TEMPERA PAINTING

(AN INVESTIGATION OF THE AESTHETIC AND TECHNICAL ADVANTAGES OF THE MEDIUM)

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INTRODUCTION

The balance between practical and theoretic components in the total submission bears relation to the title of this essay where aesthetic advantages are largely theoretical and where technical advantages refer mainly to the practical component. The historical significance of this structure is to be found in the earliest treatises on painting, Cenninni's treatment of painting as a purely practical matter is in accord with medieval tradition. His recipes are aligned according to the various individual techniques, tempera painting being the most significant to this essay. Practical recipes are interspersed with directions for the representation of various pictorial themes, and in the resultant conglomeration, the subdivisions are discernible only as basic premises. In contrast to him, the Renaissance authors beginning with Alberti[1] make a significant innovation in that they divide their material into a theoretical and a practical part. The inter-relationship of practical and theoretical - aesthetic and technical aspects are un-avoidable when it comes down to realities. This is clearly illustrated in the notes of Leonardo da Vinci. Plans for the organization of the treatise are vaguely formulated. In the chapter "On the mixture of colours" he says that his subject is to be placed between the theory and the prac-

1. Cennino Cennini (ca. 1400) Leone Battista Albertii (ca. 1435) Averlino Filarete (ca. 1460) Piero della Francesca (ca. 1485)

tice of painting.[1] The author has encountered similar difficulties in separating the aesthetic from the technical. In the search to define the nature of tempera painting the structure of the essay progressed in a seemingly logical way but aspects of aesthetic advantages are discovered within the discussions on technical advantages. The history of materials that constitutes tempera painting provides a source for both aspects while references to written evidence on the techniques usually present subjective views. Many treatises on the other hand contain strict rules and are in most cases obsolete, for the artist's demands upon his materials have changed with his changing mode of expression. Although some painters of the last century seriously concerned themselves with the technique of painting and the materials of the old masters, they left us, with a few exceptions, not many publications useful for practice. At the end of the 19th century art and science had parted company for so long that any painter who tried to learn his technique from books found himself confronted with conflicting opinions, untested recipes and unobtainable substances with obscure names. Many of the materials suggested could not be blended and used as they lacked tractability, permanence and covering power. Fortunately the

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1. Da Vinci, L. Treatise on Painting. Introduction by Ludwig H. Heydenreich. p. XXIV.

study of painting technique gradually began to take shape again. The merit for having started to collect and translate old manuscripts which clearly set forth historical sources must go largely to Sir Charles Eastlake and to Mrs M. Merrifield. We owe serious writings on the subject to Sir Alexander Church, Ernest Berger, Max Doerner, A.P. Laurie, Kurt Wehlte and Hilaire Hiler. More recently some very scholarly works have appeared, conceived and written in a purely scientific spirit by Ralph Mayer, D.V.Thompson, R.J.Gettens and George Stout. This essay has been compiled for the purpose of providing a comprehensive and up-to-date account of the materials and methods of the craft and art of tempera technique. It is based on professional experience and on experience as a lecturer and as a painter. It is because the last is the author's chief interest that it is the endeavour to present the subjects from the viewpoint of the artist and arrange the material in a useful manner. The artist studies his materials and methods in order to gain the greatest possible control over his subject, so that he may bring out the best permanent characteristics of his chosen technique and express or convey his intentions properly. Haphazard departure from approved methods will often involve a sacrifice in one of these directions, but those who have acquired a complete and intelligent grasp of underlying principles are usually able to vary the established procedures successfully to suit their individual requirements. The artist's home manufacture of painting materials has been criticized and defended on various grounds by twentieth-century commentators. The modern painter who makes or refines his own materials does so because the particular quality or variety he desires cannot be purchased, because his process demands certain operations which must be performed immediately before use, for reasons of economy, or because he enjoys it as an enlightening avocation. Well-directed experience in this activity is obviously one of the most valuable means of acquiring knowledge that leads to control of materials. In the modern usage of the term, tempera painting is painting that employs a medium which may be freely diluted with water but which upon drying becomes sufficiently insoluble to allow overpainting with more tempera or with oil and varnish mediums. Tempera paintings are characterized by a brilliant, luminous crispness which is never exactly duplicated by the use of oil or other mediums, and has a pleasing flat or faintly gloss finish. In tempera the optical function of the medium scarcely exists, and when the paint is dry the colours resemble their original dry state more than do the deep-toned oil colours. One of the prime requirements of a permanent painting technique for artist's use is colour stability - the ability of a final dry paint coating to retain its original colour effect and the relationship between its colours without fading, darkening, or change in hue. From the earliest days of painting as a highly developed craft, this matter has been one of the major concerns of painters; it is of fundamental importance in the practice of creative art. The subject of permanence, one of the all-important considerations in the creation of works of art, has many aspects, and it will be found emphasized throughout all rational discussions of artist's materials and techniques. Permanence has a different meaning to the artist from the one it has when applied to industrial paints or to raw materials originally made or designed for purposes other than easel or mural painting. To the artist it means infinite longevity; his painting is supposed to remain in good condition as long as possible, when properly cared for under the conditions that are normally given to works of art. In the remarks about the quality of painting materials it must be understood that the reliability of the paints and grounds is by itself no guarantee of infallible permanence and effectiveness of results. Just as many failures and just as many disappointing effects are caused by improper use of materials as by the use of faulty paints. Paint is not a finished product. It comes nicely labelled and put up in neat little packages, yet it is only a raw material; the finished "product" is the picture - the dried paint layer on a canvas, panel or paper, and for the "production" of this, the artist must share an equal responsibility with the paint maker. Hence the use of the right material for the right purpose, the proper selection of materials and implements, and their correct application are of equal importance.

A definition for the nature of tempera is sought in a four part structure where supports, grounds, pigments and binding media are united to determine specific characters of possible combinations of these components.

The section on the conception planning of compositions and empirical data pertaining to the practical work for the submission, is intended as a documentary note rather than a '_raison d'être_', and could be conceived as an extension to the conclusion.

HISTORICAL BACKGROUND AND REDISCOVERY

When today's painters look at the work of old masters and study them closely, they do not see them only through the eyes of the artist who is interested in the colour key, composition, or the way in which the great predecessors solved artistic problems. They also try to discover the technical means by which certain effects were achieved. While we do not wish to imitate, we must concede that a wealth of valuable insights can be gleaned from the work of past epochs. We try to learn from the old masters' experience and to apply the knowledge thus obtained to our modern concept of art, suitably adapted. The era of expressionism severed the connection with all old traditions and sought a new beginning. Attention turned once more to the so-called primitives, who were perceived in a new light. The same period saw a new interest in ancient techniques. The concept dividing the development of art into strict categories such as ancient, medieval, and modern provides the following sections with a chronological order of divisions for reasons of simplicity. The earliest works of art of which we have definite knowledge are prehistoric, that is, they were produced during periods predating the times for which we possess contemporary records and of which our knowledge is definite and accurate. It could be conceivable that the binding media used in the many examples of prehistoric painting throughout the world was some form of gum glue or even for argument sake, egg; thus establishing a natural link with painting traditions in this medium. The word prehistoric is here used in a narrow sense, relating directly to art, and does not necessarily imply that we have a definite accurate knowledge of other aspects of cultures that produced these works of art. Of some countries for example, ancient Greece, we have a good knowledge of the civilization, the literature, architecture, ceramics etc., but only a vague idea of the materials and methods of easel painting. Our information concerning the methods and materials of these periods is derived from research on relics, archaeological discoveries, and the writings of the earliest historians. Considerable time separated these writers from the periods in question, and although much of value has been learned from them, earlier writings contain much that is legendary, vague and inaccurate, some processes are described correctly in accordance with methods which have survived or developed along similar lines down to the present day, while other statements are the weirdest sorts of fantasy. It is probably that ancient painting is generally thought of in terms of wall painting or murals, vase painting, and the decoration of architecture and sculpture. The universal easel or studio painting of today is perhaps regarded as a later development, owing to the fact that it seems to be a more sophisticated and intimate form of artistic expression, deriving as a corollary from wall decoration.

Natural egg tempera and plant juices forming emulsion-media were known to the Egyptians.[1] "It is manifest on examination that ancient Egyptian painting was tempera, it follows that some adhesive was used in its production, in the same manner as size and gum are employed to-day, since although pigments, such as soot, red and yellow ochres, will adhere to plaster and stone to some extent if applied dry, and although the ochres will adhere better if wetted, others of the ancient pigments, such as azurite, malachite and the blue and green frits, will not adhere without some binding material. The possible and likely materials to have been used seem to be limited to size (gelatine, glue), gum and albumin (white of egg)."[2] The presence of gelatine or glue in a pigment does not necessarily mean that this material had been employed as a binder in the paint, since it may have been used in the same manner as modern size, namely, to fill up the pores in the plaster, stone, or other painting ground before the paint was applied. It may be mentioned, too, that there are very considerable difficulties in identifying with certainty such materials as gelatine, glue, gum or albumin when present only in minute proportions in very small specimens of pigments that have been exposed for hundreds or even thousands of years. Binding materials which have undergone change and deterioration due to age are even more difficult to ana-

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1. "A medium of egg and gum mixed with the addition of bile to make the colour glow easily is mentioned in a Papyrus found at Thebes of the third and fourth century." Laurie, A.P. Greek and Roman Methods of Painting.p.22.

2. Lucas, A. Ancient Egyptian Materials and Industries. p.293.

lyse alternately. The principal supports used in ancient Egypt for paintings, taking them in alphabetical order, were canvas, papyrus, plaster, pottery, stone and wood. Wood was usually covered with plaster before being used as a painting-ground, though this was not always so, the paint sometimes being put directly on the wood, especially in the case of furniture and boxes, which were often painted in one colour.[1] That easel painting was practised in Egypt as early as the Pyramid Age is indicated by a sculptured relief scene in the mastaba of Mereruka at Sakkarah. In this scene, a man is shown painting a picture upon an easel; being of the Sixth Dynasty and somewhere around 2600 B.C., it is the earliest representation of an artist painting an easel or studio picture. The panel upon which Mereruka is painting is presumably of wood. An actual example of such a painted wood panel, fairly contemporary with this scene, is in the Oriental Institute Museum of the University of Chicago. The panel was discovered by Sir Flinders Petrie in the tomb of the Lady Meri (or Mera) at Deshasheh on the edge of the desert near the Fayyum. It is also from the Sixth Dynasty but somewhat later than the relief. A part of the original string,

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1. "We find, for instance, that in order to prepare a proper painting surface the Egyptian of the nineteenth dynasty covered the wood of the coffin with a gesso of chalk and glue, and we find Cennino Cennini, in the fifteenth century, directing panels to be prepared in exactly the same manner, while the directions given by Pliny for using white of egg in gilding agree with the directions given by Cennino Cennini." Laurie, op.cit. p.52.

by means of which the panel was hung upon the wall, is still in place in one of the two perforations at the top; it is the oldest portable painting known. The panel is made up of two pieces of wood dowelled together and is approximately 735 mm long x 340 mm high. On each side there is a painting. The colours were applied in tempera to the wood and are representative of the artist's palette at the time. The importance of the panel, however, does not lie in whether or not it was actually intended for tomb equipment. Its real significance is that it was obviously painted to be hung upon a wall. Some years before this panel was made, Mereruka was represented painting a similar panel upon an easel, already of a highly developed form. It seems not unlikely, therefore, that the wood panel was painted upon an easel such as Mereruka is using and that it was one of many easel paintings made even before this time. These easel paintings would have been on similar wood panels, or on the much cheaper papyrus, both perishable materials. They were not for tombs but were presumably intended to hang in shrines or upon walls in houses. These paintings together with the house themselves and their furnishings, have long since disappeared. This is understandable when one considers the fact that the great number of easel paintings which were made in Greece and Rome, more than two thousand years later, have all perished except for the Hawara portraits, also on wood panels, which hung in private houses and were buried with their owners. The Egyptian painting exists today because it was placed in a tomb - it is a lone survivor of the easel paintings of the Pyramid Age.[1] The paintings of Greece were celebrated. They were done in tempera or in encaustic on wood panels and may be regarded as easel pictures; portraiture, which reached a height of great excellence in Hellenistic times, would certainly infer studio painting. Copies were made of famous masterpieces for display elsewhere and many great pictures were transported to Rome where they brought handsome prices. Some were dedicated in temples, others displayed in the Forum, and it was suggested that all pictures should be public property instead of having them confined to country houses. The pictures that Pausanius, a contemporary of Hadrian, saw in the Pinacotheca of the Propylaea on the Acropolis in Athens were paintings on wood panels and this gallery included a collection of 'old masters'. Greek paintings on panel are mentioned in Pausanius, I, 22, 6-7.[2] However, the easel paintings of Greece have perished and any idea of them must be derived from the Romano-Campanian wall paintings at Pompeii and Herculaneum.[3]

There is evidence enough that easel painting was practiced in Greece and in Rome and there

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1. Duel, P. Evidence of Easel Painting in Ancient Egypt. p. 175-192.

2. Frazer, J.G. Descriptions of Greece. p. 262.

3. Beazley, J.D. and Ashmole, B. Greek Sculpture and Painting to the End of the Hellenistic Period. p. 265.

is no reason for not believing that it is an art as old as mural painting. There are many references in Pliny to the portable paintings of classical times. Scenes showing artists at work on panel paintings supported upon three-legged easels, occur in Pompeiian wall paintings. Pliny mentions egg as a suitable painting medium in a particular case, in the following words : "Painters put on sandyx as a ground colour; thereafter, laying on purpurissum with egg they produce the brilliance of vermillion. If they prefer to produce the brilliance of purple they put on caeruleum as the ground colour, and then lay on purpurissum with egg."[1] If we consider this statement of Pliny's, it is evident, in the first place, that he does not state whether he means the whole egg or the white of the egg to be used. It seems probable that the medium in this case is intended to be the whole egg. In the second place, he only directs the purpurissum to be mixed with the egg, and fails to mention what medium the other pigments are mixed with. Observations that the painters in classical times painted on panel as well as on walls, and that there were two quite different methods of painting panel pictures, the one defined by Pliny as 'painting with the brush', and the other painting with wax.

While evidence is not conclusive, it is on the whole in favour of the view that Pliny

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1. Pliny. XXXII line 20.

regarded 'painting with the brush' as equally suitable for panels, large canvas pictures, scenery, and wall painting. The medium used for 'painting with the brush' is nowhere described. The fact that the medium is not mentioned is strongly in favour of the conclusion that it was either egg, gum, or glue, or any one of these according to the fancy of the artist. These mediums are so obvious that it might well never occur to a writer to mention them. The same omissions are to be found in later manuscripts, where the special methods and materials for laying on gold, etc., are mentioned, but it does not occur to the writer to say with what he mixed his colours. Of the three mediums mentioned, the early and almost universal use of egg as a medium in Italy and elsewhere, and the Byzantine traditions point to this being most probably the medium used in classical times.

Traditions of the ancient world were preserved by the later Roman Empire at Constantinople. A Byzantine tradition had been to some extent preserved for us in the Mount Athos handbook[1] and later in the writings of the twelft-century monk Theophilus Rugerius.[2] Painting

1. Dyonisus, P. Mount Athos Manuscript (Hermenea) Translated by Durand in Manuel d'Iconographic sacrée de Didron (Paris 1885). The recipes for temperas, plasters, glues, etc. are still used unchanged from the 10th century to this day in orthodox convents.
2. Ruggero, called Theophilus, P. Diversarum artium schedula. There are various ancient MSS, among which the Harley MS 3915 published by R. Hendrie, London, 1847, by A.Ilg in Quellenschriften, etc. (Vienna, 1876). a 15th-century MS from the Montpellier school of medicine, now in the Sorbonne, is a derivation of the Treatise of Theophilus and is called Liber Diversarum Artium.

in egg tempera became popular. Few icons painted with the brush on wood and belonging to the period properly termed Byzantine have survived, because, for one thing, such works were highly perishable. Another reason is that icons of this kind were not produced on a really large scale until the last centuries of the Eastern Empire and the period of Turkish domination. Thus few icons of the earliest period have come down to us, and even these are often inaccessible. They are mostly fifth- and sixth-century works emanating from Egyptian or Palestinian workshops and are done in tempera or in the encaustic technique; indeed they belong to an art that was "Byzantine" only in the broadest application of the term. In the fifth century (if not earlier) painting made its first appearance in Christian books, shortly after the portraits of saintly personages or heroes of the faith painted on veils or panels. From the ninth century on, Byzantine religious sentiment fostered the development of panel-painting in the form of icons on wood. Probably the craftsmen's workshops specializing in this genre were located chiefly in monastries, but few icons previous to the fourteenth century have survived. Graeco-Roman technical tradition, however, was not entirely lost, for through Byzantine sources it persisted into the Middle Ages.[1]

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1. Grabar, A. Byzantine Painting. p.11-46.

In the Lucca manuscript,[1] the earliest medieval account of any importance since the fourth century, the recipes given show clearly a Byzantine origin in many cases. Byzantine artists, working all over western Europe during the first half of the Middle Ages, carried their tradition, which may be traced back to Ancient Greece, Phoenicia and even Egypt, and as far west as Ireland.[2]

From the seventh to the twelfth century, painting and its secrets remained almost exclusively in the hands of the clergy. After the twelfth century, artisan's guilds were formed, and technical knowledge was no longer kept secret. The lay painters were usually in the service of some noble and, contrary to the rule of the earlier monastic artists, were frequently great travellers. They accumulated such technical knowledge as they could in the course of their voyages, and sometimes put it into written form. Their manuscripts were copied and recopied, and a remarkable persistence of certain recipes is to be noticed, cropping up here and there and now and then in somewhat unexpected places. The men

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1. Anonymous, Compositiones ad tingenda (MS of the Biblioteca Capitolare of Lucca, MSS 490). Published by L.A. Muratori in Antiquitates Italicae Medii Aevi. Many recipes are of Byzantine derivation; others are taken from Pliny, Dioscorides, from the Leyden papyri, from Isidore of Seville.
2. Hiler,H. Notes on the Technique of Painting. p.18.

who worked with them often added marginal notes, and these were incorporated into the body of the manuscripts by later copyists. The manuscripts of Lucca and that of Cennino Cennini are famous medieval collections of recipes. They tell us much; but some of the most important processes were kept secret.[1]

Methods of easel painting are described in the 'Book of Mount Athos', based on old traditions going back to the year 1000 and may even be derived from painting instructions originating in antiquity. The first monks of the monastery of Lavra in northern Greece were undoubtedly as familiar with size paint as the ancient Egyptians and Greeks. They were probably acutely aware of the disadvantages of paint layers redissolving during painting and the drawbacks of poor moisture resistance. The advantages and disadvantages of beeswax were known from encaustic painting. Then, at a surprisingly early point in history they thought of making beeswax water-miscible by partial saponification and adding it to size paints to improve them. Paintings executed with this medium could be polished after drying. This wax-alkali-size paint was the famous ceracolla from Mount Athos, and it was used on sized wooden panels. Soon natural egg-yolk tempera, which could also be polished after drying, also came into use. It combined the advantages of a medium that could be

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1. Bazzi, M. The Artists'Methods and Materials. p.1-9.

applied in fine, fluid lines like a water tempera with the enamel like effect of the old encaustic technique. We can get a good impression of the texture of egg painting from old icons that were painted in this medium, a medium still used by icon painters in Eastern Europe. It must be remembered that tradition prescribes the use of egg as a paint medium partly for religious reasons, for the egg has always been the symbol of new life.[1]

It was the intellectual rebirth that brought about rediscovery and revival of the ancient methods of tempera painting. The scientific principals laid down by the Renaissance scholars have provided many twentieth century authors with tried and tested formulas and methods. Two principal characters, Cennino Cennini and Giorgio Vasari, emerge from the wealth of source material from this period, by virtue of the fact that they provide specific principles that are still usefull to the tempera painter today. Cennino Cennini was instructed in the art of painting for twelve years by Agnolo Gaddi, the son of Taddeo Gaddi, the godson and pupil of Giotto. He was living in Padua in 1398, while his master, Agnolo Gaddi, died in 1396.[2]

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1. Wehlte, K. The Materials and Techniques of Painting. p. 209.

