with green. Safety shower locations and the head of the showers should be painted safety green.

Stocks of raw materials or merchandise quite often are piled in the aisle or before fire equipment in such a manner as to completely block the area. Floor space which is apt to be used for periodic storing of material should be clearly marked in solid white, in such a manner as to leave traffic lanes and safety stations free and open. White is used as the guiding hand for indoor traffic. White arrows on the floor indicate traffic flow. White areas on the floor around waste receptacles will promote good housekeeping.

<u>Color In Identification Of Pipe Lines</u>: Fire protection materials, equipment and sprinkler system are painted a bright red. Dangerous materials such as acids, gasses and steam above 212° F. should be painted yellow or orange. Safe materials such as drinking water, compressed air and steam below 210° F. can be painted green, gray, white or black. Extra valuable materials which are usually safe but of high value should be painted purple.

There is now a proper application and use of color for walls, ceilings, floors, piping, fire and safety equipment, tools, machines, production lines, and work benches. This application and use of color in school shops and in industry has been termed color dynamics. Color conditioning and coloramics and all of the names are excellent but relatively unimportant. The vital fact is to utilize the energy in color scientifically so as to promote efficiency in school shops and in industry to reduce accidents.

Chapter V

CONCLUSION AND SUMMARY

The American way of life has become highly scientific and industrialized. Industry has kept pace with scientific discovery. Therefore changes will have to be made in the school shop that will be in keeping with the industrial, economic, civic and social nature of society, providing the student with work experiences that will make possible a better understanding of the processes of industry.

<u>Summary</u>: The paint industry has assumed an important role especially in regards to scientific study and the use of color in the industrial world. For many years, the Pittsburgh Plate Glass Company and the E. I. DuPont De Nemours and Company have devoted much time and attention to the study of this influence of the energy in color upon people. From this exhaustive research the system of color dynamics and color conditioning was developed.

Since the introduction of color dynamics nearly a decade ago, it has been widely applied in many hundreds of important industrial plants with highly satisfactory results. Eye fatigue has been reduced, physical fatigue has been lessened, absenteeism has been curtailed, health of workers has been safeguarded and the number of accidents has diminished. As more work per man hour and more hours per man have resulted, the relationship between employees and the management has become better. Color dynamics should be given a prominent place in the industrial arts program.

The psychological effect of color is important. When selecting colors for the school shop which merely seem attractive, one may be forcing those who occupy this room to work and study in surroundings that are psychologically unsuited to them. Such surroundings may gradually get on their nerves, affect their work, and cause them distress and unhappiness. With color dynamics, one avoids such errors. Decorative arrangements which will increase efficiency and improve morale, health and well-being may be selected with scientific accuracy. Color arrangements based on the principles of color dynamics can lessen or prevent eye fatigue, which so often contributes to physical fatigue, and leads to nervous tension, absenteeism, and less efficient shop work.

Reduction of eye fatigue will not only stimulate energy and improve concentration but will, likewise, raise morale. One may help to bring about a better spirit among teachers and students. Their spirit of cooperation and loyalty may improve which is important to the industrial arts program and the shop teacher because students in the school shop today will be in industry tomorrow.

In conclusion, the writer would like to state that color dynamics be included in courses taught to teachers in Industrial Arts Education and color dynamics be used in all school shops. The correct use of color, combined with proper maintenance, gives teachers and students a feeling of pride in their surroundings and fosters a desire to assist in keeping the shop neat and orderly.

It is recommended that all school shops, for the future, be painted or redecorated as suggested in the preceeding pages of this report. If a shop is to be painted or redecorated, all of the advantages previously mentioned may be achieved without extra cost by following the principles of color dynamics and color conditioning.

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APPENDIX A

This is a list of the manufacturers and distributors of color products who replied to requests for information on their products.

1. Pratt and Lambert, Inc., New York, New York.
2. Devoe and Reynolds Company, Inc., P. O. Box 328, Louisville 1, Ky.
3. De Sota Paint and Varnish Co., Forest Lane and Shilo Road, P. O. Box 186, Garland, Texas.
4. The Sherwin-Williams Co., 101 Prospect Avenue N.W., Cleveland 1, Ohio.
5. E. I. DuPont De Nemours and Company, Inc., N.W. 10th and Market Streets, Wilmington 98, Deleware.
6. Allied Paint Mfg. Company, 2300 North Lewis, Tulsa, Oklahoma.
7. Pittsburgh Plate Glass Company, 632 Duquisne Way, Pittsburgh 22, Pa.
8. National Paint, Varnish and Lacquer Assn., 1500 Rhode Island Ave. N.W., Washington 5, D. C.
9. National Lead Company, 722 Chestnut Street, St. Louis 1, Missouri.
10. The Glidden Company, 1101 Madison Avenue, Cleveland, Ohio.
11. Phelan-Faust Paint Mfg. Co., General Offices, 932 Laughborough Ave., St. Louis 11, Missouri.

OKLAHOMA INSTITUTE OF TECHNOLOGY
OF THE
Oklahoma Agricultural and Mechanical College
SCHOOL OF INDUSTRIAL ARTS EDUCATION
AND ENGINEERING SHOPWORK
Stillwater, Oklahoma

February 5, 1954

Gentlemen:

I am starting a research project in which a study is to be made of color and its use in school shops. This research is part of the work required for a Master of Science Degree, and is under the direction of C. L. Hill, Associate Professor of the School of Industrial Arts Education and Engineering Shopwork, Oklahoma A. and M. College, Stillwater, Oklahoma.

I would appreciate any information about colors which are manufactured and distributed by your company. This may include catalogs, description bulletins, and circulars on subjects such as:

The use of color
Psychological effects of color
The use of color in industry
The use of color in school shops
Color and safety

I would appreciate any information which you may give. Your immediate attention will be appreciated.

Yours very truly,

Warren G. Frazior
1217 Cypress Street
Hot Springs, Arkansas

Approved by:

C. L. Hill, Associate Professor
School of Industrial Arts Education
and Engineering Shopwork

VITA

Warren G. Frazier
Candidate for the Degree of
Master of Science

Report: COLOR IN THE SCHOOL SHOP

Major: Industrial Arts Education

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Date of Final Examination: July 1954

REPORT TITLE: COLOR IN THE SCHOOL SHOP

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TYPIST: Betty Tate