2. Laurie, A.P. Materials of the Painters Craft. p. 175.

The Vatican MS. of Cennino Cennini is dated 1437, but this is probably the date attached by the copyist, who seems to have done his work in the debtor's prison at Florence, so it was probably written before this date. The treatise, therefore, can be considered as summing up, on the one hand, the teaching in painting of the fourteenth century and founding the methods of the fifteenth century. This gives us a detailed insight into the way the great school of tempera painters did their work.[1]

Of Cennini himself little is known. Vasari refers to him among the minor painters, but more because of his treatise than because of his work. Vasari tells us "that Cennino di Drea Cennini of Colle-di-Valdelsa learned painting from this same Agnolo (Agnolo Gaddi), and for love of his art he wrote with his own hand on the methods of painting in fresco, in tempera, in size, and in gum, and besides how to paint in miniature, and how gold is laid on for all these different kinds of painting, which book is in the hands of Giuliano, a Sienese goldsmith, an excellent master, and a friend of these arts."[2] No picture known

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1. Cennini, C. Libro dell'arte Manuscript in Florence : Mediceo N°23 at the Laurenziana Library.
In the Vatican Librari Ottoboni Manuscript, the most complete, translated into English by Mary Merrifield and Christian G. Herringram (London, 1899). It is the clearest, simplest and most practical of the ancient treatises (Bazzi, op.cit. p.210)
2. Laurie, op.cit. p. 172-177.

to be by Cennino Cennini is in existence, and consequently his fame rests upon his treatise and not upon the actual work of his hand. But his treatise is not only of technical interest on account of his receipts and directions how to draw and to paint; it is also of the greatest value as the unconscious, umpremeditated revelation of the character and point of view of the man who wrote it, and consequently of the influence upon him of the environment in which he lived. In this treatise by Cennino Cennini we have the writer inspired simply by the desire to give information about his craft, and therefore his way of giving that information is a purely unconscious revelation of his personality and point of view.[1] The egg mediums described by Cennini are : "The first tempera consists of the white and yolk of an egg, (and then proceeded with a medium for wall painting). The second kind of tempera is the yolk of egg only; and you must know that this tempera is of universal application on walls, on panels, and on iron, and you cannot use too much of it; but be sure and take a middle course. You must always temper your colours with yolk of egg for panel-painting."[2] There can be no doubt, therefore, that yolk of egg was his tempera, the pigments being first ground in and kept wet with water. The proportion between egg and

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1. Laurie, op.cit. p.172-177.

2. Ibid., p. 243.

water is, however, left uncertain; but apparently the yolk of egg, after breaking up, is mixed with an equal quantity of water and this used to blend with the paste-like wet pigments. With this medium used thin, repeated paintings were made one over the other.

It is interesting to note Vasari's historical background to painting in tempera; reference is made to the Greeks. "Before the time of Cimabue and from that time onwards, works done by the Greeks in tempera on panel and occasionally on the wall have always been seen." He then proceeds with a description of the preparation of gesso panels with ground, glue of parchment shreds and procedure for the making of the egg medium, and links Egyptian practices in panel painting to Cellini's method. Vasari's historical record carries interesting reference to the permanence of the medium. "..nor will the colours suffer for this since there are yet seen things in tempera by our old masters which have been preserved in great beauty and freshness for hundreds of years. And certainly one still sees things of Giotto's, some even on panel, that have already lasted two hundred years and are preserved in very good condition."

In his appreciation of technical processes Vasari reserves his enthusiasm for fresco painting, but gives oil the advantage over tempera's great convenience. The only advantages with tempera is the fact that all pigments can be used with it, and that the same media serves for work on grounded or ungrounded panels or on the dry plaster of walls; it is also long lasting. When Vasari came to write of his own works at the end of the Lives in the second edition, his conscience seems to have smitten him, for he gives the process a word of special commendation. He speaks of using it for some mural paintings in his private house which he had just built at Arezzo, and says, "I have always reverenced the memory and the works of the ancients, and seeing that this method of colouring "a tempera" has fallen out of use, I conceived the desire of rescuing it from oblivion. Hence I did all this work in tempera, a process that certainly does not merit to be despised or neglected."[1]

The foregoing account of tempera painting is intended to be an outline of the pure or classic method as practised in Italy from before the fourteenth century until oil techniques took over in the fifteenth. All other tempera procedures stem from it. The painter who has mastered this method is well equipped to control, adjust, and experiment with the modern innovations. Because of overlapping and the survival of older forms under various

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1. Vasari, G. Vasari on Technique. p.223.
The Florentine edition of 1568 contains information on several Flemish masters. 1st English translation by F. Foster, London 1850.

circumstances it is impossible to ascribe the various tempera developments to specific dates and names of individual artists, but the works of Giotto are examples of the early perfection of this technique and those of Botticelli, its culmination or highest development. The early Italian painters, though taking great care to produce durable works, made no attempt to lessen executive difficulties, tending rather to overcome such difficulties by superior skill.

Tempera painting was eminently successful in meeting the demands of the fourteenth and fifteenth century painters, but during the fifteenth century, the demand and preference arose for a new type of easel painting that could not be produced by using the pure egg-yolk technique. "The fifteenth and sixteenth century paintings of the kind innovated by Flemish artists soon after 1400 and referred to by Vasari and other older writers on oil paintings, were, for the most part precisely the sort of works we call tempera painting today when referring to tempera in the highest stage of its development and some were produced by employing alternate coats of tempera and oil resinous mediums as in the accepted tempera variations."[1] An intermediate or transitional stage of development

1. Mayer, R. The Artists' Handbook of Materials and Techniques. p. 241. Bazzi, op.cit. p. 118.
'A Putrido' tempera. Certain authors such as Max Doerner, Rosa and others, on the strength of a wrong transcription of the venetian MS in the Marciana Library made by Mrs Merrifield, believed that 'a putrido' painting was a mixture of oil and egg tempera and so started the legend that this medium was used by great Venetian masters like Titian and Veronese. In reality the manuscript mentions among the various techniques the 'a putrido' method that is to say egg tempera, and discusses oil painting as something quite distinct, but the manuscript never mentions a mixture containing both oil and egg tempera.

followed the pure egg-yolk technique, in which oily, resinous or waxy materials were introduced into the process in some manner. Contact between the Renaissance painters in Italy and the Northern countries is established through Vasari's reference to the techniques of van Eyck.[1] In order to explain the link between traditional egg tempera techniques and the development of oil painting on historical grounds, reference must be made to old manuscripts in order to acquire a convincing argument in favour of a simultaneous evolution through the use of tempera emulsions in painting.

We learn about the earlier German tempera painting from a book by Theophilus, the monk of Paderborn (Westphalia), who under the title 'Diversarum artium schedula'[2] wrote the first systematic work for the use of painters, a work which is at least a hundred years older than Cennini's treatise. It goes back to Byzantine sources and contains recipes similar to those found in contemporary painters' manuals of the Southern countries. Here again we learn about panels and how to size them and cover them with canvas, how to prepare grounds made of glue, gypsum or pipe clay, and casein glue, how to paint over tin foil, and so on. But most important is a recipe for tempera. Cherry gum served as a vehicle,

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1. Vasari, op.cit. p.212,225.

2. See footnote 2, p.15.

while light colours were applied with the watery residue of beaten white of egg. Underpainting with green in the shadows is also mentioned, as well as heightening in the light areas with white and the use of reddish tones in the flesh. Especially noteworthy here, however, is the fact that intermediate varnishes were laid between the separate colour coats of the tempera-mixtures, moreover, of oils and resins and coloured varnishes, i.e., glazes; in short, what we have here is a mixed technique. This in turn was followed by the jewel-like glazed tempera paintings as exemplified by the fifteenth-century Flemish painters. Finally this gave way to pictures painted throughout with oil colours, and the older tempera methods became dead techniques until their revival in the recent past.[1]

Renaissance painting had its very inception in the denial of its physical support. The painting surface lost the materiality which it had possessed in high-medieval art. It ceased to be an opaque and impervious working surface as formed on a wall, a panel, a piece of canvas or a leaf of vellum, and became a window through which to look out into a section of the visable world. The rediscovery of tempera painting could be found in the rediscovery of the picture surface. "In the Romantic period painters acted as if they had

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1. Doerner, M. The Materials of the Artist and their use in Painting. p.328.

ceased to look through the veil or pane of glass and had determined, consciously or not, to acknowledge its existence, whether in the form of a wall, a panel, a canvas or a sheet. It was as if transparency had begun to opacify, the screen to consolidate, the veil to tighten its mesch, to resist. The impenetrable flatness of the working surface would seem to have reasserted itself and thus come to influence the painter in every aspect of his art."[1]

From the technical point of view, painters disclosed a revived interest in the materials of painting. They became implicitly aware, even before getting into figuration, of the fact that the mattness, cloudiness, and density of wax produces certain specific effects. They even considered the kind of surface texture the medium might offer, thereby going against their training, which has subordinated everything to the mimetic reproduction of relief and modelling. This openness to the potential expressivity of techniques is reflected in the heterodox interest in tempera shown by Ingres (whose own pupils would soon revive fresco painting). It was also echoed in contemporary England, where Blake refused to employ oil because by its very nature the medium seemed to connote a materialism altogether at odds with this artist's spiritual aspirations. But such an attitude simply con-

1. Clay, J. Romanticism. p. 25-27.

firmed that the notion of technical categories had begun to lose meaning. Already, expression would invariably be implied in the choice of materials. In 1809 Blake expressed his vehement hatred of oil as a medium in the following passage that further supports the premise of changing attitudes. "Oil has falsely been supposed to give strength to colours: but a little consideration must show the fallacy of this opinion. Oil will not drink or absorb colour enough to stand the test of very little time and of the air. It deadens every colour it is mixed with, at its first mixture, and in a little time becomes a yellow mask over all that it touches. Let the works of modern artists since Rubens' time witness the villainy of some one of that time, who first brought oil painting into general opinion and practice : since which we have never had a picture painted, that could shew itself by the side of an earlier production. Whether Rubens or Vandyke, or both, were guilty of this villainy, is to be enquired in another work on painting, and who first forged the silly story and known falsehood, about John of Bruges inventing oil colours : in the meantime let it be observed, that before Vandyke's time, and in his time all the genuine pictures are on plaster or whiting grounds and none since."[1] Blake used a technique he called 'fresco' invented by himself. For grinding his colour, Blake used as a base a slab of

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1. Lister, R. Infernal Methods. (A study of William Blake's Art Techniques) p. 36-37.

marble, mixing the powder with diluted carpenter's glue. His palette was of small range : according to Gilchrist, it was restricted to 'indigo, cobalt, gamboge, vermillion, Frankfort black freely, ultramarine rarely, chrome not at all.

In his water-colours Blake, at the end of his life, introduced a new dimension into his technique. This consisted of taking the final stage of added retouching and highlights to a much more complicated conclusion, sometimes covering the whole surface with them. This required great care if a muddy effect were to be avoided, and it is clear that Blake allowed the original washes to dry thoroughly, and then added the final strokes over them, keeping his brush as dry as possible so as to avoid disturbing the under surface, yet allowing it to remain damp enough to be manageable. It is possible that, in order to help him gain these ends, he added a minute amount of glair to the water. This would have had the added effect of making the colours as brilliant as possible, and partly to keep the colours from mingling as successive layers were added. This technique and manner of applying water-colour may also be attributed to the fact that Blake owned a copy of Cennino Cennini's 'Tratto della Pittura', and we have the authority of John Linnell, who gave the book to Blake, that he 'soon made it out and was gratified to find that he had been using the same materials and methods in painting as Cennini describes'.[1]

The fact that he uses the words 'soon made it out...' would imply that he was able to translate from the published version in Latin, another indication as to Blake's rediscovery of tempera is found in a published announcement of 1809. "The invention of a portable fresco : a wall on canvas or wood, or any other portable thing, of dimensions ever so large, or ever so small, which may be removed with the same convenience as so many easel pictures; is worthy the consideration of the rich and those who have the direction of public works. If the frescos of Apelles, of Protogenes, of Raphael, or Michaelangelo could have been removed, we might, perhaps, have them now in England. I could divide Westminster Hall, or the walls of any other great building, into compartments and ornament them with frescos, which would be removable at pleasure. Oil will not drink or absorb colour enough to stand the test of very little time and of the air; it grows yellow, and at length brown. It was never generally used till after Vandyke's time. All the little old pictures, called cabinet pictures, are in fresco, and not in oil. Fresco painting is properly miniature, or enamel painting; every thing in fresco is as highly finished as miniature or enamel, although in works larger than life. The art has been lost : I have recovered it. How this was done, will be told, together with the whole process, in a work on

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1. This information is based on a letter by Mrs Anne Gilchrist, dated 10 December 1862; Iving Manuscript. Lister, op.cit. p.42. The first known publication of Cennini's treatise in Latin is listed as 1885, and the first English translation by Merrifield and Herrington was published in 1899. Bazzi, op.cit. p.210.

art, now in the press. The ignorant insults of individuals will not hinder me from doing my duty to my art. Fresco painting, as it is now practised, is like most other things, the contrary of what it pretends to be. The execution of my designs, being all in watercolours, (that is in fresco) are regularly refused to be exhibited by the Royal Academy, and the British Institution has, this year, followed its example, and has effectually excluded me by this resolution; I therefore invite those noblemen and gentlemen, who are its subscribers, to inspect what they have excluded : and those who have been told that my works are but an unscientific and irregular eccentricity, a madman's scrawls, I demand of them to do me the justice to examine before they decide."[1] Although Blake published this announcement in 1809, he had been using tempera certainly since 1790, and perhaps earlier. He was still using it as late as about 1825.

The main difference between Blake's 'fresco' and ordinary tempera lies in his use of carpenters glue instead of the usual egg yolk. The fact that he did not use egg could be accounted for by the possibility that he had not come across Cellini's reference to the use of egg in tempera, and the fact that he referred to his own technique as 'fresco'. But the reference to the use of 'glair' would suggest that there was some knowledge of egg media. Blake's preparation of grounds for panels and other supports are very much the same as

1. Lister, op.cit. p.51.

will be described in the section on grounds and supports. Though there is little indication as to his thoroughness in this regard. The available evidence on his preparation of pigments and medium is not too convincing as to his technical accumen in this regard. From a study of most available source material it would seem that tempera technique as such remained submerged until well after the publication of the English translation of Cennini's treatise. The attempts to revive medieval techniques was to be resumed by the Pre-Raphaelites twenty five years after the death of Blake.

The relationship between Blake and the attitude of youthful participants in the arts is well documented in the history of the times. Ruskin's involvement may also serve as a link to the perpetuation of a particular attitude in the making. It can be substantiated with this observation by Wilensky. "Blake passed his last years surrounded by young disciples who formed themselves into a species of Brotherhood and called themselves 'The Ancients'".[1] This fact would suggest a kind of prophetic preparation for what was to follow.

In order to trace an evolutionary pattern to which contemporary tempera painting can be linked, two particular aspects must be looked at. Firstly the renewed interest in collec-

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1. Wilenski, R.H. English Painting. p. 243.

ting and preserving paintings of past masters and the rediscovery and translation of ancient manuscripts. These two aspects could be said to be linked to a change in general attitude towards art. "Prince Albert, Victoria's German consort, made a collection of paintings which included works by Van Eyck, Roger van der Weyden, Duccio and Fra Angelico. In 1848 Albert together with Ruskin and others, formed the Arundel Society, whose object it was to record and reproduce early paintings. The aim was to stimulate the greater familiarity with the severe and purer styles of earlier art, that would divert the public taste from works that were meretricious and puerile, and to elevate the tone of our National school of Painting."[1]

The formation of the Pre-Raphaelite movement in the same year[2] is another significant link in the assumption that the revival of attitudes towards technique and aesthetic principles was evident at that time. In essence it was a return to a purity which a few artists believed to have existed in the Middle Ages. Although Rosetti also worked in water-colour on

1. Hilton, T. The Pre-Raphaelites. p. 23.

2. Bazin, G. A concise History of Art. p. 421-422. The Pre-Raphaelite Brotherhood was formed in 1848. The Brethren were Dante Gabriel Rossetti (1828-1882), William Holman Hunt (1827-1910), John Everett Millais (1829-1896) and an older artist Ford Madox Brown (1821-1893) was associated with the movement but was never a member of the Brotherhood. The movement began with Rossetti and ended with Sir Edward Burne-Jones (1833-1898).

canvas, his significance in the link with tempera painting is by association with the general attitude towards medievalism. Very significant observations on painting technique by the biographer of Edward Burne-Jones, provides us with conclusive evidence of the employment of tempera medium. "Although Rosetti returned to oils, Burne-Jones continued to work in water-colour, mixed with various media and used much like oil. The underpainting was in monochrome, flat washes were laid over it, sometimes thickly, sometimes as fine as powder, details were added after, mistakes wiped clean with a rag. Sometimes the painting was in gold, sometimes there were gold lights as though the picture was a precious object for its own sake."[1]

A contemporary of the Pre-Raphaelites was Arnold Böcklin, who can be grouped with the symbolist movement in Europe and was very much involved with tempera and other painting techniques. Böcklin and his contempories are known to have carried out extensive tests of materials before certain artistic effects could be accomplished with technical safety. From the perusal of various bibliographies from 19th and 20th century, Ernst Berger emerges as an author who wrote extensively on painting technique. A book that could give extensive insight to the rediscovery of tempera technique is Berger's publication titled

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1. Fitzgerald, P. Edward Burne-Jones A Biography. p. 83.

'Böcklins Technik' 1906, unfortunately unavailable locally.[1]

The fact that Blake and some of the Pre-Raphaelites employed water-colour in a manner that has an undoubted affinity with tempera technique establishes the fact that artists had specific preferences for media suited to their means of expression. What is most conspicious in a survey of water-colour since 1900 is that it is reverting to the state in which we found it in the sixteenth and seventeenth centuries. Many artists regard it as an auxiliary mode of expression, to be used not as their predominant or exclusive medium but for sketches and occasional complete statements. The boundaries of definition have also been extended. The desire to confuse the distinction between water-colour and oil, exceptional in Burne-Jones and Moreau, has become commonplace. Collage, poster paint, coloured inks and thin oil have all been used in a manner which produces results like those of water-colour and tempera. The value of available published material by artists writing about technique is that the subject usually is approached from a point of view that reveals specific methods. Giorgio De Chirico's publication "Piccolo trattato di tecnica pittorica" Milan, 1928, could be cited as such an example, however this work is not available locally for scrutiny ; we only have a quotation of a recipe for tempera emul-

1. Wehlte, op.cit. p. 32-40-370.

sion.[1] A chronological list of published works on painting techniques will reveal a number of works that specifically include sections on tempera painting, which have all been contributory to the rediscovery of the technique.[2] As many of these publications and manuals are referred to in the specific sections on technique, materials and methods, it will suffice to mention their relevance to the phenomenon of rediscovery.

Most available published material on the subject share a common source in Cennino Cennini's treatise and they all refer to his writings. Close on a century has passed since Mary Merrifield first translated 'The Book of the Art of Cennino Cennini'. The appearance of this work and of her translations of other manuscripts were important steps towards the unearthing traditional methods in painting. It was not, however, until early this century that Lady Herringham, herself a translater of Cennini, founded together with John Batten a small band of enthusiasts, the society then calling itself the 'Tempera Society' and since

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1. Bazzi, op.cit. p. 127. De Chirico says :"This, in my opinion, is the safest of the temperas. Of all those I have tested, this has given the best results. It is clear, solid and flexible. When varnished it turns brighter and does not darken; the whites do not change and the colours do not become too opaque from the start. It allows slow work and can be used in a dense impasto with no risk of cracks. It has the same qualities as the tempera made with cooked linseed oil and has the advantage of not being liable to change. Moreover it is very easy to make : Yolk of egg, essence of turpentine or of petroleum, white vinegar, water : 1 coffee spoonful of each, poppy oil : 2 coffee spoonfuls, glycerine, chemically pure : 1/2 coffee spoonful.

2. See bibliography list.

renamed the 'Society of Mural Decorators and Painters in Tempera'.[1] Since that time, this small body of experts has been doing steady research work, a record of which is to be found in the society's papers.[2] These give an interesting account of modern experiment in ancient methods and prove how successfully the gap between tradition and practice has been bridged.

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1. Borradaile, V. & R. The Students' Cennini A Handbook for Tempera Painters. p. 4.

2. Hiler, op.cit. p. 318. Papers of the Society of Mural Decorators and Painters in Tempera. 2 vols. Second ed. First ed. out of print. Vol.1, 1902-7. Second ed. "Revised and brought up to date with Appendix by the Society of Mural Decorators and Painters in Tempera". Edited by M. Sargent Florence. (Brighton 1928.) vii + 95pp. 8vo. Vol. II, 1907-24. Second ed. Edited by John D. Batten. (Brighton 1925) iv + 130pp. 8vo.

THE NATURE OF TEMPERA

Paintings carried out in opaque water-colours are often erroneously called tempera. However there is a significant difference between the behaviour of tempera and that of water-colours. The latter will easily redissolve when wetted. This is not considered a disadvantage but is one of the characteristics of this paint system and is occasionally exploited by the artist. Opaque gouache colours of this type will become lighter when drying and will display the unsaturated appearance characteristic of pastel - that is, the surface of the paint reflects all incident light. With oil paint there is no visual difference between wet and freshly dried paint. The paint is always saturated with medium, which means that some light is reflected from the interior of the paint layer. Tempera occupies an intermediate position between gouache and oil paints, containing both types of media, watersoluble gums or proteinaceous materials, as well as oils or resins. In the section on the binding media, the optical effect of tempera, as opposed to gouache or oil, will be explained.[1] Whether the tempera paint resembles gouache or lean oil paint in its final effect depends on the ratio of aqueous to nonaqueous components. The tempera medium is thus always a mixture of aqueous and nonaqueous binding materials.(Temperare[2] in medieval Latin

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1. See binding media p. 101.

2. Vasari, op.cit. p. 223.

means blending or mixing.) In the past the term was used indiscriminately for all types of combinations of media. Today the word always implies an emulsion, and tempera is therefore invariably a mixture of aqueous and nonaqueous binding materials, no matter which of the two predominates. This simple definition is certainly not sufficient to encompass the wider implications of variables contained in the terms aqeous and nonaqeous.

In order to define the nature of tempera various physical characteristics of the materials which constitute this medium have to be examined. The interaction of these physical characteristics combine to produce specific aesthetic responses and therein lies the key to the definition of the nature of the medium. The essential components to the formula are four basic and equally important factors of a rational painting technique, **the** supports, the grounds, the pigments, and the binding media. Each is closely dependent on the other. Their composition and their harmonious relation to each other not only influence the future permanence of the work, but also - and this is of immediate interest to the artist- the textural effect that is of no small importance to the appearance of the whole. Certain materials and special methods of application bring about specific results, which painters seek and need for the realization of their ideas. These four basic factors must not be neglected if an aesthetic purpose is to be attained and to engender a quality of permanence to the work. The choice of support will in effect determine the type of ground most suitable for a specific intension. The primary function of the support is to provide a base for the other components to interact, represented by S on the diagram. (fig.1.) The ground is of fundamental importance, because it is the base of any painting. Normally it is specially prepared. Here we may already find the causes of failures and reasons why some desired results are unattainable, as well as the groundwork for specific effects that cannot be achieved by any other means. Everything is founded on the painting ground, and it is truly a foundation. To demonstrate the equivalence of the four factors, they are represented as the corners of a square.The fundamental importance of the ground represented with the point G. Point P demonstrates the part played by the pigments. These consist of tiny agglomerates of coloured microscopic particles. To be sure, these pigment particles constitute most of the visible effect of the painting, but only when they have been mixed properly and adhere solidly to the ground. The fourth factor cements the particles to each other and to the ground. Point B shows the importance of the binding medium. The overall visual character of the painting will be determined by this factor - e.g., whether the pigment particles are only just held together and attached to the ground or whether they are entirely surrounded by the binding medium or, as it were, embedded in it. The degree of absorption of the medium by the ground is also important, as is the question of whether the ground will show through the pigment particles, as with glazing, or will be entirely covered by it. Painting means, therefore, distribution of pigment particles plus medium on a painting ground. How this is done depends largely on the individual working method of each artist. In fig. 1. this function is represented by a square connecting all four factors. The best pigments are useless if the ground is unsuitable or faulty, even if the binding media with which they are supplied are good. Too much medium can in time disfigure the appearance of even the most brilliant colours; too little can cause them to chalk or even fall off. Binding media can also turn yellow. Sometimes ground and binding media are in order, but the pigments may bleach or react chemically with each other. Again, the whole system is upset by the failure of one basic factor. Even if each of the basic factors is perfect, the ultimate result will be uncertain if the artist disturbs the harmony among the four by technically inappropriate or inconsistent methods. This happens occasionally. The painter, having made sure of using only first-rate materials on reliable grounds, will then be surprised. He has neglected important rules of craftmanship in the heat of the spontaneous creation, or the materials have been abused to achieve certain artistic effects.

The nature of tempera as related to the type of support is the primary point of departure in search of a definition. Most tempera techniques initiate immediate and directly visable responses to the surface texture of the support, because of the character of the paint layer. Here viscosity and miscibility play an important role. The surface of the support in turn will be affected by the type of ground and the method of application. The type of tempera vehicle whether natural emulsion or prepared emulsion will result in specific behaviours in absorbability of the ground which in turn affect the 'matier' of the painting's surface. Final variables are the chemical character and physical structure of the pigments. It will be perceived that the definition of the nature of tempera is dependant upon the examination of a complexity of interrelated factors. In order to extrapolate the nature of tempera painting from all the interrelated variable factors, it is necessary to impose an umbrella concept of practical and functional principles that take into consideration the authors personal working methods. A definition of the nature of tempera painting is thus limited to the authors practical experience and the results of this academic research. No universal definition is possible due to the infinate variable factors permiating the fundamental components of the medium. After the examination and documentation of the variables in the factors pertaining to tempera techniques, such a definition may emanate from the conclusion of this essay. The four components, supports, grounds, media or vehicles and pigments will be dealt with in the sections that follow.

SUPPORTS

RIGID OR FLEXIBLE
WOOD PANELS
PLYWOOD
HARDBOARD
CANVAS AND FABRIC

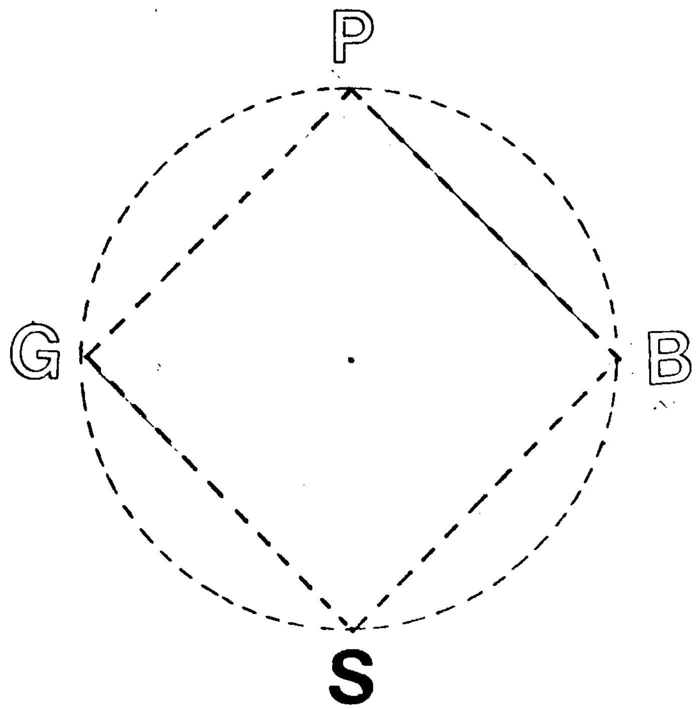

Fig. 2.

The term support refers to the material which carries the physical substance of the painting, the surface to which the painting ground is applied; on the diagram fig.2. represented by the symbol S. The number of various supports known to the painter today can be classified in two categories, i.e., flexible and rigid. The historical significance of rigid supports may be a convenient point of departure as wood panels have been established as the most common traditional support for tempera painting.[1] Although tempera on wood is

1. Stout, G.L. & Gettens, R.J. Painting Materials. p. 269-270. "In western civilizations the use of wood as a paint support can well be supposed to have reached into the earliest practice of the art. Painted wood sculptures exist from the time of the Old Kingdom in Egypt, as early as the IV Dynasty (2900-2750 B.C.), and by the Middle Kingdom (2160-1788 B.C.) sarcophagi with painted representations are known. Duell draws attention to the practice of easel painting in the VI Dynasty, and by the time of the mummy portraits, executed largely in the Fayûm during the early centuries of the Christian era, wood is found as a regular, independent support for pictorial designs. Practically nothing survives in the way of painting on wooden supports from classical times, though a set of parade shields, pine and covered with representations, have been found by a Yale University expedition at Dura-Europos in Syria. They are of Roman origin, somewhat before 256 A.D. Pliny (XXXV, 77) says that Pamphilo, IV B.C., taught his pupils to paint on panels of boxwood, and such a support must have been common for the portable pictures of antiquity. The joining of pieces to make a wood panel is described by many of the early treatises on painting; such a description is in the Schedula diversarum artium of the monk Theophilus (early XII century) and is given by Laurie (Materials, etc., p.158, from MS chapter XVII). It calls for making a glue from cheese-casein, with quicklime to dissolve it. Similar directions are found in the famous Libro dell' Arte, the Craftsman's Handbook of Cennino Cennini (early XV century; ed. Thompson, p.68). From very early times other materials, like cloth, leather, and (later) paper, were combined with wood to make a compound support for paint. Structures of this kind are found in Egyptian mummy cases where linen with gesso over wood forms the support of paint and gold. a Roman parade shield of the II century A.D., found at Dura-Europos, is made of plywood covered with leather on which the painting is executed. In European panel painting, particularly in Italy, the practice of applying cloth over the wood was common before 1400, and is specifically described by Cennino Cennini (ed. Thompson, p.70). He directs the use of old thin linen cloth that is cut or torn into strips, soaked in a good size (i.e., a glue made from goat or sheep parchment), and spread over the panel. During the Renaissance in Europe cloth supports came to be more common, particularly for larger compositions, but wood continued in use and is still frequently employed by painters."

rare today there could be a certain appeal to an artist responsive to traditional methods, however the permanence and stability of natural wood prohibit the practical viability of the seductive charm of this material. The dangers exposed to are cracking and warping, otherwise avoided by using more stable supports. A few guiding factors in the assessment of the physical characteristics of wood are necessary for the intention of this essay in exploring the full possibilities of the medium.

Wood is a complex natural combination of cellulose, lignin, protein, starch, water, and other substances. Being the product of organic growth, it is heterogeneous and anisotropic and therefore to some extent unpredictable. After felling, wood loses from twenty-seven to sixty-one percent of its moisture. A certain amount of moisture remains even in air-dry wood (ten percent in deciduous wood and fifteen percent in coniferous wood). Certain soft varieties, such as poplar, can reabsorb up to 200 percent water once they are dry. During this absorption the wood expands, and while giving off moisture it shrinks. The dimensional changes can be considerable, and they are most disastrous in panels with tectiform cleavage of the paint layer. The degree of shrinkage and expansion depends not only on the species of wood but also on the way the boards were cut from the trunk. This consideration is essential to the artist in choosing the most suitable and stable panel to paint on. Let us consider the cross section of a tree. The central core is usually of inferior quality and is therefore discarded. It is surrounded by the heartwood, the most valuable portion of the tree, showing more or less distinct annual growth rings. The outer, softer portion, which in some varieties of wood differs in colour from the heartwood, is called the sapwood. The cambium and other tissues of the growth zone immediately below the bark are of no interest to us here. A conspicuous feature is the radially arranged medullary rays along which the wood may crack if dried too rapidly. The core with the usually soft medulla can occupy an eccentric position in trees that have had more favourable growing conditions on one side, as with those growing at the edge of a grove. Knotty and twisted wood has always been avoided for making panels for paintings. When logs are plain-sawn into parallel planks by a modern machine saw, one can observe that the individual boards gradually warp during drying, as a rule away from the center. Only the center board, and possibly the two immediately adjoining it, remain flat. These can always be recognized because they have their growth rings at right angles to the panel surface. The foregoing explains why the best panels were always made from the center boards, although they had to be reglued after removing the core. In the past a tree was often quartered - i.e., split in such a way that a maximum of number of radially cut boards were obtained with growth rings vertical to the surface. Plain-sawn boards with growth rings vertical to the surface are naturally affected more seriously by radial checks than quartered boards. Persistently recurring open cracks on panel paintings are usually due to the inclusion of the former. When joining panel members, the edge nearest the core should be glued to another such edge. The above partially explains why panels composed of plain-sawn boards warp eventually and how this can lead to the wavy washboard surface. Wood undergoes the greatest dimensional changes in tangential direction, at right angles to the growth direction. It therefore needs a certain freedom of movement that should never be entirely constricted by mechanical means ; otherwise, tensions may occur during shrinkage that can rupture even thick panels. In an attempt to maintain this freedom of movement, and at the same time to reduce the warping, dovetailed battens are inserted without glue into grooves cut into the back of the panel. These battens should be made of a hard timber and should be inserted upright. The most advantageous ratio of width to depth is 5:7. Flat battens are sometimes bent by the force of the warping panel. To glue, nail, or screw transverse supports to the back of a panel is to invite disaster. Good natural wooden panels properly seasoned and treated are expensive and difficult to procure, the necessary preparation and manufacturing process being elaborate and labour intensive. The universal application of wood for floors, doors and furniture is proof of this material's dependability and durability. The physical characteristics such as, good insulating properties, relative high tensile strength, density, fibrous structure, workability and relative weight to surface expanse, also makes it an ideal support for painting.[1] The aforementioned limiting factors of procurability have been overcome to a certain extent, in that wood, and wood fibres have been used for their specific characteristics in manufactured panels that are extremely suitable as supports for tempera painting, i.e., various types of plywood and Masonite. These materials have most of the natural characteristics of wood panels without the numerous disadvantages such as warping and cracking. The physical characteristics of various manufactured panels will be discussed individually.

Within recent years plywood has become an important material in building construction. That now used is made from 'rotary' veneer cut in thin sheets from a log of wood. Three and sometimes five or seven sheets of the ply are glued together with the grain of each extending in a direction at right angles to that of the adjacent sheet. Plywood can be recognized not only by the laminations at the edge, but also by the wavy grain of the surface, particularly in coniferous woods where alternate wide bands of spring- and summerwood are exposed by the rotary cutting of the log. Large sheets up to 1220 x 2440 mm in dimension are now available. Frequently, the 'core' or middle ply is thicker and of cheaper wood than the surface plies. For furniture and interior panelling, the surface ply

1. Wehlte, op.cit. p. 326-331.

may be of an expensive hard-wood like walnut or gum-wood, slices or sawed. Coniferous woods are used throughout for the cheaper plywoods. Plywood has certain advantages over ordinary lumber. The plywood panel is stronger, in some respects, than a single board of the same thickness. Large plywood panels are not likely to crack, shrink, and warp so much as solid pieces of the same size. They do not suffer so much from the grain characteristics of a solid piece of wood. This is important since tensile strength, compression strength, binding strenght, and stiffness along the grain of the wood are twenty times more than that across the grain. In the authors experience various types of plywood are suitable for use as supports for tempera painting. Specific applications will determine the choice of wood type, thickness in the number of veneer layers and the type of glue. Most plywood panels available locally are manufactured from rotary cut veneer. South African pine, commercial, marine ply are recommended types of plywood.[1]

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1. P.G. Timbers : In the author's experience, various types of plywood are suitable for use as supports for tempera painting. Specific applications will determine the choice of wood type, thickness in the number of veneer layers and the type of glue. Most plywood panels available locally are manufactured from rotary cut veneer. The table of corresponding plywood thicknesses in ratio to the number of layers of veneer is supplied by the manufacturer. Plywood thickness in mm (number of veneer layers) : 3(3) - 4(3) - 6(3) - 9(5) - 12(5) - 16(5) - 18(7). S.A. Plywood : multi purpose panel for joinery and construction industries. Construction : both faces rotary cut S.A. Pine veneer with rotary cut pine inner veneers; bonded under heat and hydrolic pressure with urea formaldehyde S.A.B.S. 929 adhesive. Commercial grade : veneers of meranti are used. Marine ply : mahogany veneer is used with pheno formaldehyde adhesive to effect water resistant lamination. Manufacturer's apecification : United Plywood South Africa.

The simplest plywood consists of three layers : a thick core faced on either side with a thin veneer. Such a board will remain flat as long as an equilibrium exists between the two veneers and their glue layers. Thick plywoods have three core layers plus two veneers, and even heavier ones have a total of seven layers. A problem inherent in the manufacture is the fact that the glue layers introduce much moisture into the wood, making all the layers swell, so that even the most carefully dried plywoods may eventually warp. This is not noticeable while the sheets are stacked horizontally, since their own weight keeps them flat. The disappointment comes later in the studio. Complaints to the dealer are usually useless. Modern synthetic-resin glues are better, but far from ideal. The various species of wood behave differently even as plywoods : beach warps most readily; alder, birch, and whitewood are better, but the best are soft, porous woods like poplar and gaboon. Experience has shown that three-ply boards are best, but such thin panels will remain plane only in sizes up to approximately one square meter. Larger formats should be reinforced by the following proven method. The plywood is reinforced with a supporting frame with overlapping glued corner joints. The section of the frame should be in the ratio 5:7, and the members should be placed on edge. The thickness of the frame depends on the size of the panel; a joiner will advise on this point. The plywood is glued to this frame with casein glue or a synthetic-resin dispersion glue of high quality. Scotch glue sets too fast to permit a correct alignment of the plywood on the frame. Nailing has several disadvantages. The plywood should be clamped to the frame for twenty-four hours, while the face is protected by battens against dents likely to be caused by the clamps. Panels measuring up to one square yard can be reinforced this way.

Larger sizes require a number of battens parallel to the shorter side of the panel. These need not be connected to the outer frame by lap-joints, as long as the ends are carefully glued to it. They are best inserted after the plywood has been attached to the supporting frame but are not glued to the plywood unless the size of the panel is excessive. If this is the case, the construction had best be left to a joiner. He should glue all battens to the plywood, but only after the glue faces have been grooved; otherwise the framework may show on the front. Such a panel, covered with fabric on the front and all four sides, can be made in large sizes. It is light and remains plane. Strong, tightly woven materials should not be used as a covering because these contract too much when wet. Loosely woven unbleached cotton or open-weave canvas are best; they do not trap air bubbles. The Berlin painter A.O. Schumacher developed this system in 1930. These panels were later produced commercially under the name Ossa panels, until the war stopped production. Supported by a more complex construction, some of them measuring more than one square meter were exported to Switzerland, where they have remained without warping for more than thirty years. There can be no doubt that panels such as these surpass the solid supports used by the old masters.[1] Plywood has a further advantage : it is less readily affected by woodboring insects, which have attacked and indeed destroyed many old panels and altarpieces. However, since the introduction of Masonite or hardboard, both solid-wood panels and plywood panels have lost a great deal of their former importance, Masonite is relatively cheap and - at least for small dimensions - the best available support for paintings. Wood owes its strength and hardness to the quality of its fibres. The unwelcome side effects of shrinkage and swelling during the inevitable loss and gain of moisture are due to its cellular structure. The raw material for Masonite, first made in the United States in the 1920's, is wood disintegrated into fibres by an explosion generated by steam. With the aid of various synthetics this is compressed into sheets and heated. The result is a board with a homogeneous structure that is not as sensitive to climatic changes as wood. Although hardboards were made originally as wallboards for the building industry, they were quickly adopted by painters. Depending on the kind of wood used, their colour ranges from dark brown to pale ochre. Some reddish-brown grades made for special purposes contain pigments. Their quality depends on a number of factors, among them the type and proportion of

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1. Wehlte, op.cit. p. 332.

synthetic resin used and the manufacturing process. The higher the pressure during manufacture, the harder and denser the board. The soft, porous insulation board can only be used for mural sketches (after they are covered with a thin coat of plaster). Extra-hard Masonite, on the other hand, is rarely used for painting because it will take only oil grounds. Normal Masonite is the most commonly used grade. Thicknesses from 4 to 8 mm are suitable as supports.[1]

Hardboards are made under various brand names.[2] One of the oldest is the dark brown Masonite,[3] first produced in the United States almost fifty years ago. Insulite, a Finnish

1. Wehlte, op.cit. p. 334.

2. P.G. Timbers

3. Stout & Gettens, op.cit. p.223. One type of fibre building board has aroused a considerable interest among painters of the present. It is of the compact, homogeneous type and is made by the so-called 'Masonite process' from wood chips of thelong-leaf yellow pine. The wood fibres are torn apart by exploding the chips with high-pressure steam. The natural wood lignins are used to cement the wood fibres together again on large plattens with the aid of heat and pressure. The finished fibre board, which is chestnut brown in colour, has one smooth side and one rough side; this is caused by imprints of the wire screen on which the board is formed. The rough side may be coated with a gesso ground or it may be primed with a white paint. The wire mesh imprint gives the surface a texture somewhat similar to that of coarse canvas. The Masonite product is hard and dense; it does not bend or warp easily. It is prepared in sheets four feet wide and up to twelve feet in length and from one eight to one half inch thick. Three general types of the Masonite product are available : a thick, porous board for insulation purposes, a semi-hard board and a hard or 'tempered' board. Artificial building boards have one advantage : they are homogeneous in physical properties in all directions. They have no grain and, hence, are not subject to unidirectional shrinking and swelling. In large sheets, unless properly supported, they are liable to twist and to warp from their own weight.

product, was marketed soon afterwards. They are now generally available in sizes up to 1220 x 3660 mm, the most common size being 1220 x 2440 mm. All brands are superior to cardboard, but also more expensive. One side is always smooth. The wire grid pattern on the reverse is not meant to be a canvas imitation; it is the result of the manufacturing process. One can paint on either side. Primings sometimes fail to adhere to the smooth side. This is not due to any special treatment, but to a residue of paraffin oil with which some manufacturers treat their presses. This residue can be removed with acetone. It would be a mistake to roughen the smooth side with sandpaper, as is sometimes recommended. Unless this is done quite uniformly, the sanded wood fibres swell unevenly as soon as they become wet, resulting in a lumpy surface that is difficult to eradicate after the ground is applied. High-quality hardboard is an ideal support for tempera painting, surpassing all kinds of plywood and even the old masters'solid-wood panels. Their use as a new support for old-master panels that had to be transferred because the original support was irretrievable damaged was pioneered in the United States. Their only drawback is the vulnerability of the corners of these boards, but they can easily be protected by strips of wood with a rebate or by supporting battens. Sizes up to one square meter are normally left without these additional supports, as the edges are in any case protected later by the frame. Sizes over two square meter are usually made from thick hardboard, if necessary supported by a framework. As in the case of plywood, the inner parallel battens should not be glued to the back of the board. Hardboard is not attacked by woodboring insects.[1]

As supports for tempera painting, fabrics may be considered according to the weave and also according to the thread and to the origin of the fibres. For practical purposes, the bast fibre, flax and the seed hair cotton will be discussed as the most commonly used. The application of flax and cotton fibres in the production of fabric for implementation as support for painting is well documented throughout history.[2]
The word canvas does not refer to any specific material in the field of textile fabrics, but is applied to a number of closely woven materials of relatively coarse fibre, such as are used for sails, tents, awnings, etc. In painting, the term canvas generally implies a coated fabric, ready for use; the word is also employed by commentators to mean a finished oil painting. Practically every closely woven textile has been utilized at some time as a support for paintings. It may be interesting to compare some relative comments on the suitability of cotton versus linen or flax canvas. "Canvas should be woven of pure flax

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1. Wehlte, op.cit. p. 335.

2. Stout & Gettens, op.cit. p. 269-270.

fibre, unbleached or very slightly bleached, so as to secure the greatest possible durability of material. The test of time has shown that linen canvas is very durable, pictures painted on linen canvas of the fifteenth century, being in existence today."[1] "Linen canvases have proved themselves to be strong and enduring painting supports."[2] Cotton canvas has proved the most universally popular support in this century. Cotton is not as durable as linen but is cheaper and takes the application of paint equally well. Paintings on cotton canvas will probably require lining before those on linen. Cotton canvases, such as duck, sailcloth, and twill, came into occasional use after the commercial production of cotton, but they are entirely inferior to linen; they stretch poorly, they tend to give an inferior surface, and most of them do not take the size or priming well. Only the cheaper sort of ready-made artists'canvas is cotton. The best material is a closely woven pure linen with the threads of warp and woof equal in weight and strength. Linen-cotton mixtures are probably worse than pure cotton; their unequal absorption and discharge of atmospheric moisture will cause variations in tension. Jute becomes very brittle and lifeless on short aging and should not be used. Linen canvas is distinguished from cotton by

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1. Laurie, op.cit. p. 66.

2. Kelly, F. Art Restoration. p. 53.

its natural linen colour (cotton is white or very pale) and by the bold character of its weave effect which persists through layers of paint - desirable in both fine and coarse textures. Prepared or primed cotton canvas presents a flat and flimsy surface; it could really be called an imitation of the original, and its use is justified only in the cases of extreme economy and shortage of supply.[1]

The preference most authorities have for linen above cotton canvas could be seen as traditional but the physical characteristics of the fibres used to manufacture both types of canvas impart a specific character to the woven fabrics. The structure of the fibre determines the character of the thread, which in turn will influence the woven fabric. A comparison between cotton and linen fibres will reveal the essential difference.[2] The lenght of the linen fibre implies greater binding properties and less need for twist in the spinning of the yarn. The fibre is under less tension. Cotton has to have greater twist to achieve bonding for the length of thread. While cotton has a single, short white downy fibre, linen is a tough long semented fibre, this textural difference is critical to the

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1. Mayer, op.cit. p. 256.

2. Stout & Gettens, op. cit. p. 226 & 239.

cotton fibre	linen fibre	
20-36 mm	60-600 mm	length
0.0163-0.0215 mm	0.012-0.026 mm	diameter.

behaviour of the fabric as support.[1]

Cotton canvas or duck is woven in a plain weave or a twill weave. The plain weave is preferable as the surface texture lends itself more suitably to preparation. Various weights of this fabric are available, cotton duck most applicable as a support to painting is purchased in rolls 2100 mm wide. [2]

The largest variety of weaves qualities and weights comes from Belgium. The choice of weave and weight will mainly depend on the size of the painting, finer closer fabrics being suitable for smaller works and the heavier coarser weaves for larger works. Unlike cotton duck, cheaper linen canvas can be woven with fewer threads and spaced wider apart, sufficient fibre being exposed to support the ground. The quality of the fibre and thread thus compensates for the lack of density. However greater stability is achieved with

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1. Watson, W. Textile Design and Colour. p. 14. "The influence of the twist of the yarn. The twist which is put into yarns in order to bind the fibres together affects the handling strength and weaving property of a cloth. Generally just sufficient twist is inserted to enable the threads to withstand the strain of weaving. More turns per inch are required in fine than in thick threads, and for short than for long fibred material. The twist while strengthening the yarn makes it harder and reduces its luster."

2. Cotton Canvas (White Cotton Duck) is available in various weights i.e., 110-270-340-510 grams per square meter. Manufacturers specifications : Tongaat Textiles, Cape Town.

heavier and closer woven linen thread.[1]

1. Linen : During the course of study at the Royal Academy of Antwerp, in the academic years 1971-72 and 1975-1976, through cultural exchange scholarships, visits were made to manufacturers of artist canvas. The firm P. Alfons Van Mulders de Knibber, p.v.b.a., Geraardsbergse Steenweg, 126, Erembodegem-Terjoden, Belgium B9440, supply the author with a fine and a heavy linen canvas of high quality, see fig. 2. and fig. 3. Technical specifications are not available from the supplier.

GROUNDS

RAW MATERIALS
BINDING MEDIA
WHITE PIGMENTS
SEALERS AND SPECIAL TREATMENT
RECIPES AND PREPARATIONS

GROUNDS

RAW MATERIALS
BINDING MEDIA
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RECIPES AND PREPARATIONS

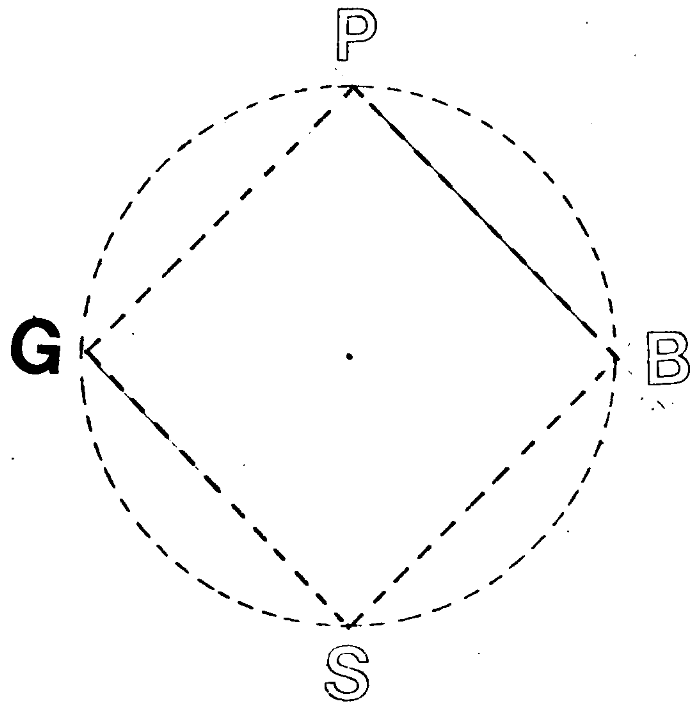

Fig. 3.

Having established the characteristics of the first component of a four part relationship of support; ground; medium; pigment;, in pursuit of determining the nature of tempera, the second part namely, grounds will be investigated. Represented by 'G' on diagram fig.3. By implication of the nature of two types of supports, i.e. rigid or flexible, grounds will also be investigated in two main categories, grounds for rigid supports and grounds for flexible supports. As most of the raw materials used in the preparation of grounds are common to most formulas for use on either flexible or rigid supports, it will be practical to deal with the raw material components first and then with the procedures for the preparation. The proportional balance between these substances also determine their adaptability for use on relative supports. The ground is by definition and general understanding never a direct part of the design. It is a smooth, flat coating put over the support. The colour or tone of the ground is usually white or light. This allows for easy development of the drawing. The material which gives this tone is a white powder, and many such materials have been used for the purpose : gypsum, chalk, China clay and white pigments. To make the powder hold in a firm layer on the support, some kind of binder or adhesive is needed, and the usual one is a skin glue or any animal glue. The reason for the choice of a water-soluble adhesive is largely that it works better - dries quicker and smooths more easily - and also that it keeps the white tone of such inert materials as gypsum or chalk.

These look drab and brown when mixed with oils. Grounds containing oil however include white pigments such as white lead or zinc or titanium white. In a structural sense there is no difference between ground and paint. The different terms merely indicate different functions or uses in the construction of a picture. Ground is a smooth, even coat, the purpose of which is largely mechanical. Whether the material is ground or paint, it is usually composed of two very different substances - the pigment and the binding material. The difference between these two components needs to be kept clear because there is a tendency to use the term 'pigment' in place of the word 'paint'. Pigments have to be thought of as powders. Thus far the components of grounds that have been mentioned are pigment and binder. These two are extended by the inclusion of a distinctive factor of the character of the support i.e. rigid or flexible, and pigment and extender are grouped because of the addition of oil as a binding medium. Thus binding media are represented as aqueous and nonaqueous binders. These distinctive factors are critical to the understanding of the nature of tempera grounds.

Various types of animal glue are known and fully described by many authorities but the local availability of the more 'exotic' glues are acknowledged for academic purposes only. The practical application of locally available materials must serve as a primary limitation to this essay. An alphabetical list of known animal derived adhesives will follow as an indication of the wide range of adhesives that are known : casein, collagen, fish glue, gelatin, glue (bone glue, skin glue), Isinglass, parchment size, glue size. Casein is one of the natural components of milk.[1] However, the binding power of skimmed milk is very low because it contains only a small proportion of casein. It was nevertheless once used extensively after the butterfat, which was likely to cause nondrying grease stains, had been skimmed off. In order to obtain higher, more useful concentrations of casein it is first precipitated from milk and then reconverted into glutinous casein glue. Various methods of precipitation may be used : rennet, an enzyme prepared from parts of calves' stomachs, bacteria promote the formation of lactic acid, which will precipitate the casein. For technical purposes, casein is obtained with the aid of mineral acids. Curd, cottage, or pot cheeses are considered the best source of freshly precipitated casein. Nowadays, however, curds of reliable quality are not always easy to come by. Cottage cheese is still made from fat free-skimmed milk. It is safer to use casein powder. Since one ounce of dry casein requires almost two pints of milk, it is hardly profitable for the artist to prepare it himself. High-quality casein powder is an even, fine powder and

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1. Wehlte, op.cit. p. 211.

should look pale yellow, but even in this form it cannot be stored indefinitely, because it hardens on ageing and becomes partly or wholly insoluble. Neither the buttery fresh casein nor the dried, powdered curds has any binding power. This only develops when the casein is changed to casein glue with the aid of alkalis. The nature of the alkali determines to a considerable extent the properties of the casein glue. In practice, the term casein glue is rarely used, but one refers to lime-casein, borax casein, or ammonium casein, thereby identifying the alkali used to hydrolize it. Of these, lime-casein is the most stable compound and is made by the oldest known method of producing casein glue. [1] It may be produced from cottage cheese or casein powder soaked in water. The hydrolizing agent is thick, slaked lime putty taken from a lime pit, or sometimes powdered calcium hydroxide. The application of casein glue as an adhesive in grounds, as well as an isolating medium will be discussed in the section on formulas.

Adhesives derived from animal bones, skins, tendons and cartilage, as well as different

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1. Stout & Gettens, op.cit. p. 8. "Craftsmen of ancient Egypt, Greece, Rome and China are considered to have used it. Without doubt it was a joining adhesive in the cabinet work of the Middle Ages. MSS of the time give directions for preparing an adhesive out of lime and cheese, very similar to an adhesive that is now used for putting together the wooden parts of an aeroplane. (A large part of the casein used as a glue today is consumed by the woodworking industries.) Ancient Hebrew texts mention the use of curd (casein) in house painting and decoration. Michelangelo is said to have used a combination of sour milk, oil, and pigments to produce highlight effects on walls. The material used in the many well preserved XVIII century ceiling paintings in upper Bavarian and Tyrolean peasant houses is lime-casein."

parts of fish, have a common organic composition which is called collagen. There is no tissue which consists exclusively of collagen and it is invariably associated with other protein material such as keratin, elastin, mucin, chondrin, etc., in addition to other non-protein organic material and inorganic salts. When collagen is heated in water to 80° or 90°C, it is slowly converted into the protein gelatin.[1] Taking into account the variety of collagen type glues it may be circumspect for practical purposes to apply the general term 'glue size' that encompasses this variety, to all preparations that include animal organic adhesives. The application of glue size as a binding medium is referred to on p221 Collagen adhesives are used as isolating media and as emulsifying agent in grounds for flexible supports. These types of glue can be obtained in the form of sheets, beads or granules.

Animal derived collagen adhesives have been replaced by synthetic water miscible adhesives to a large extent, because of economic and technical factors.[2] Among the various synthe-

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1. Stout & Gettens, op.cit. p. 14.

2. It is common practice to classify film formers into chemical and physical drying types. a. The drying of a film former by chemical means results in a film that is either largely or completely insoluble in the original solvent in which it was dissolved. b. Physical drying of a film former produces a film which may be re-dissolved in the original solvent.
Emulsion polymers, these film formers used in household P.V.A. paints, do not fit precisely into this scheme, ...

tics that have become accepted as substitutes for natural products, a number of the aqueous dispersions have proved useful for artists. Although a dispersion includes an aqueous and a nonaqueous phase, the aqueous phase contains no glue or gum. Some synthetic resins can be dispersed directly in water by special processes, i.e., they are distributed so finely that they form a kind of emulsion. The dispersions of synthetic polymers made from vinyl, styrene, and others have been successfully introduced into the artists' techniques. Polyvinyl acetate and acrylic esters are made in many different types, most of which are unknown to as well as unobtainable for the individual artist. He must therefore rely on ready-to-use dispersions sold for the decorating trade or manufactured products by artists suppliers. Paint manufacturers occasionally combine these with suitable additives

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...for although physical processes were involved in the film formation, the final film is not soluble in the original solvent, i.e. water. Films from emulsion polymers are formed by the primary particles of the latex coalescing on drying and then welding together by 'cold-flow'. To achieve this successfully, the binder must be sufficiently tacky and soft to prevent the film rupturing whilst drying. Film formation in emulsion polymer depends on polymer plasticity, which can be influenced by plasticises and coalescent solvents. A household P.V.A. which is a polymer dispersion thus forms a film quite suddenly, after sufficient water has been removed either by migration into the substrate or by evaporating. This results in the polymer particles coming into contact with one another, followed by the emulsion coalexing to form a film. About 20 years ago the choice of emulsion polymers was limited, eg. vinyl acetate, homopolymers, styrene butadienes, polystyrenes. The vinyl acetate homopolymers, plasticised with DBP, were most popular, but exterior durability of these paints was weak. Interest was then shown in vinyl acetate copolymers which possessed superior properties insofar as exterior durability and usage in humid atmospheres were concerned. The most commonly used copolymer available today is the viny acetate-acrylic ester copolymer, and almost all household paints are made with this emulsion polymer, the now world famous P.V.A. -polyvinyl acetate emulsion.

and market them under a variety of names.[1]

As mentioned on p. 63, the main component for all grounds is a white powdery substance in the form of gypsum, chalk, China clay or various pigments. A distinction between the terms pigment, extender and filler is necessary to clarify the functions of substances in the ground. A pigment is a finely divided colouring material which is suspended in discrete particles in the vehicle in which it is used as a paint (as opposed to a dye, which is soluble in the vehicle). Pigments are derived from a wide variety of substances, organic and inorganic, natural and artificial. They may be classified according to colour, chemical composition, or source.[2] An extender is an inert, colourless or white, and

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1. Rowney catalogue Rowney P.V.A. Medium, Rockgrip P.V.A. Sealer, PLASCON, DECRO,etc. P.V.A. Medium is a polymer emulsion that may be diluted with water. When spread out in a thin film and allowed to dry, the water evaporates and the resin particles coalesce to form a clear, transparent, elastic-almost tack-free film which is extremely resistant towards yellowing. PVA medium will adhere to most non-greasy surfaces and possesses excellent binding power for pigment. It may be used as a sealer for paper, cardboard and hardboard and with its aid many surfaces can be converted into grounds suitable for painting. Paper, sand, glass, marbles, string, and other materials embedded into the surface will stick firmly in position. When used with Fixed Powder Colour as a painting medium, objects may be placed on the painting surface and they will adhere as the paint film dries. The Medium should be diluted with water when it is desired to brush out in thin films. Equal quantities of water and binder are suggested for most purposes. PVA Medium when undiluted dries with a highly glossy surface. This is increasingly diminished if the Medium is reduced with water. PVA Medium is water soluble until dry. If PVA Medium is allowed to dry on brushes and equipment it may be removed with hot water and/or methylated (denatured) alcohol.
2. Stout & Gettens, op.cit. p. 137-149.

and usually transparent body used to diffuse or to dilute coloured pigments. Extenders up to certain proportions may increase and improve the wearing qualities of paints. The barium sulphate which is used up to 75 per cent with titanium dioxide may be regarded as an extender. The cost of the mixture is materially less than that of pure titanium dioxide but there is not a proportionate lessening in hiding and covering power. The same is true of the calcium sulphate which is often present in considerable quantities in artificial iron oxide reds. Some of the insoluble dye pigments or toners have such high tinctorial power that it is more economical and practical to use them with carriers and extenders. When an extender is added to a paint or pigment in such quantity that it lowers the tinting strength, it becomes an adulterant.[1] A filler is a white, inert, transparent material low in refractive index, which is used in paste form to fill imperfections in a surface that is being prepared for finishing. Wood filler is a paste made with crystalline silica. It is used to fill the pores or grain of the wood with hard, non-shrinking, transparent material so that varnish coats will go on smoothly and take a fine polish. The word 'filler' is sometimes used synonymously with 'extender'.[2] An alphabetical list of suitable

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1. Dekro Manufacturers specifications p. 4.

2. Mayer, op.cit. p. 105-106.

substances for this purpose is given below; barium sulphate (barytes), bole, bone white, chalk, China clay, gesso (gypsum), lithopone, talc, titanium dioxide, white lead, zinc white.

Barium white (barytes, blanc fixe, permanent white) is barium sulphate which may be obtained naturally from the mineral known as barite, barytes, or heavy spar, or it can be made artificially. It can be prepared for use as a filler or extender in paints by the simple process of grinding and settling. Frequently it serves as a base for lake pigments. An extremely inert material, it is quite unaffected by strong chemicals, by heat, and by light; but it does not have enough hiding power for a pigment because of its transparency and medium refractive index. Barytes have low oil absorption; some colours, which alone have high oil absorption, need much less oil when ground with it. Blanc fixe is the name given to the artificial barium sulphate made by precipitation from barium chloride solution with sodium sulphate. It is identical with barytes, except that it is a finely divided powder and has much greater hiding power than the natural material. Blanc fixe is not opaque enough to be ground alone with oil for a white paint. As an extender it is sometimes put into artists'flake white and other artists'oil paints.

Bole (Armenian bole, red bole) is the name frequently given in the arts to clay, either white or coloured. White bole is about identical with kaolin. Red bole is a natural, ferruginous aluminium silicate. It is similar to ochre in composition but is softer and more unctuous, and because it is capable of receiving a high polish, it has served since early medieval times as a ground for gilding. It is obtainable today under various names such as 'gilders red clay' or 'red burnish gold size'.

Bone white (bone ash), which is made by calcining animal bones, is composed chiefly of tricalcium phosphate; calcium carbonate and minor constituents make up the rest. Ash from the bones of diferent animals varies little in composition. Bone white is a greyish white and slightly gritty powder.[1]

Chalk (whiting, lime white) is one of the many natural forms of calcium carbonate. Natural chalk is a soft, white, greyish white, or yellowish (iron oxide) white rock which is largely composed of the remains of minute sea organisms. The crude lump from the quarries is prepared by grinding with water and by levigation to separate the coarser material. A very fine variety prepared in this way is known as 'gilder's whiting'. Chalk is quite homogeneous microscopically; its refractive index, however, is low, and this, in part, explains its poor covering power and its discolouration in oil, although it covers well when used in water paints and in distempers. Mixed with white lead and linseed oil, it makes gla-

1. Stout & Gettens, op.cit. p. 99. Virtually unknown commercially.

zier's putty. As a filler and adulterant, it is put into cheap paints and it serves as a base for lake colours. Under ordinary circumstances, chalk is stable, but when heated strongly it changes to calcium oxide (lime), and it is decomposed by acids, with effervescence of carbon dioxide gas. Made artificially, it is known as 'precipitated chalk', and this is whiter and even more homogeneous than the natural material. There are many other forms of calcium carbonate, some of which are useful in painting. One of them, marble, is a familiar crystalline variety of calcium carbonate or limestone. Marble dust has been mixed with lime for the plaster ground.[1]

China clay (pipe clay, kaolin, white bole), the natural hydrated silicate of aluminium is found in vast beds in many parts of the world and is the essential raw material of the ceramic arts. The term is usually reserved, however, for the nearly pure (iron oxide free) white clay with satin lustre; it is mixed and worked with water. In European paintings, China clay was, on rare occasions, mixed with glue for a ground or priming material on canvas or panel. Among painters it has been known as 'white bole', which is closely related to the red bole. Kaolin is not very characteristic microscopically, it is semi-transparent, finely divided, and homogeneous. The refractive index is low, it is inert chemi-

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1. Doerner, op.cit. p. 60.

cally. When heated, it loses water and becomes harder, it is unaffected by strong acids or alkalis.[1]

Gesso (see also gypsum), in its broadest meaning, is any aqueous, white priming or ground material that is used to prepare wood panels or other supports for painting. The word is Italian for gypsum. The word, gesso, has taken on a wide meaning and may include grounds made from chalk (whiting), zinc oxide, or any other inert white.[2]

Gypsum (terra alba) (see also gesso) is important among the raw materials that have been used in grounds. It is calcium sulphate dihydrate, and, often associated with salt deposits, occurs widely over the world. There are several varieties : selinite is crystalline, transparent, and folated; satin spar, a fibrous form with silky lustre; alabaster is fine grained, massive, and may be nearly pure white or delicately shaded; ordinary, dull-coloured rock gypsum, which is a compact granular form, coarser grained than alabaster, often contains impurities of calcium carbonate, clay, and silica.[3]

Lithopone is a co-precipitated pigment which is made by adding zinc sulphate to barium

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1. Mayer, op.cit. p. 48.

2. Borrodaile, op.cit. p. 13-17.

3. Stout & Gettens, op.cit. p. 117-118.

sulphide in solution. The press cake, which is a mixture of zinc sulphide and barium sulphate is dried, calcined at red heat, and quenched, a process necessary to give it useful pigment properties. It is very finely divided, opaque, and has about the same whiteness but has greater hiding power than zinc white. After years of research, a lithopone is now produced which does not suffer change in light. The so-called 'titanated lithopones', which contain about 15 per cent titanium oxide, have hiding power superior to that of plain lithopone. It has a combination of exceptional whiteness, brightness, and low cost. One may expect to find it in the priming coats of modern, prepared artists' canvas.[1] .

Talc (soapstone, steatite) is a natural hydrous magnesium silicate and is found as a soft stone. It has properties like those of China clay. Talc is white to greyish white in colour. It is very inert and is used commonly as a filler in grounds.[2]

Titanium Dioxide (titanium white) is the whitest and has the greatest hiding power of any of the white pigments. Both the pure titanium and the barium base titanium oxides are microcrystalline and fine in texture and have a high refractive index and, hence, the great hiding power, is the outstanding characteristic of titanium dioxide. Paints made

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1. Mayer, op.cit. p. 58.

2. Stout & Gettens, op.cit. p. 160

with pure titanium white have nearly twice the opacity or obscuring power of paint made with pure white lead. Titanium dioxide is a very stable substance; it is unaffected by heat, by diluted acids and alkalis, and by light and air. As a pigment, it is non-reactive with drying oils and is a poor drier; hence, it gives soft paint films unless much zinc oxide or drier is added. The oil absorption of pure titanium dioxide is fairly high, 23 to 25 per cent, but that of barium base pigment is lower, 17 to 18 per cent.[1]

White Lead (flake white, Cremnitz white) is the most important of all the lead pigments; it is the basic carbonate of lead, and ordinarily contains about 70 per cent of lead carbonate and 30 per cent of lead hydrate. Although white lead has been used in tempera and in water-colours, it is not so satisfactory in these mediums as in oil; and in oil it is meeting serious competition from the titanium pigments. The pigment is sold to the artist under the name, 'flake white'. Cremnitz (Kremnitz) white is a special kind of white lead which is prepared by the action of acetic acid and carbon dioxide on litharge.[2] It is now

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1. Stout & Gettens, op.cit. p. 161.

2. Ibid., p. 129. "Both 'massicot' and 'litharge' are names which have long been used for the yellow monoxide of lead. Some writers have used them as synonyms but, on better authority, they are separated in meaning to indicate lead monoxides that are derived from different sources and have slightly different properties. Litharge or 'flake litharge' is the fused and crystalline oxide which is formed from the direct oxidation of molten metallic lead.

greatly favoured by artists because it is considered to be whiter, denser, and more crystalline than ordinary, Dutch process white lead.[1]

Zinc White (Chinese white) has now almost the importance of white lead as an artist's pigment. Zinc oxide is a pure, cold white. In the dry state it is lighter and more bulky than white lead. It is non-poisonous but is a mild antiseptic. It requires more oil (18 to 20 per cent) to form a paste than white lead. It has a tendency eventually to dry brittle and to crack. Mixtures of zinc oxide and white lead combine the advantages of both pigments. It has been widely used in paintings since the middle 19th century. It continues to be popular for water-colour under the name, 'Chinese white'.[2]

As mentioned above, the ground, which is always applied in several layers, has to fulfill two requirements : it should act as a white reflector on which the colours come into full play, and by its thickness and porosity it should provide a base of even, controllable absorption of the tempera medium. The first function requires various white pigments of

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1. Stout & Gettens, op.cit. p. 174-176.

2. Windsor & Newton catalogue : "A specially dense variety of oxide of zinc. Chinese white was first introduced by us and is still one of our greatest specialities. It should be noted that ordinary zinc white is often sold as Chinese white; buyers should therefore test it for covering power on a piece of black paper."

high opacity. To fulfill the second requirement, these are mixed with less expensive white earths, which are also called fillers. They may also look white as dry powders or when applied in aqueous media, but in nonaqueous and especially in oily media they lose much of their opacity and may even look drab grey. This also happens when they are penetrated by oil media from the paint layer long after they have been applied with aqueous media. However, this can be effectively prevented by adding white pigments of high refractive indices. The ratios of white pigment to filler will be given in the recipes. Some pigments such as titanium white and lithopone already contain extenders, a fact taken into consideration during the addition of further fillers.

The cheapest and by far the most common extender is levigated chalk or whiting. The best grade is champagne whiting, not only because of its purity but also because it has a low moisture content and is thus free of lumps. There is no need to soak it before use, which considerably facilitates measuring out the necessary quantities. Finely ground calcite and marble dust, an even whiter material, are closely related to whiting. Although they are the same chemical compound, they differ from whiting in their crystalline structure. Artists who wish to add sand to their ground should use slightly coarser grades of calcite or marble dust. If necessary, one can obtain the exact grain size by sieving the material. Another calcium compound is gypsum. Pure grades are whiter than whiting and have a slight tooth. Finely powdered gypsum is also called light spar or _terra alba_. Plaster of paris or modelling plaster is calcined gypsum. This fine white powder hardens when combined with water and is therefore unsuitable as a filler for grounds, unless it is carefully slaked in excess water and stirred until it no longer sets. This is the _gesso sottile_ of medieval recipes.[1] Insoluble anhydride is a 'dead-burnt' gypsum that has lost all its water of crystallization by calcination at high temperatures; thus, it can no longer harden when mixed with water. White bole, kaolin, and China clay are appreciated for their soft plasticity, a strong contrast to the slightly rougher texture of gypsum, calcite, or marble. White clays are used for smooth grounds. Barium sulfate is used in two forms : as the slightly coarse natural mineral baryte and as the extremely fine precipitated _blanc fixe_. Both may be difficult to obtain from the retail trade and may have to be bought from a paint manufacturer. The fillers described above permit a great number of combinations with white pigments of a higher refractive index.[2]

The main reason for using rigid supports is to facilitate application of a thick ground and from the authors own experience, must consist of ten or more layers. This is naturally

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1. Borrodaile, op.cit. p. 13-17.

2. Wehlte, op.cit. p. 172.

only possible on rigid supports. In the following recipes, a clear distinction is made between rigid supports (wood panels, plywood, hardboard) and flexible supports (woven fabrics). The difference shows immediately in the isolating treatment of the support. The textured, relief like surfaces on which the author prefers to work, are adaptations of the recipes provided. The materials mentioned here may not always suffice to realize diverse effects, and proprietary texture paints or spackling compounds may have to be used, some of which contain sand, marble chips or lithographic stone sludge, or experimentation with unconventional materials, such as sawdust, may be considered as well.[1] Most manuals, however, at least begin with a description of the classical methods. Starting from these, any artist fond of experimenting will readily find technically sound ways of achieving his aims. To ensure sound adhesion of the ground layers, it is essential to pretreat the support. For aqueous grounds this is achieved by an application of hot size solution 70:1000 with an addition of ten percent alum. With less porous supports, the strength of the solution can be reduced to 60:1000. Primings based on synthetic-resin dispersions are often applied to a support prepared with dilute dispersion. Nitro Cellulose (KNL 20)[2] has no

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1. Polycell Spackle, polyfiller, litho sludge, marble dust, sand, etc.
2. Nitro Cellulose : a polymerized acrylic resin characterized by their strong adhesion to most surfaces, ultra violet transmissibility and stability to light. Manufactured by I.C.I. - KNL 20 formula code, Brand name:Buffalo GT 100. Manufacturers specifications undated.

swelling action on the support, dries in a few minutes without tension. Size coatings all dry with more or less pronounced tension. It is therefore necessary to coat both front and back of the panel with size, in order to equalize the tension developed during drying and thereby prevent any warping. Although sealing the back of panels is not strictly necessary with nonaqueous coating, it is still recommended as a moisture barrier, which will also guard against warping to some extent. In both cases all edges should be coated as well. This will prevent moisture from seeping into a particularly vulnerable area and also increase the mechanical strength of soft panels.

It should be obvious that all sealers applied to the support should be dry before one can apply the ground. Size coatings require three to five hours to dry, depending on the dimensions of the panel and the weather. The rough side of hardboard always dries considerably more slowly than the smooth side. This usually causes the panel to warp, but the distortion will disappear on complete drying. The drying process should not be accelerated by placing the panels in the sun or near a stove or radiator; otherwise they will warp strongly. It is much better to stand them in the center of a room where the air can freely circulate. Drafts help to speed up drying. Whether sealing the support or applying the ground, one always coats the edges first. The ground must be built up of several layers, and not just one or two thick coats. Thickly applied layers tend to crack, and the amount of time saved hardly justifies this risk. With all primings, each layer is brushed at right angles to the preceding layer. The last layer can be applied a little more generously if the surface is not intended to be smooth but is meant to be enlivened by brushmarks. In this case it is not applied in even, parallel brushstrokes but in random, crisscross manner. A rough surface is achieved by stippling the wet ground immediately after application with the brush. This is done with a large, short stippling brush or with a rectangular rubber sponge. In an emergency an old clothes brush will do. Lamb's-wool and nylon paint rollers have been introduced to the painting trade. The best of these are seamless. Paint rollers are available in various widths and have proven very useful for applying the ground. They leave a stippled surface texture, permit corrections without showing joints, and above all save time. They wear better than most flat brushes, provided they are soaked for about five minutes before use and carefully washed afterwards. A sturdy wire screen can serve to remove all excess ground after the roller has been dipped into the paint tray. For paintings of large dimensions the author prefers a rough ground or one with a pronounced texture. There is no single method of preparing the ideal ground. Within certain limitations the painter can choose his materials to suit his own requirements. The above sections should have made abundantly clear the importance of the ground and the role it plays in the appearance of the painting. The choice of ground also depends on the tempera system to be used. Tempera painting sometimes requires a ground that is partly or entirely water-insoluble, and the use of both emulsions and pure tempera is influenced to a large extent by the degree of absorbency of the ground.

Collagen glues should always be allowed to swell for an adequate period of time. This process should never be rushed, and it should always take place in cold water. It should be continued until one can no longer recognize hard particles among the mass of swelled glue. The necessary time depends on the type and form of glue. Thick sheets may require up to forty-eight hours, while granules of a low-viscosity grade can absorb sufficient water in two hours. Glue in small particles should be stirred occasionally at the beginning of the swelling period to prevent the formation of lumps. In order to simplify the recipes, glue is always allowed to swell in the amount of water in which it will later be dissolved. All recipes are based on one liter and the quantity of glue is given in grams. The strength of a size solution can thus be expressed as a ratio of glue to water. Instead of speaking of a five percent size solution, we say "a size solution 50:1000".

Glues of high quality should not dissolve until it is warmed. During the swelling process it may absorb up to 600 percent water. It would be a mistake to use warm water for the soaking. The container holding the soaked glue should always be placed in a water bath,[1]

1. Double boiler.

and never directly on a hotplate or gas flame. The glue will dissolve at a temperature of 60°C. Only then should the alum solution be added. Under no circumstances should the alum-size solution reach the boiling point. Normally, all alum-size solutions given in the recipes that follow should gel when they are cold. If they do not, the wrong type of glue may have been used, the solution may have been too weak, or it may imperceptibly have begun to decompose. Only during very hot weather may a normal size solution remain liquid. If several size solutions of different concentrations are used simultaneously, it is advisable to mark the containers with the appropriate ratios. The solutions are used to prepare the supports and to make the various grounds.

All collagen glue layers swell again when an aqueous coating is applied over them. This can be a nuisance when priming large surfaces. This solubility can be reduced by hardening the size with alum (aluminium potassium sulfate). This also increases its jelly strength, which is an advantage when priming fabrics. Alum should never be added in powder form to the size solution; it should always be dissolved in water first. For this purpose, approximately one-quarter the amount of water in which the glue is to be dissolved is kept separate in order to dissolve the necessary amount of alum, always ten percent of the dry weight of glue. The glue is usually soaked overnight to make sure that all glue particles have swelled sufficiently. The alum put into water at night should dissolve to a clear solution by morning, if necessary aided by a little warming. The maximum amount of alum that may be added to size is fifteen percent. Even this amount will only reduce the solubility to a certain degree. In cases where the ground is to be made completely water-insoluble, it should be brushed (but not sprayed) after drying with a six to ten percent solution of Formalin. Formalin is the trade name for a solution of gaseous formaldehyde in water. It is usually sold as forty percent solution, and for our purpose it is diluted with water. While the water evaporates, the gas irreversibly hardens the proteins contained in animal glue. Formaldehyde is heavier than air. The surfaces to be brushed are therefore placed on the floor. This is usually done at the end of the day so that the gas can take effect overnight. Care should be taken, however, that no dry glue is left exposed in the room in which Formalin is being used, because it, too, would be affected by the tanning action. Although formaldehyde does not directly endanger the operator's health, it has a highly irritant effect on the mucous membrane of the eyes and the nose. Formalin serves its purpose best on grounds intended for tempera underpainting or varnished tempera painting that should not dissolve readily.

From the following recipes the author has prepared his own grounds without much difficulty. As with all other manipulations, it requires a certain amount of practice and experience to achieve proficiency, but eventually other combinations will be invented to begin a creative process by working with texturing compounds while preparing the ground.[1] Several artists have produced interesting examples of the possibilities, and abstract painters in particular are fond of such unorthodox methods. Rigid supports are suitable for all types of ground, whether flexible or brittle.

Recipe for whiting or chalk ground : the support should be sized with 60:1000 size solution containing 10 percent alum (i.e., 10 percent of the dry weight of size), 1 part champagne whiting, 1 part zinc white. Size solution 60:1000 containing 10 percent alum in a quantity sufficient to produce a brushable consistency.

In all the recipes for grounds, "one part" means one part by volume. Paint to be applied with a roller may be a little thicker. It must be stressed again that the alum should always be completely dissolved in part of the total amount of water. The ground is made in the following manner : white pigment and filler are first mixed together dry, and the size is then added carefully under constant stirring. The amount of size should be increased gradually to avoid lumps. If the size is too hot, the ground may contain air bubbles. Unlike Doerner,[2] the author has deliberately avoided giving quantities for the size solution

1. The author's adaptation and application of various recommeded procedures by Doerner, Wehlte, etc.
2. Doerner, op.cit. p. 13-14. "1. Size : 70 parts(70 gm.) glue to 1,000 parts (1 liter) of water. After the size has dried, the priming is applied with a brush, as follows : 2. An equal measure of chalk, gypsum, or pipe clay, etc., an equal measure of zinc white, an equal measure of glue solution 70:1,000; all mixed. 3. After this has dried, possibly still another coat the same as 2. One liter of glue size will cover about eight square metres."

since the consistency of the mixture also depends on the moisture content of the whiting and the particle size of the white pigments. Moreover, special methods of application (e.g. paint rollers) require a slightly different consistency. Once the mixture has cooled it will have to be warmed in a water bath before it can be used again. It may then be necessary to add a little water to restore the same consistency, because some pigments and fillers tend to absorb more water while standing.

Recipe for stone dust ground : the support should be sized with size solution 60:1000 plus 6 grams of alum or 70:1000 grams alum. 1 part stone dust (Jurassic limestone, i.e. dry lithographic stone sludge),[1] 1 part zinc white or lithopone, and size solution of the strength used to size the support. A ground made with stone dust will become rather hard and rough. With coarser particles, which the artist can separate himself with a sieve, one can achieve a slightly sandy texture, which is all the more pronounced if left unsand-papered.

Recipe for ground containing marble dust (water-insoluble) : the support should be sized with borax-casein solution diluted with equal parts of water. 1 part marble dust or marble grit, 1 part titanium white, and casein solution (as above) to produce a brushable consis-

1. The sludge resulting from the abraisive action of fine sand and water between two lithographic stones in the resurfacing and graining process.

tency. A marble ground such as above is less absorbent than a ground made with whiting. It gives the paint a particular brilliance and charm. Since it is insoluble in water, it is particularly suitable for tempera painting. If marble grit is used and the last layer is left rough, one can obtain a fresco effect with casein tempera.

Recipe for gypsum ground :· the support should be sized with a size solution 70:1000 plus 7 grams alum, 1 part gypsum powder, 1 part titanium white, and size solution (as above) to produce a brushable consistency. Gypsum tends to settle out and has to be stirred frequently during application.

Recipe for kaolin (China clay) : the support should be sized with a size solution 60:1000 plus 6 grams alum, 1 part kaolin, 1 part lithopone, and size solution (as above) to produce a brushable consistency. This will produce a smooth, resilient ground suitable for fine brushwork, (but will also retain its brilliance when used for oil paintings).

The above recipes containing neither oils or resins are typical for absorbent grounds. This absorbency is further increased if the ground is made thicker by repeated applications. However, this invariably increases the tension within layers, and with it the risk of cracking. One should therefore follow with particular care one of the basic rules of painting technique : the upper layers of coating should be bound more weakly than the lower layers. This means that the size concentration should decrease in the upper layers.

Any layer applied after the third should therefore be diluted with a little water (but not with size solution) or, even better, with some ground prepared with a weaker size solution. This is most important when working with casein, which dries with particularly high tension. Should it be necessary to increase the absorbency of the ground, a size solution of lower concentration can be used. Size made in the ratio 50:1000, or even 45:1000, will be found to be quite satisfactory. The important ratio, however, is the one between binding material (dry size) and pigment (white pigment and filler). If the ground is made rather fluid in order to make it easier to apply with a brush, the dried ground layers will contain more size than if the ground had been made more viscous. A ground that is to be applied with a paint roller can be made with less size solution, but with one of a high concentration. Should the painter need a less absorbent ground, he could reduce its absorbency by increasing the size content. However, practical experience has shown that recipes, using up to 100 grams of size per 1.000 millilitres of water, or finishing with a coating of dilute size, make the ground prone to cracking. It must be mentioned that recipes are only meant as guidelines and can be adapted by introducing minor variations. The absorbency of a ground can be reduced with technically acceptable means, as will be seen op p. 91.

When painting or underpainting with water-colours or water-base tempera, any normal absorbent ground will soften or even partly dissolve. The alum content of the size will not be able to prevent this entirely. Although it may occasionally be possible to exploit the effect created by a redissolving ground layer, in most cases this solubility will be a nuisance. The ground should therefore be hardened. The same holds for ground layers containing size. It is achieved by a six percent solution of Formalin lightly applied to the horizontally placed surface with a soft-bristle brush or a rectangular sponge. A specially marked brush should be kept exclusively for this purpose, because any brush that is also used for priming is certain to harden irremediably in time. Traces of size left in priming brushes will be affected immediately. In order to expose all ground layers to the action of Formalin, one can harden the size coating of the support and the final ground layer. However, if lower layers soften during the priming of large areas, causing the brush to drag and making an even application difficult, one may at any time harden each layer as necessary. This takes very little time and is best accomplished while support is lying on the floor. It is advisable to leave the room before the gas affects the mucous membranes of the eyes. However, if the treatment is carried out in the open, the vapour disperses before it can take effect. This slightly unpleasant task can easily be done just before one normally leaves the studio. The gaseous formaldehyde reacts overnight, and in the morning the room can be thoroughly aired. However, on no account should size or gelatin supplies be left exposed in the room, for these would harden on the surface and thus become insoluble. There is so far no chemical that can reverse the tanning action of Formalin. Once a ground has been hardened with it, it can no longer be washed off and can be removed only with sandpaper. It must be admitted that Formalin slightly reduces the elasticity of the ground, but this minor drawback is compensated for by many other advantages. Hardened grounds naturally show a greater resistance to moisture, even later on, and are thus a major factor in prolonging the life of the painting. It has been the author's experience that Formalin hardening is sometimes confused with an isolation of the ground. Although the practical effect of hardening resembles somewhat that of an isolation when aqueous paint systems are used, the absorbency of the ground is in no way affected by Formalin. Its hardening action is a chemical process that leaves no isolating substance, such as a resin, in the ground. It should also be pointed out that water-colour and gouache, which are bound with vegetable gums, cannot be rendered water-insoluble with formaldehyde. Only animal proteins are affected by its tanning action. Casein ground need not be hardened, since it becomes water-insoluble anyway.[1]

A highly absorbent ground may not be ideal for all purposes. While primings made without

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1. Stout & Gettens, op.cit. p. 7.

oil are not subject to yellowing, they are often too absorbent and are therefore sometimes coated with sealer. The simplest method would be to regulate the absorbency of the ground by adding more size to it, but this greatly increases the risk of cracking. Sealers should preferably be unaffected by water. Suitable substances are soft and hard resins, nitro cellulose, and various synthetic resins. Since they are always applied very thinly and are normally covered by paint later on, they are hardly subject to the yellowing action of light. Nitro cellulose lacquers should be diluted with their appropriate thinners. Giving exact quantities is impossible, since there is a wide range of viscosities of commercial nitro cellulose lacquers. These are sold under a variety of names. KNL 20 lacquer is clear and colourless. It is sold in various grades and concentrations; some recent products are none-yellowing. KNL 20 swells considerably when in solution, and therefore shrinks accordingly to form an extremely thin layer. This is a marked advantage, since the isolating layer can be brushed on fairly liberally without any danger of leaving a glossy film. The isolating effect depends on the dilution.[1] Tempera colours adhere well to nitro cellulose lacquer. It is most important that the sealer be applied evenly and that it not be too thick. It should never dry with a glossy surface. Tempera sometimes adheres poorly to iso-

1. Dilution KNL 20, author's recommendation and proportion.

lating films that are too thick.

Certain synthetic resins are supplied in water-miscible form as dispersions. These are eminently suitable as sealers, as long as they are used in thin layers. If allowed to form a film on the surface on the ground, they will of course impair the adhesion of the paint. There is already an imposing number of products that have undergone sufficient testing to establish their behaviour as painting materials. Traditional materials were by no means ideal in every respect, and they are surpassed by some of the modern products. The artist can use these with confidence. PVA dispersions are synthetic dispersions that have been used widely and successfully by house painters for more than twenty years. The concentrated dispersions used by the painting trade are available in art-supply stores, but some manufacturers of artists'paints are selling them diluted and already to use as isolating materials. One can recognize these dispersions by their milky appearance.

When emulsion grounds are used on rigid supports, it is not so much to increase the elasticity of the ground as to reduce its absorbency and solubility by a simple and foolproof method. In emulsion grounds, oily components are finely dispersed in aqueous media, forming plasticizing particles that dry with little tension and later on have the effect of sealers. To prepare an emulsion ground, one starts the same way as with an ordinary whiting ground, but as soon as the ground has reached the consistency of thick cream, one adds the oil, at first drop by drop while stirring vigourously, then in progressively larger amounts. Although only about one-third of one part of oil is added, the ground does not become fluid; on the contrary, it thickens noticeably. This strange phenomenon is a sure sign that by vigourous stirring the oil has been so finely dispersed that oil droplets and the aqueous medium have reached a state of equilibrium. One cannot confidently add more size solution until the ground has reached a brushable consistency without any danger that oily and watery components may separate. Should this ever happen, it would be due to faulty materials or manipulation. An egg-yolk, on the other hand, is a legitimate means of saving an imperfectly emulsified ground.

Recipe for emulsion ground : sizing : 70:1000 plus 7 grams alum, 1 part champagne whiting, 1 part zinc white, and size solution as above, to produce a consistency of thick cream. Then add : 1/2 part boiled linseed oil,[1] and size solution as above, to produce a brush-

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1. Stout & Gettens, op.cit. p.6. "Boiled oil is oil which has been heated with the addition of lead, manganese, or cobalt oxides, or other suitable compounds of these elements, such as the linoleates or resinates. Formerly it was usual to heat the oil at 260°C to 290°C., to add a metallic oxide, and to continue heating for a few hours until a homogeneous solution was obtained. The modern practice is to operate at lower temperatures (130°to 150°C.) and to employ 'soluble driers' such as the metallic resinates or linoleates. If the oil is blown with air, the driers may be incorporated at temperatures as low as 100°C., for slight oxidation of the oil facilitates dispersion of the driers. Boiled oils have the property of absorbing oxygen from the air at a much more rapid rate than does raw linseed oil, and the time required for drying is thereby much shortened. ...

able consistency. The high size content is without danger here, because its tension is counteracted by the boiled linseed oil. One-third of one part of oil added to chalk ground sufficiently reduces its absorbency and solubility, and even this amount may be reduced further. Emulsion grounds brush on more easily than oil-free grounds. On the other hand, they are slightly more difficult to wet-grind and sandpaper, but with skilful brushing this may not be necessary. Hardening with Formalin can be omitted, especially since the oily phase of the emulsion diminishes the efficacy of Formalin to some extent. The synthetic-resin dispersions have been described on p.66. Several types of synthetic-resin dispersions have achieved popularity among house painters that artists could no longer afford to ignore them. Since then, their use as a medium for grounds has become widespread. This innovation comes as a boon to anyone unwilling to buy suitable kinds of size, prepare the size with alum, and choose the correct mixtures of white pigments. Preparing

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...Hiller, op. cit. p. 156. "Tie up 20 grains of dry and powdered manganese borate in a small piece of muslin. Suspend the bag in a glass quart flask or bottle containing 1 pint of good linseed oil so that the bag is just covered by the oil. Lightly plug the mouth of the receptacle with cotton batting(cotton wool). Stand in a warm place. In two weeks the oil will have become strongly siccative. The change may be brought about more quickly by heat, and, if a temperature of no more than 100°C. is attained, the product is equally good. Sunlight aids the process, at the same time bleaching the oil. The oil may be tested for drying quality by spreading a little on a piece of glass. Having been found good it is poured into a smaller bottle (which it should fill) and well corked. Impurities will form in this bottle in the course of the next few weeks, upon which the oil should be carefully poured into another clean bottle and the residue trown away."

a dispersion ground is extremely simple. Even the sizing of rigid supports is carried out with diluted dispersion, which dries water-insoluble. Lithopone, consisting of thirty percent zinc sulfide and seventy percent barium-sulfate filler, is a suitable mixture for painting grounds.

Recipe for dispersion ground : sizing with dispersion diluted with water 1:1, lithopone (additions of lime stone or marble dust extend the possibilities of absorption, texture, etc., and dispersion diluted as above, to produce a brushable consistency). As with emulsion grounds, three to four layers of dispersion ground should suffice to produce a fine, even white surface. This can be reduced to two layers by using a paint roller and a slightly more viscous mixture, or by substituting the opaque titanium white for lithopone. Some grades of titanium white also contain the necessary proportion of fillers. Synthetic-resin dispersions have simplified considerably the manufacture of painting grounds. They have stood the test for more than twenty years. There are now many different types of dispersions on the market, and anyone with a little experience can choose the kind that suits him best. Because dispersions dry water-insolubly, the lower layers are not redissolved during application, and hardening treatment is unnecessary. Ready-made dispersion grounds have been on the market for some time.[1] One reason for making one's own grounds with pigments and dispersions is the ease with which one can regulate the absorbency of the ground by varying the dilution of the dispersion. Two parts of dispersion diluted with one part water, together with the necessary pigment, produce a fairly nonabsorbent ground. On the other hand, a ratio of 1:1.5 or 1:2 will increase the suction considerably. As with all other types of ground, the absorbency increases with the number of applied layers. Owing to their outstanding elasticity, dispersions permit greater variatons of concentration than size, casein, or even emulsions. It is neither advisable nor should it be necessary to sandpaper dispersion grounds. If one suspects that the ground paint contains lumps or foreign bodies, it should be strained through a nylon stocking, but this is necessary only in exceptional cases. Should the ground require sealing, the most suitable coating is synthetic-resin dispersion diluted with water in the ratio of approximately 1:4. There is no chance of this medium drying with excessive tension, and it is not necessary to decrease the proportion of dispersion in the upper layers of a multi-layer ground. Finally, an important advantage of synthetic-resin dispersions should be mentioned : they do not yellow.

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1. Windsor & Newton : Acrylic painting primer porvides an acceptable surface on textiles, boards, paper, etc., for acrylic, oil and water-colour painting. Specially selected blend of white pigment in an acrylic resin dispersion. Extremely flexible primer with good adhesion to most non-oily surfaces, non-yellowing, non-cracking. Dries to a white matt surface with enough tooth to give excellent adhesion to superimposed colour. Thinning with water is not recommended but may be considered as a first coat on very absorbant surfaces if followed by an undiluted final priming coat - contains toxic pigment. p. 17.

It is much simpler to prime a panel than to prepare a canvas for painting. To begin with, a canvas must be nailed to stretchers. However, a medium-grain canvas or a cord fabric has an interesting texture, while on a panel the surface texture must be artificially created. Although synthetic-dispersion texture paints can also be used on canvas, there is a certain limit to the depth of the profile of such an artificial texture on flexible supports. In spite of the outstanding elasticity of modern synthetic dispersions, even the strongest canvas should not be coated with layers exceeding 3 mm. All fabrics, whether bleached or not, should first be carefully sized. For this purpose they must always be stretched. Well-stretched fabrics need not be wetted before priming; they should be sized immediately with glue jelly made from fifty grams of dry size[1] in 1,000 millilitres of water, with an addition of five grams of alum. The cold size jelly is first stirred well to make it a little smoother and then spread with a ten cm wide, flexible spatula with rounded corners. All excess size must be scraped off carefully. In five to ten hours the size dries to a thin, flexible film bridging the pores of the canvas and thus preventing the ground from soaking through to the back. For this reason fabrics are never sized hot.

1. Windsor & Newton : glue size : protects textile fibres against degradation by drying oil based primers. Reduces absorbency of textiles, hardboards and wood panels. Animal skin glue, friable granules soluable in hot water 70°C., seals the substrate against oil absorption. p.17.

The priming of canvas does not differ much from the same operation on panels. As with panels, one begins by coating all four edges with a 10 cm wide brush, using recipes for emulsion grounds and dispersion grounds, with the slight variation that the size concentration is kept lower (approximately 50:1000 plus ten percent alum). One should apply only four thin coatings to flexible supports in order to preserve their flexibility. Paint rollers can make this work much easier.

Commercial painting canvas must be rolled. This was the reason for the use in the past of hygroscopic additives such as glycerin or even soap, which made the ground flexible and preventing it from breaking. Artists, on the other hand, roll their canvas which has been primed on a stretcher only when absolutely necessary. It should be noted that primed canvas should always be rolled with the painted side out. Grounds containing size and whiting are relatively brittle. Those made with gypsym should also be avoided on fabrics and paper, especially since the latter is normally cut from the stretcher after the ground has been allowed to dry for at least twelve hours. Emulsion ground is much better than the traditional oil-free recipes. (see p. 93) Since the introduction of nonyellowing synthetic resin dispersions, these have largely replaced the traditional materials as grounds for flexible supports. (see p. 95). The practice of sizing the support with diluted dispersion is, however, not recommended for open-weave fabrics. They should preferably be prepared with size jelly as described above. The sizing can be hardened with Formalin before the dispersion is applied. Regulating the absorbency of the ground by varying the proportion of dispersion is just as safe on flexible as on rigid supports and is another point in favour of this medium. The oil ground has therefore almost disappeared from the studio of the technically versed painter, and many a commercial ground is in fact a well-bound, nonabsorbent dispersion ground. Even the leanest and therefore most absorbent dispersion ground is more flexible than any chalk size ground, and yet the delicacy of the latter remains inimitable. The ground of the flexible support can also, of course, be hardened, but this will make it slightly more brittle, while linseed oil emulsion ground does not respond as readily to Formalin. Dispersion ground becomes water-insoluble in any case and needs no hardener. The methods for sealing the surface to counteract high absorbency are the same as for panels, but since the most widely used dispersion grounds need no sealing, this step is rarely undertaken. Grounds of traditional composition applied to flexible supports should be sandpapered after each layer. The elastic fabrics are not easy to sandpaper, and there is always a danger that the canvas will be pressed against insufficiently chamfered edges of the stretcher, and the ground might be removed entirely in those spots. Dispersion ground pigmented with titanium white needs no sandpapering, providing it was made free of lumps and grit.

BINDING MEDIA

DEFINITIONS
AQUEOUS AND NON-AQUEOUS
ADHESION AND BINDING ACTION
VEHICLES
EGG YOLK AND EGG WHITE
EMULSIONS, NATURAL AND SYNTHETIC

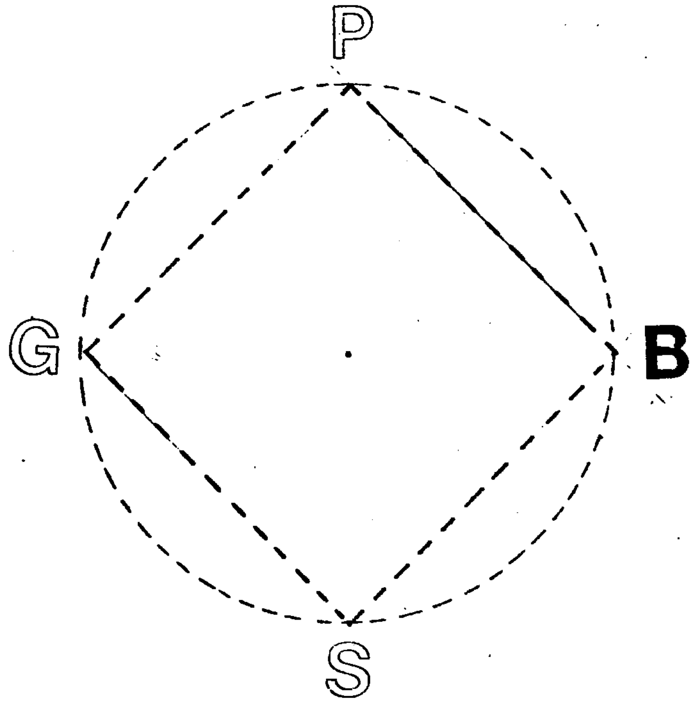

Fig. 4.

The first two components of a balanced four part relationship that provides indications pertaining to the nature of tempera are thus found in the specific character of supports and the added combination of a selection of suitable grounds. In the diagram, fig.4., the symbols 'S' (support) and 'G' (ground) have been filled in and appear as solid lettres; the remaining 'B' (binding media) and 'P' (pigment) are indicated as outline lettres, which will be dealt with in progression. It will be shown that tempera binding mediums embody the main characteristics of the technique, physical, chemical and physical optical functions of tempera are directly attributed to the nature of the vehicle. As with the previous sections it may be circumspect to list the types of tempera vehicles that will be examined.[1] Firstly it must be pointed out that it is necessary to be selective in the choice of vehicles, because of the large variety of tempera vehicles that are generally known. The selection will be limited by practical reasons based on the author's direct involvement with the preparation, application and testing of the relevant binding mediums. The author's personal preference has been carefully documented from p. 157. of this submission, only reliable and technically sound vehicles will be discussed; a variety of known tempera systems will be listed seperately as foot notes.[2]

1. Natural egg yolk, natural egg white, egg and damar varnish emulsion, egg and synthetic resin emulsion, egg and various types oil emulsions, casein tempera.
2. Gum tempera, glue tempera, starch paste tempera, cellulose paste tempera, soap emulsions, wax and gum emulsion, egg and wax emulsion.

A few pertinent definitions have been gleaned from available standard source material. "Medium is the word usually applied to the binding material or vehicle that hold together pigment particles in paint." In this statement the relationship of symbols 'B' and 'P' are brought into play. An additional dimension is given to the meaning of the word by the following quotation. "Medium : the liquid constituent of a paint, in which the pigment is suspended; a liquid with which a paint may be diluted without decrease in its adhesive, binding or film forming properties."[2] The reference to the liquid form of a medium has a certain aesthetic and physical implication, this aspect is further qualified by the same authority in another definition. "A term which is interchangeable with medium is 'vehicle' which can be defined as a liquid used as the carrier of pigments in a paint, but it is perhaps more properly applied to the liquid used as an ingredient in manufacture, than to a liquid added during painting procedures."[3] In avoiding the complexity of organic chemical definition it should be appreciated that certain physical chemical principles of paint systems, vehicles and binding mediums are necessarily immanent. Tempera mediums have

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1. Stout & Gettens, op.cit. p. 35.

2. Mayer, op.cit. p. 662.

3. Ibid., p. 665.

a wide range of chemical components, most are organic and consequently complex. To appreciate the full possibilities of various tempera vehicles, binding action will be briefly outlined.

There are several types of binding action, and the materials which depend upon one action should not be expected to produce either the visual effects or the physical properties of the others. A dried oil film encloses pigment particles in a continuous, glassy, solid substance. The film of a resinous varnish acts in the same way; it is even glassier, and is so impervious to atmospheric conditions that a thin layer of clear varnish will produce a durable film without any pigment. Tempera paint films are adequately strong and durable, but when dry the volume of binder in relation to the volume of pigment is less than that of oil paints. This is so because the bulk of tempera (and also of all other aqueous paints) is water, and when the paint has dried, a relatively small volume of solid matter remains to bind the pigment particles together, whereas a film of pure oil paint loses nothing by evaporation and normally has a surplus of oil beyond the amount necessary to bind the paint. The pigment particles are surrounded by the binder, but unlike the condition in the glossy oil film there is little or no surplus medium; the surface has a matt or semi-matt finish, and the layer is porous. Simple solutions of gum, glue, casein, etc. are more powerful adhesives than oils and resins; they will bind the pigment particles into a mass and attach them to the ground, but they do not form very durable films by themselves. When such paints are thinned to a brushing consistency, the pigments will be well bound but not locked in by a continuous level film, and so their surfaces will not be glossy. Binders such as the lime in fresco painting fall into another class. They act merely as cementing materials; they hold the particles of pigment or sand to each other but give no protection against outside influences. The surface is porous and any resistance against external attacks it may have is due to its own inert nature and that of the pigments. In the language of the technologist they would be called cementitious rather than pellicular;[1] the latter term refers to an enveloping film. Fixatives, such as are employed to bind the pigment of pastel and charcoal pictures, are very weak solutions. They are expected to be absorbed by the surface and they supply only enough superficial binding action to reduce the fragility of the picture so that it can be handled with somewhat more freedom. A number of vegetable oils have the property of drying to form tough, adhesive films either by themselves or when assisted by the action of added ingredients. These oils do not 'dry up' in the ordinary sense of the evaporation of a volatile ingredient, but

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1. Mayer, op.cit. p. 7.
Cementitious : "Substance applied as a paste and hardening into a stony consistency for binding together..."
Pellicular : "Thin skin, membrane; film forming action." The Concise Oxford Dictionary.

they dry by oxidation or absorption of oxygen from the air. The drying process is accompanied by a series of other complex chemical reactions, and the dried oil film is a new substance which differs in physical and chemical properties from the original liquid oil; it is a dry, solid material which cannot be brought back to its original state by any means.[1] In the discussion of the role of oil as a paint vehicle above, a distinction is made between its function as a binder of the pigment particles into a continuous film and its function as an adhesive in securing or anchoring the coating to the surface to which it is applied. Each vehicle that has been handed down to us from the past is a survivor of the test of time and a vast amount of experience gained through trial and error; the same properties which make it a successful paint binder also make for good adhesion and usually, if ingredients are properly compounded and applied, for facility in manipulation. The ability of a paint film to remain securely attached to its ground is, of course, one of the basic considerations of permanence. Several properties contribute towards permanent adhesion; these include the natural adherence or glueyness of the fluid material, the nature of the surface to which it is applied, the elasticity of the dried layer in following the movements of expansion and contraction, its toughness, its impermeability and

1. Stout & Gettens, op.cit. p. 38-41.

resistance to chemical attacks, and its ability to retain such characteristics with a minimum of deterioration upon ageing or exposure to external forces. In the wet stage of the painting, adhesion can be promoted by the use of fresh materials which will behave in the way in which they are supposed to function, by proper application, and in the selection of faultless grounds with the correct degree of absorbency and tooth. Paints such as oil, egg tempera, casein, and ethyl silicate, whose binding actions are due to chemical reactions, will always lose adhesive power to some degree if they are allowed to enter the adherent stage before they get put where they belong, on the canvas, panel, or wall. In the case of fresco, where the wall plays the adhesive role, this principle is accepted as an unquestionable part of the technique; no fresco painter will attempt to apply further strokes after the fresh cementitious character of the surface begins to pass and the wall ceases to imbibe the colour. But painters frequently lose sight of this basic principle, and as a result their oil paintings may blister or flake off and their temperas and caseins crumble or dust away.

It is important to establish the specific structures of various types of vehicles. Not all media are homogeneous substances. Some of them occur in nature combined with solvents, others are combined with diluents for technical reasons, or they are combined with each other. They can thus be single-part, two-part, and combined. In order to avoid confusion of the various components, those materials that actually bind pigments shall here be called binding materials. The following classification applies mainly to easel painting.

Single-part vehicles : homogeneous binding materials, which dry and harden by chemical change.

Two-part vehicles : solid binding materials and solvents, which dry by evaporation.

Combined vehicles : mixtures of single- and two-part vehicles, or further combinations, which dry by combined processes.

Vehicles that are mixtures of solid or liquid binding materials with solvents or diluents, or combinations of these, should correctly be called vehicle systems. Painters usually just call them vehicles or media. To express it more exactly, we have one-part, two-part, and combined vehicle systems.

There is some justification for the apparently paradoxical arrangement of listing two-part vehicles first : they really represent the more primitive category. The solid binding material first had to be dissolved in a volatile solvent to enable it to be mixed as evenly as possible with pigment particles. Two typical examples are cited :

(1) Dry size + water = size solution (not a true solution)

(2) Resin + turpentine = resin solution (true solution)

(Certain solids do not form true solutions when dissolved in a solvent. Chemists call these colloidal suspensions.)[1] First example : a solution of size, used to bind pigments, is such a two-part vehicle. It consists of a pure glue and water, the glue being the solid binding material. Water is the solvent and is also used to dilute and apply readymade size colours. Second example : resin and turpentine. In this case resin is the solid binding material, while some volatile solvent serves to liquefy the resin to disperse it, to make it workable as a medium or brushable as a varnish. In the first example the water evaporates completely from the finished size painting. Only the solid binding material remains extremely finely dispersed between tiny pigment particles as well as between paint and ground. In the second example, the solvent volatilizes and the rehardened resin remains as a more or less continuous film. Both the water and the volatile solvent disappear completely from their respective systems.

One-part vehicles are chemically complicated materials. They are normally liquid at room temperature (wax being an exception). In spite of their complicated chemical composition, they are homogeneous substances, and therefore no part of them evaporates during drying. They harden by internal chemical changes, which result in the formation of new substances. Linseed oil or modified linseed oil will suffice as an example here. By absorbing oxygen

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1.Morren, R.S. Synthetic Resins and Allied Plastics. p. 452-453.

from the air, these are changed to linoxyn, a film of completely different composition that is at first elastic but is later hard and even brittle; at that stage it is insoluble in solvents like turpentine.[1] In practice, most drying oils often need to be diluted with suitable solvents (e.g. linseed oil and turpentine) for the sole purpose of aiding dispersion. The oil still dries by an oxidation process and thus becomes a solid binding material, while the turpentine evaporates. Of course the combination of vehicle and diluent makes this mixture a two-part vehicle.

The third group of media includes combinations of one-part and two-part vehicles. A simple example would be a mixture of drying oil (one-part vehicle) and a resin solution (two-part vehicle). The common painting media and oil varnishes are composed like this. Another variety is the combination of aqueous and nonaqueous vehicles or vehicle mixtures. The result is an emulsion. The drying of emulsions involves three processes : the drying oils harden, the solvents evaporate from the resin solutions, and the water leaves the glue phase, i.e. tempera emulsions. Dispersion, on the other hand, belong to the two-part vehicle mixtures, although they are so similar in their practical application as well as in their effect that painters often make no distinction between them and emulsions. These

1.Stout & Gettens, op.cit. p. 38.

consist of resins finely dispersed but not dissolved in water by special manufacturing processes. When the water evaporates during drying, the resin remains as a water-insoluble binding material. Like emulsions, dispersions always look milky due to light scattering, but the latter invariably consists of undissolved solids in liquids.

Certain substances that have no binding properties may play an important role as additives to vehicles. They may be divided into the following categories : (a) solvent and thinners (b) driers and siccatives; (c) wetting agents and emulsifiers; and (d) preservatives.

(a) Solvents and thinners are among the most important additives. Together with solid binding materials they comprise the two-part vehicle systems. Resins and waxes must be dissolved in them before use. Added to drying oils, oil varnishes, etc., they dilute or liquefy these further, i.e., turpentine and lacquer thinners.

(b) Siccatives are used to accelerate the drying of oxidizable oils. (see boiled linseed oil p. 93.)

(c) Emulsifiers are used to aid the emulsification of immiscible liquids. Many wetting agents can also act as emulsifiers.

(d) Preservatives are used mainly by paint manufacturers to save aqueous media from the attack of microorganisms and mold. Artists only use them in perishable materials that have to be kept for an extended period, i.e., oil of cloves in egg yolk. It should be stressed that tempera paint is always an intimate mixture of a pigment as colouring principle and a vehicle or vehicle systems. Tempera paint is therefore never a solution, but merely solid particles dispersed in a liquid.[1]

Egg yolk is an example of a paint vehicle which contains a non-drying or semi-drying substance mixed with a quick-drying substance, the whole mixture drying successfully. There are also other instances where varying amounts of non-drying or semi-drying substances may be added to a paint or varnish whose drying properties are strong enough to carry it along, in order to impart favourable properties to the product. Albumen belongs to a class of proteins which have the property of being coalgulated by heat, as demonstrated by a cooked egg. The same effect is obtained when it is diluted, spread out in a thin layer, and exposed to daylight. The pure egg-yolk film becomes adequately insoluble, tough, leathery, and permanent, and as a film it serves as a standard by which to judge the artificial tempera emulsions. Artificial or compounded tempera emulsions are employed more for their improved executive or working properties than for any superiority in the quality of their films.

Egg yolk is an oily emulsion in which the oil particles are suspended in a solution of

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1. Wehlte, op.cit. p. 172. "Chemists call this a suspension."

albumen. Its coverage is given in percentage proportions : water 51.5, albumen, vitellin, etc. 15.0, fat or oil 22.0, lecithin 9.0, mineral matter 1.0, other substances 1.5. The lecithin is a fatty substance to which has been given the empirical formula, $C_{42} H_{84} NPO_9$, but it differs from most fats in containing nitrogen and phosphorus and in being very hygroscopic. It evidently acts as an emulsifying agent. When egg yolk is used as a painting medium, it dries to a strong film, first by evaporation of the water and then by a slow hardening of the oil which remains suspended in the albuminous matrix. This oil content is greater than that of the albumen and, in consequence, the ultimate film is very little affected by water.[1]

A number of instructions for the use of egg tempera have come down to us from all periods of European art.[2] The traditional pure egg-yolk technique proceeds in the following way. The yolk is first separated from the white. Some painters are extremely careful to keep it free from any traces of white; others are less particular; but a pure yolk, free from white, is the standard material. The white is practically pure albumen and water, and there is enough albumen in the yolk alone for a well-balanced tempera emulsion. An excess

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1. Stout & Gettens, op.cit. p. 20.

2. Borrodaile, op.cit. p. xiii - Table of reference to Cennini's 'Trattato'.

would not injure the dried tempera film so much as it would increase the speed of drying and cause difficulties in manipulations or brushing. After the yolk has been separated from the white by the usual method of pouring it back and forth in the half shell, it is rolled briefly on a paper towel to dry off the layer of clinging egg-white and most of the chalaza, then transferred to the flatly held (not cupped) palm of the hand, picked up by the thumb and forefinger of the other hand gently, so as not to break the skin, and suspended over a jar or cup. The skin is then punctured at the bottom by stabbing it with a knife or other sharp point, and, if desired, after most of the yolk has flowed out, the little that remains can be squeezed from the skin on the slab with a finger. Instead of rolling the yolk on the paper towel, it can be rolled from one hand to the other, the hands being alternately wiped on a towel or apron, until the skin of the yolk is dry, or merely break the egg into a coarse strainer, and after the white has drained off, puncture the yolk and allow it to run into a container. If this is done it is well to strain the yolk again through muslin, but the result will not be so pure a yolk as that separated with greater care. For ease in the straining and handling of egg yolk, a small amount of water may be mixed with it; so much water is used in the painting that it will not matter. However, if the yolk is being prepared for use in some exact recipe, this addition should be taken into consideration.

The pigments are well ground in distilled water with the muller, and placed in small screw-cap jars where they will keep indefinitely. Just prior to use, an equal volume of this colour paste (about the consistency of tube oil colours) and egg yolk are mixed. A little water can be added to the egg - 1/6 to 1/8 of the volume. A set of kitchen measuring spoons is handy to use in measuring proportional amounts of both dry and liquid substances. There is no technical objection to grinding the colours directly into the egg or into a mixture of egg and water, for pigments that do not grind easily in water alone; but keeping them in the form of a water paste and adding the egg just prior to use ordinarily saves much labour because the pigment-and-water paste keeps indefinitely, whereas colours made by grinding pigments directly in egg yolk will have to be thrown out at the end of the day's work. While the painting is being done the main supply of the egg-tempera paint may be kept in little covered jars or cups instead of on the open palette where it will harden more quickly. If these containers have no screw caps they may be covered with a damp cloth during painting operations. A piece of moistened filter or blotting paper inserted in the cap of a jar will produce a humidor effect and retard setting or skinning of the surface, but in warm weather will tend to encourage decomposition or mould. Pure egg tempera is best applied to the absorbent gesso panel without previous coating; if it is desired to have the panel somewhat less absorbent, a very dilute gelatin size may be employed.[1] When an accurate and careful drawing is made on the gesso before painting, use the size as a fixative for the drawing. It is better not to colour the first size and use as a veil, because of its penetration into the pure white gesso; but a coloured veil or size may be applied as a second coat. Other materials suitable for a first sizing of the gesso are very much thinned down shellac varnish, egg water made by mixing a teaspoonful of egg yolk in a full glass of water, a much diluted casein size or diluted nitrocellulose. The unsized gesso surface is , however, most desirable in the average case. Its absorption of the tempera medium is not usually sufficient to destroy its whiteness, but it is not considered advisable to use very heavy, thick strokes at first, before thinner coats of paint have reduced absorptive action. The theory is that too much absorption of binder by a ground will leave the pigment of a thick layer insufficiently bound. The gesso surface can be made less soluble by treatment with formaldehyde (see p. 84) but this is seldom necessary. Pure egg yolk is primarily suited for smooth painting; it is not useful for heavy impasto like gum or egg/oil tempera. It is better not to use preservatives in egg. The egg alone or in mixture with colours will keep in a dark, cool place for three or four days; if it becomes necessary to keep it longer, a few drops of oil of

1. See also isolation of grounds p. 88-92.

cloves or a 10-per-cent phenol solution (carbolic acid) may be added in minute amounts, or 1 per cent or less of a 3-per-cent solution of acetic acid, vinegar being the traditional egg preservative. Most vinegars contain from 3 to 5 percent of acetic acid. Acid solutions will attack chalk or whiting grounds, ultramarine blue, and the cadmiums. The decomposition of tempera paints and similar materials can be delayed by refrigeration, but freezing will destroy their properties.

When painting with egg, plenty of water should be used, and the brush should be dipped into water frequently. When the amount of egg is in proper relation to that of pigment, a large amount of water may be added to the paint. When too much egg is used, the paint will dry too rapidly and brush out with difficulty; when not enough egg is used in relation to the amount of pigment, the resulting film will be weak and powdery. To test the paint film it should be brushed out and allowed to dry on a sheet of glass. If it can be peeled off in a continuous, tough film with a knife, there is enough egg to bind it; if it powders or flakes off there is not enough. Some pigments require a little more egg than others. This procedure does not, however, afford a fair test of the paint film's time of drying, brushing properties, etc., because the conditions are too far removed from those of actual painting on a gesso ground. In working the paint on a fully absorbent gesso panel, the following three points must be observed.

1. Use the very finest quality sable water-colour brushes. For general use, the best round pointed water-colour brush is essential.

2. Mix some of the egg colour with water to the desired consistency on the palette, dip in the brush, loading it fully, then squeeze half of the charge out between the left thumb and forefinger. The purposes are to produce a uniform translucent stroke and to avoid unwanted drops or drips at the end of the stroke. If the paint is not applied in some such manner, it will not have the tempera effect; if overloaded it will produce an opaque, pasty film for which one might as well use gouache.

3. Use single strokes in one direction, not back and forth. Do not go over the same spot twice rapidly, wait a short time (3 to 5 seconds) for it to set, whereupon it can be gone over in the same or any other direction without danger of its being picked up which will expose the white gesso and produce muddy, clogged effects.

The traditional handling of egg tempera is in light, hatching strokes, but wide strokes and thin washes are not forbidden. Build up a thickness of paint and (if desired) a hiding of underpainting by several coats; keep each layer translucent, even in the whites and flesh tones which normally have a greater degree of opacity than the darks. Despite the hiding power of this build-up, the ground and underlayers will still contribute their effects to the result even when apparently obscured. A translucency can sometimes be recovered by overpainting a clogged or opaque spot with thin or transparent layers.

Egg white contains in quite different amounts the same substances found in the yolk. The percentage proportions are as follows : water 84.8, albumen, vittelin, etc. 12.0, fat or oil 0.2, lecithin - trace, mineral matter 0.7, other substances 2.3. The albumen is the adhesive substance of egg white and is complex, containing, besides carbon, hydrogen, nitrogen, and oxygen, about 1.6 percent of sulphur. As a pure film it is clear and brittle and is readily dissolved by water. Egg white as a medium is called also by its other name, 'glair'.[1]

Egg white, or glair, had been used to a minor extent in painting techniques from early times,[2] especially in the application of colours to illuminated manuscripts,[3] but its poor brushing properties limit its use for techniques which demand any degree of flexibility or variation in manipulations. It is virtually a pure colloidal solution of albumen, it has

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1. See p. 123.

2. Laurie, op.cit. p. 22-27.

Pliny Book XXXIII Chapter XIX line 36 "Gold is laid with white of egg..."

3. Doerner, op.cit. p. 217. "Egg white together with gum or hydromel was used in the early Middle Ages by illuminators of missals."
Theophilus Presbyter mentions a liquid composed of egg white beaten to a froth as a medium used for grinding white paint."

comparatively weak film-forming and binding qualities, but it reacts in the same way as the other substances of its class in that it becomes denatured (coagulated) when exposed in thin layers to air and sunlight, and its consistency is altered by agitation or beating. Its dried film is a little more soluble in water than some of the others; like a gelatin or glue film, it may be hardened with formaldehyde. Medieval recipes call for beating it to a frothy liquid; sometimes it was used to bind very pale or very reactive colours which gave less desirable effects when mixed with egg yolk. Its sole desirable use in modern tempera painting is as a constituent of those egg/oil emulsions in which the whole egg is used instead of the separated egg yolk, as in the traditional pure egg tempera method. It appears to contribute a stability to such emulsions, probably because the additional colloidal solution of albumen overcomes any tendencies on the part of the other ingredients to form undesirable or unstable types of emulsions.[1] A popular conception is that, because it is colourless in comparison with the yolk, egg white was extensively used in early paint mediums; but it was never used to any extent in standard, well-developed easel-painting techniques. Its mention in this connection is an example of the type of

1. Mayer, op.cit. p. 241. "When egg white is employed on a commercial scale, as it is in various industrial processes, a dried material is used. This is available on the market in a form resembling crushed gum arabic, and is called egg albumen. Egg white is used more successfully as a size for attaching gold leaf to gesso, picture frames, and leather than for painting purposes."

inaccuracy that finds its way into compilations and accounts written or translated without first-hand knowledge of the subjects. Doerner records first hand experience of the use of egg white by Arnold Böcklin. "I myself watched Böcklin apply the blue air of the left wing picture of the"Venus Genetrix" with such an egg-white liquid. He had beaten the egg white to a froth according to the recipe of Theophilus and allowed the liquid to run off a slanting plate placed on a stove. With this he applied the blue. The colour foamed when applied and appeared to be very white. When it had dried, the saturated blue colour appeared. Certain small areas, however, were left uncovered. Böcklin said that he would have to paint clouds on these places, for the material permitted of no retouching. Painting with such egg white is not a true tempera but a size-colour technique (distemper). There is no emulsion, which is essential to tempera."[1] For white-of-egg tempera the artificially dried egg white is generally used, which comes in the trade in small transparent pieces. It is mixed 1:1 in cold water, allowed to stand for a few hours, and then filtered through a cloth. The proportions are 200-300 grams to a liter of water. It can be made into an emulsion with fatty oils, resins, etc., in the same way as egg-yolk tempera. As a result of its light colour, it is favoured as a medium for grinding white or as an addition to

1. Doerner, op.cit. p. 217-218.

the grinding medium in tube colours of the trade. Egg white mixed with alum gives a paint with good body and permits of an opaque brush stroke. The alum is dissolved in water 1:10, and a quarter of the solution is added to the egg white. The mixture can be emulsified with oils and resins. When alum is used, cobalt must take the place of ultramarine. Egg white mixed with thick dammar or mastic varnish serves as a medium for oil painting which is very unusual in effect but is not easily handled. Egg white 'sets' when exposed to light, that is to say, it becomes insoluble in water, exactly as it does when warmed, especially if sprayed with a 4% solution of Formalin. A small addition of egg yolk always seems to be advisable in order to make the tempera work smoothly.

Three useful formulas for the preparation of egg white vehicles are :

1. Albumen mixed with water containing glue or honey was used when illuminating missals; it produces a brilliant and vitreous impasto, which tends to crack and should never be used with heavy brush strokes. Albumen mixed with water and alum (water 10 parts, alum 1 part, albumen 30 parts) forms an emulsion which can be used together with oil and resins. These temperas can be fixed with a solution of tannin (tannic acid 6 per cent) or of Formalin (4 per cent), or by warming the picture to a temperature of 155.2°F. These temperas are often used by forgers of ancient pictures, for which the tendency to crack and the hardness of the impasto are indispensable. To preserve albumen for use : mix with an equal

volume of water, emulsifying well. Place a small piece of litmus paper in it and add, drop by drop, some diluted acetic acid until you can see the paper changing colour. The albumen keeps better since its alkaline nature is thus neutralized. Strain and preserve in a well-sealed bottle.[1]

2. Glair (egg white). Medieval artists needed very delicate paint to illuminate parchment. Glair means clear; this substance is transparent. Making glair is rather a fun project if you like to whip egg whites. Use either a kitchen fork or a wire whisk. Place the egg white on a platter and beat until the froth becomes dry. Despite the apparent conversion of egg white into dry froth, you will find a small amount of liquid at the bottom; pour this into a little jar, for it is the glair. Or, after beating, put the froth into a paint jar, mix in four tablespoons of water, and decant the liquid after eight hours. The first method yields a viscous medium; the second produces a fluid medium. Traditionally, the best glair was mellowed by a few days of aging, but it serves quite well in its fresh state. Grind dry pigments with water to form as much colour paste as you need; be sure to grind well, for this paint is similar to water-colour and needs fine pigment particles. Dip a fine sable brush into glair and pigment to paint on parchment and paper; use it to

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1. Bazzi, op.cit. p. 127.

add tiny details wet-in-wet on oil paint.[1]

3. Mix as many whites as you need in a wide-mouthed bottle or jar which can be corked or closed hermetically; put in twice their bulk of water, shake up thoroughly and drop a piece of turmeric paper into the mixture. Then add weak acetic acid or light-coloured vinegar, drop by drop, until the reddened turmeric paper has just about regained its normal yellow colour. By doing this, you both neutralize the natural alkaline solution of the mixture and, as vinegar or acetic acid is antiseptic, also helps to preserve it. The liquid is then strained through a white cloth in a funnel and a practically pure solution, which is said to contain about four per cent albumen, is obtained. It is rather brittle and easily cracks. If it is heated to 70-75°C., it becomes no longer soluble in water. If used for painting, with water as a diluent, it may be heated when finished and will become waterproof in the same way. Or a solution of tannin will give a result similar to that obtained by heating, and I believe better, as it makes the paint tougher.[2]

The principal type of tempera emulsion is a natural one - pure egg yolk, as observed in

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1. Massey, R. Formulas for Painters. p. 78.

2. Hiler, op.cit. p. 174.

the preceding pages, the yolks of hen's eggs contain a water solution of a gummy substance albumen, a non-drying oil called egg oil, and lecithin, a lipoid or fat-like substance which is one of nature's most efficient emulsifiers or stabilizers. Tempera vehicles owe their distinctive characteristics to the fact that they are emulsions. An emulsion is a stable mixture of an aqueous liquid with an oily, fatty, waxy, or resinous substance. Tempera emulsions dry to form transparent films; their milky appearance when wet is caused by the refraction and dispersion of light from the countless tiny globules of oil. Although the chemistry of principles of emulsions are complicated, it will be advantageous to quote a simplified explanation in order to appreciate the difference between various types of emulsions.

An emulsion consists of drops of one liquid suspended in another liquid. In most cases there is an actual film around the globules which keeps them from coalescing. With any pair of non-miscible liquids, such as oil and water, there may be two kinds of emulsions, one with drops of oil suspended in water and one with drops of water suspended in oil. The necessary conditions for forming a stable emulsion are that the drops shall be so small that they will stay suspended and that there shall be a sufficiently viscous or plastic film around each to keep the drops from coalescing. An emulsifying agent is a substance which goes into the interface and produces a film having satisfactory physical properties.

According to Bancroft's[1] theory, an oil-in-water emulsion is formed if the emulsifying agent at the interface is chiefly in the water phase, and a water-in-oil emulsion is formed if the emulsifying agent at the interface is chiefly in the oil phase. For example, sodium and potassium oleates are water-soluble colloids, and they are excellent for emulsifying oils in water. The gums are also water-soluble colloids and certain ones are much used in pharmaceutical work for emulsifying oils in water. Calcium and magnesium oleates form colloidal solutions in oil and can, therefore, be used to emulsify water in oil; rosin and the resinates behave in the same way. Since sodium oleate emulsifies oil in water and calcium oleate emulsifies water in oil, a mixture will behave according to the relative amounts of each present. There will be some ratio of calcium to sodium at which the two oleates will practically balance each other and the slightest relative change will change the type of emulsion. Although most emulsions are made with gelatinous colloids as emulsifying agents, theoretically, this is not necessary. Anything that will go into the interface and make it sufficiently viscous will give the same result. If enough of a fine powder is put into the interface, a plastic mass is formed which will stabilize the emulsion. It is not always easy to tell by inspection whether water is the external phase or

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1. An authority on applied colloid chemistry.

the internal phase in a given emulsion. One way is to examine the emulsion under a microscope while a little water or a little oil is being added. The one that is the external phase will mix readily with the emulsion and the other will not. If the emulsion is not deeply coloured, its type may be recognized by means of a few minute crystals of a fat-soluble dye, such as Sudan III or Scarlet R, which are dropped on the surface and give a spreading colour to a water-in-oil emulsion but not to an oil-in-water type.

The addition of stand oil, sun-thickened oil, Venice turpentine, Dammar varnish, synthetic resin varnish, and cold-pressed linseed oil of normal viscosity to egg yolk and whole egg has been mentioned in early writings, but there is little record of the establishment of any standard, traditional technique or of any exact formulas; all recipes in present-day use are of comparatively recent origin. Addition of oil to egg changes the latter's qualities, and without entirely losing its tempera character, the medium tends to acquire some of the oil characteristics. It becomes somewhat easier to handle and is more adaptable to a wider range of effects, especially when used by an artist whose training and experience have been principally confined to oils; it piles up a little more satisfactorily than pure egg yolk; that is, sharply textured or semi-impasto strokes stay put. For really heavy impasto spots, such as those produced by the early painters in making small spots stand out in bold relief, it can be used to much better advantage than the pure egg yolk, but still not so well as gum tempera. For the technique which paints tempera into wet oil-medium, an egg/oil emulsion seems to be the most desirable.

The various recipes that are given below have been tried and tested by the author and have been adapted from different sources. The methods of preparatio, quantities, etc., will inevitably vary slightly from many published sources, these variations are due partly to availability of raw materials and to the author's requirements.

Whole egg and dammar resin emulsion : A little dammar resin helps toughen egg film during its tender early months. After it has completely polymerized, egg becomes one of the toughest most insoluble substances known. Ingredients : whole egg (4 parts), dammar varnish[1] (1 part), water (12 parts). Take a pint jar and break the egg into it; cap the jar and shake it until the egg is mixed. Add the varnish to the contents and repeat the process; finally add the water. After shaking thoroughly, strain the emulsion through two

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1. Massey, op.cit. p. 141. "Dammar resin : almost universally used, dammar resin is sold in pale yellow lumps, and serves many purposes : medium, glaze, final picture varnish. Ingredients : dammar lumps 1 part (by volume) turpentine 1 part (by volume). Place the resin lumps and turpentine in a tightly capped bottle, agitating or turning daily until the resin has dissolved, which will take a number of days. Allowing the bottle to stand in warm sunshine accelerates the process. This solution will have a thick, honey consistency. If the dammar lumps contain dirt or foreign matter, strain the solution through cheesecloth or nylon stocking, and decant it into a clean bottle. To use as a final varnish on oil paintings, dilute the solution with an equal quantity of turpentine; for varnishing egg tempera, dilute with four times as much turpentine. The original heavy consistency is ideal for use in emulsifying or for combining with other ingredients to make glazes or painting mediums. This dammar solution dries in one hour."

layers of cheesecloth into another jar. One egg makes about one half pint of emulsion. With a painting knife or palette knife, grind as much dry pigment as you need for one painting session. As you paint, combine the pigment paste with more emulsion. Paint on a gesso panel or on canvas. Egg-resin also makes an excellent underpainting vehicle. A stock solution of emulsion that can be diluted with water as desired can be prepared in the following way. Whole egg shaken up constituting 1 part (by volume), add 1 part (by volume) dammar varnish, shake up well to emulsify. A thick viscous emulsion will result. Pigment can be ground or mixed with this solution and thinned with water as desired. Dammar varnish is marketed by commercial artist material manufacturer,[1] and is rather expensive. The raw crystal lumps are available from specialist suppliers.[2] A varnish suitable for tempera emulsions and other purposes may be prepared quite easily and at a relatively low cost. The author has found that a synthetic resin (Keytone 'N' known as LARAPOL) can effectively serve as a substitute for dammar. The viscosity of the emulsion is different and consequently brushing and binding quality are also at variance with dammar emulsion (see p. 157. author's preferences). The synthetic varnish is prepared much in the same

1. Windsor & Newton Catalogue p. 21. Rowney Catalogue p. 17.

2. "De Balans" Grote Markt, Antwerpen, Belgium.

way as dammar varnish. Dissolve 'LARAPOL' crystal flakes 1 part (by volume) in 1 part (by volume) Shell Solve'K.[1] Use this viscous solution instead of dammar varnish.[2]

The emulsification of viscous natural or synthetic resin solutions produces 'lean' emulsions i.e. the oil component is minimal. Solvents employed to affect the suspension of the above resins are also called nonaqueous diluents. These have no binding properties by themselves but, together with solid or liquid binding materials, make up the two-part and the combined vehicles. Many of these relatively volatile, nonaqueous liquids used in painting are called essential or volatile oils. Emulsions can effectively be made to be less or more oily by the proportional relationship between egg and substances to be emulsified. (as explained in the section on emulsions). The most common and the most practical oil used for tempera emulsions is linseed oil. Two important factors emerge as critical in the choice of type of linseed oil for this purpose : viscosity and drying properties. The chemical considerations pertaining to viscosity in acrylics and resin acetates was briefly touched on in the section on grounds. It is also necessary to refer to the physical chemi-

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1. Shell Solve'K : white spirit or mineral spirit distilled directly from coal.

2. See advantages and disadvantages. (section B personal preferences binding media).

cal phenomina of viscosity in natural oils. Linseed oil is commercially available with different characteristics. Stand oil[1], strong drying oil[2], linseed stand oil[3], sun thickened linseed oil[4]. The change in viscosity can thus be achieved by various means, the term used for this is polymerization. Polymerized oil : if air is excluded, most oils can be heated to a temperature of about 250°C. without undergoing any appreciable chemical change. Some oils (e.g. linseed oil) become pale in consequence of the destruction of the

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1. Windsor & Newton, op.cit. p. 18.

2. Ibid., p. 18. Strong drying oil No.1. Strong drying oil No.2.

3. Rowney, op.cit. p. 16.

4. Doerner, op.cit. p. 105. "Sun-thickened oil : the oil is poured into a flat container, for example, a plate, in a thin layer, perhaps 1/2 cm deep, and exposed to the sun. It may be covered with a piece of glass supported by small corks, so that the air will have access to it, but as much dust as possible be kept out. The oil thickens quickly in a few days, depending on the heat of the sun and the access of the air. The oil must be stirred occasionally, in order to keep it from forming a skin. When the oil has acquired the consistency of honey, it is put into flasks. This thickened oil dries with a certain gloss, is varnish-like, and has been used for centuries as an excellent painting medium as such or as an addition to painting media, by Rubens among others. It gives the colours an enamellike character and permits, despite its viscidity, a great amount of technical freedom. Since it has already absorbed oxygen, it dries more quickly than ordinary linseed oil. The old masters still further accelerated the drying by setting the oil out in the sun in leaden vessels. According to my experience, sun-thickened oil is to be preferred to boiled oils, as also to the resin-oil varnishes, such as copal, amber, and mastic dissolved in hot oil. When used as small additions to painting media, it has a good drying effect, like siccative. It does not crack and is very elastic. The old masters knew well the great advantages of this oil, especially that it had lost all objectionable qualities before being introduced into the picture. Cennini calls it the best of all oils. "I could not give you anything better, " he says."

dissolved colouring matter. When heated above 259°C., and up to 300°C., most drying oils undergo a change which is essentially one of polymerization. The iodine number falls rapidly. When the iodine number has fallen to about 100 ('thin stand oil'), the density has increased from about 0.935 to 0.966 and the oil has become somewhat more viscous. On further heating at the same temperature, the iodine number falls lower, though more slowly, the viscosity increases rapidly, and the oil becomes very thick but remains clear.[1] Emulsions that have 'thickened' oils as second ingredient are generally more plastic in their working consistency and relate more closely to oil paint. Stand oil and sun thickened oil differ essentially in their drying properties and also in their natural yellowing. But the drying factor affects the working quality of the emulsion. The recipe given below has had limited general practical use, in the authors specific application, but this vehicle can be useful for more 'succulent' passages in certain textural contrast of paint. Egg, stand oil, water emulsion[2] : egg-oil emulsion produces a non-dripping paint which permits the finest, most detailed brushwork in a wet oil painting. Ingredients : egg yolk 2 parts (by volume), stand oil, heavy 1 part (by volume), water 3 parts (by volume).

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1. Stout & Gettens, op.cit. p. 48.

2. Massey, op.cit. p. 71.

Separate the yolk from the white and deposit the yolk in a small jar. Pour the oil into the yolk in a very thin stream, continuously stirring until the oil has been used up. Add the water in the same fashion. Egg yolk, which already contains oil, is a natural emulsion and thus insures the easy addition of oil and water. Directions for use : grind the dry pigments into this emulsion and paint directly on gesso panels or on primed canvas, diluting the paint with water as desired. Undercoats should be quite thin. Subsequent coats may be applied thinned. This is an excellent paint for adding fine detail on wet oil paint, for it sets immediately without running, yet is permanently bonded to the wet oil. Sun thickened linseed oil can be substituted for stand oil, which would result in a considerable cost saving, as sun thickened oil is quite easily manufactured.[1] Boiled linseed oil is also emulsified with egg quite easily and results in a tempera vehicle that dries fairly quickly but not as rapidly as either plain egg yolk, or egg-dammar emulsions. A factor that experience has taught the author is perhaps insignificant to the academic but important to the practising tempera painter, and that is the shelf life of an emulsion. Egg-dammar varnish emulsion lasts for months, whereas natural egg yolk and oil emulsions last only a few days before putrifying. The natural resin in combination with natural

1. See footnote 4 p. 131.

turpentine spirits have a preservative action. Synthetic resins and mineral spirits do not prolong the shelf life of egg emulsions. Various recipes include the addition of preservatives like oil of cloves, phenol, vinegar, acetic acid, etc., to extend the shelf life of emulsions. It is thought that the old recipes like those of Cennini employed the latex exuded from fig cuttings as a preservative.[1]

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1. Hiler, op.cit. p. 175.

PIGMENTS

ORGANIC AND INORGANIC
COLOURS
OPACITY AND TRANSPARENCY
REFLECTION AND REFRACTION

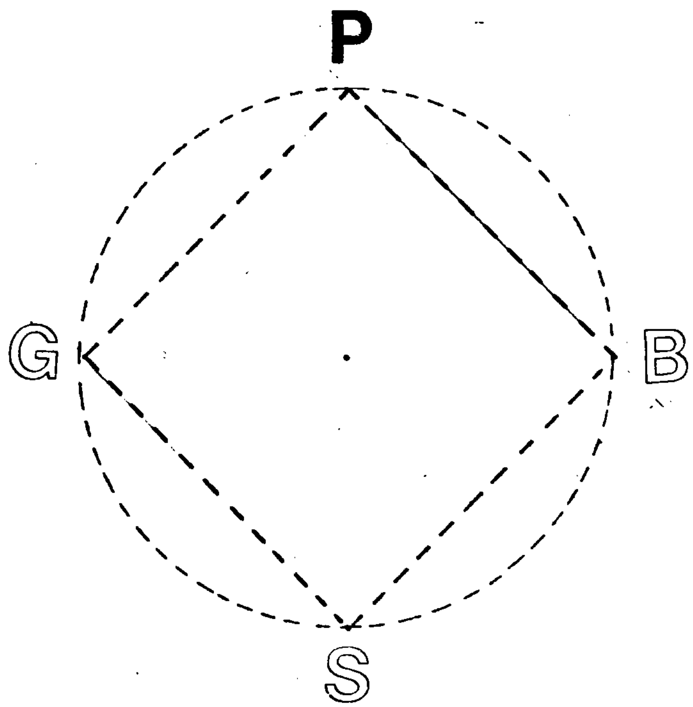

Fig. 5.

The final link in the chain of four factors governing the nature of tempera is pigment, 'P' in the diagram fig. 5. Through the examination of available source material on pigments it is evident that various physical characteristics need to be documented before their nature and behaviour pertaining to supports, grounds and especially tempera binding media or vehicles can be evaluated. By way of a formal definition, "Pigment is a finely divided colouring material which is suspended in discrete particles in the vehicle in which it is used as a paint (thus being opposed to a dye, which is soluble in the vehicle." Colour is the most important physical property of a material determining its immediate usefulness as a pigment. Physical properties are those properties inherent in a material itself and which do not involve its relationship or combination with other materials. Pigments in tempera painting however cannot be discussed without the involvement of the effect of binding materials on their appearance. Factors that effect the visual appearance of pigments attached to a ground with a vehicle, are size and shape of pigment grains that govern the refractive indices. "Pigment grains reflect most light when surrounded with air, less light when surrounded with vehicle, and paint reflects in proportion to the difference between the refractive indices of the pigment and the surrounding

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1. Stout & Gettens, op.cit. p. 137-138.

medium. The higher the refractive index of the pigment and the lower that of the vehicle, the greater the light reflection, and, with white pigments, the greater is the resulting whiteness and hiding power. There is also a close relationship between refractive index and colour."[1] Pigments also vary greatly in density or specific gravity and this variation has to be taken into consideration, both in the preparation of tempera paints and the practical application of tempera paint to ground. A factor that affects pigments for tempera painting to a lesser degree is oil absorption. Oil absorption is dependant essentially upon the total surface of the pigment particle, the interfacial tension relationship between pigment and vehicle, particle shape, size and distribution, and the chemical nature of oil and pigment. All these are important factors that have much influence on the plastic and flow properties of tempera paints. Pigments are derived from a wide variety of substances, organic and inorganic, natural and artificial. They may be classified according to colour, chemical composition, or source.

Pigments comprise a wide variety of chemical compounds; hence, they differ greatly in respect to their chemical properties. Among the inorganic colouring materials are the oxides, sulphides, carbonates, chromates, sulphates, phosphates, and silicates of the heavy me-

1. Stout & Gettens, op.cit. p. 144.

tals. A very few like Prussian blue and emerald green are complex metallo-organic compounds. Carbon in the form of lamp black or charcoal and the metal pigments like gold and aluminium are the only elements that serve in a relatively pure state. Dyestuffs are complex organic compounds, that are found in certain plant or animal derived colouring matter. For certain special purposes, a pigment should be as nearly chemically inert as possible. So far as the demands of ordinary painting are concerned, a pigment need only be stable and chemically inert enough to withstand light, air and moisture or environments in which all three agencies are combined. Stability and inertness enough to insure complete compatibility with others are among the first requirements of artist's pigments because they are intermixed or intimately juxtaposed. The wealth of available material on the history of pigments is seductively interesting, the historically significant facts relative to this discussion are limited.

Colouring materials from animal, vegetable, and mineral sources to be used for personal adornment, for decorating tools, weapons, and utensils, and for making pictures were sought by man as early as remote prehistoric times. Most easily procurable were vegetable colours, flowers, seeds, berries, nuts, bark, wood, and roots of plants. Most of these were fugitive and they soon faded when exposed to sunlight. There were notable exceptions, however, like the materials obtained from the madder root, the woad plant, or from the lac insect which, under conditions not too unfavourable, sometimes lasted for centuries.[1] Only slightly less available were the coloured earths which included the yellow, red, and brown ochres and clays that abound on the earth's surface in sedementary deposits. Carbon black in the form of soot, charcoal, and even charred bones, could have been found about the most primitive hearth. Such colouring materials as these were known and used as early as there are archaeological criteria. Somewhat less readily available than the earths were the coloured minerals of the heavy metals, but, even so, such brightly coloured minerals as cinnabar, orpiment, realgar, azurite, malachite, and lapis lazuli were known to the ancients and were used for pigments in very early historic times. Since these materials were not widely distributed but were almost in the class of semi-precious stones, their earliest use was restricted to the particular regions in which they were found. Long before classical times, however, such minerals became articles of commerce and were transported to regions far beyond their origin. There is archaeological evidence of the use of cinnabar (vermillion) as a pigment in China as early as the third millenium B.C.; azurite was used in Egypt fully that early.[2]

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1. Varley, H. Colour. p. 60.

2. Lucas, op.cit. p. 283.

Artificial pigments came to be made almost with the beginning of written history. There is evidence that the blue artificial pigment, copper calcium silicate, more commonly known as Egyptian blue, was manufactured by 2000 B.C. and perhaps much earlier.[1] The artificial yellow and red oxides of lead, as well as basic lead carbonate, were known in classical times and perhaps much before that. And so was verdigris. There is knowledge of the use of these from archaeological as well as from literary sources. It seems that artificial vermillion was not known in the West that early but it is mentioned in the Arabic alchemical writings of the VIII and IX centuries. It may have been made by the Chinese centuries before.[2] The archaeological remains of ancient Egypt are rich in information about pigments used for decorative and architectural purposes. So are those of classical times, particularly of the later and more far-reaching Roman period. Laurie has commented generally on literary and archaeological information about painting materials of classical times. The materials employed for pigments remained much the same through the Dark Ages,

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1. Stout & Gettens, op.cit. p. 112. "The inorganic blue colour most commonly found on wall paintings of Egyptian Mesopotamian, and Roman times is an artificially made pigment which contains as its essential constituents copper, calcium, and silica. Lucas, who gives a very good summary of the history and occurrence of this blue, says it was made by heating a mixture containing silica, a copper compound (probably generally malachite), calcium carbonate, and natron (natural sodium sesquicarbonate).

2. Ibid., p. 140.

and information about them comes largely from direct observations on parchment illuminations. On the pages of books, where light and moisture have been excluded, conditions have been nearly ideal for the preservation of painting materials.

Pigments in medieval as in earlier times were still important articles of trade and were carried for long distances. In value, some of them were in a class with precious metals and stone and, since they were light and not bulky, they were easily transported. In Byzantine times, ultramarine[1] began to be brought to Europe from the region of the headwaters of the Oxus in modern Afghanistan, and for centuries remained the most precious of all artist's colours. Ultramarine was carried north to Chinese Turkestan at the same time, but it was probably only the bright, exotic pigment materials that were carried such distances. The more sombre colours, apparently, were usually obtained nearer at hand and for such colours there are perhaps greater geographical limitations of use. The green earths, the siennas, and the umbers were first used in Italy and adjacent regions because best supplies were found there and still are. In later periods smalt[2] seems to have been

1. Stout & Gettens, op.cit. p. 165. "Various ancient sources have been ascribed to this stone, including Persia, Tibet, and China, but the most reliable information indicates that the lapis lazuli which was brought to Europe in medieval times originated in mines which were located in Badakshan, now a province of northeast Afghanistan. The Badakshan mines, lying in a most inaccessible region at the headwaters of the Oxus, on the north side of the Hindu Kush near Firgamu,. appear to have been worked very early and possibly they were the source of the lapis lazuli used in Mesopotamia and in classical times."
2. Ibid, p. 157. "Smalt was the earliest of the cobalt pigments. It is artificial, in the nature of glass, a potash silicate strongly coloured with cobalt oxide and reduced to a powder."

favoured in the Low Countries because it was made principally in Germany.[1] The mineral pigments on the palette of the European painters of the XV and XVI centuries differed little from those of the classical painters, with the possible exception of the blue glass pigment, which came into use in Europe during this period. Perhaps, also, some new vegetable colours were added about then. Knowledge of the painting materials of this time begins to be handed down in numerous treatises and manuscript writings. From this period there has come, also, a wealth of objective evidence in the form of actual paintings. Examination of these paintings and the identification of materials in them yields technical information that is often more important than that to be had from literary sources.[2] The first years of the XVIII century mark the beginning of modern synthetic pigments. From then on, equally definite knowledge of the date of discovery of new pigments is available from published records in scientific journals. Since about 1850 first dissemination of knowledge of new pigments and dyestuffs has come from the patent literature. Dozens of patents on pigments and dyestuffs are now taken out every year, but most of them are concerned with improvements and variations in methods for manufacturing long-esta-

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1. Stout & Gettens, op.cit. p. 141. "The Mayans in Central America used a native earth blue in their paintings, a colour that seems not to have been known in any other place in the world."

2. Ruhemann, H. The Cleaning of Paintings. p. 132-134.

blished materials. Although artists are still conservative in accepting new painting materials, the interval between discovery of a new colour and acceptance for artist's purposes is much shorter than it was formerly. Today the artist has a greater range and variety of durable pigment materials to choose from than at any time in history. For use in tempera, vehicles pigments need to be selected for their compatability with both medium and other pigments.

The most useful and reliable pigments freely available locally can be divided into various groups : organic and inorganic, natural and artificial. For the purpose of this essay it may be more practical to group pigments by their colour appearance, i.e. yellow, red, blue green, etc. White pigments have been fully examined under the heading, grounds, see p. 62-100.

Black pigments are mostly organic in origin. Ivory Black and Bone Black (Frankfort Black) are natural pigments of animal origin produced by carbonization. Vine Black is a natural vegetable pigment, originally made by charring dried vines or grapeskins, nowadays obtained from nutshells, fruitstones, and other vegetable matter. Lamp Black is an artificial pigment of organic origin, obtained by incomplete combustion of volatile carbohydrates (mineral and vegetable oils) : formerly ordinary soot from oil lamps; nowadays usually heat-treated to remove oily residues. All the above pigments are light fast, permanent and compatible with all pigments.

Manganese Black is a natural mineral pigment. Manganese dioxide is the fastest drying of all black pigments, with a catalytic effect on drying oils. A mixture with white pigments has a decided blue tinge. It is compatible with all pigments and permanent in every respect, with a very high tinting strength and excellent hiding power.

Black iron oxide (mineral black) is an artificial mineral pigment made by a number of very complicated patented methods using metallic iron. It is perfectly light-fast and alkali-proof, and fully weatherproof, compatible with all pigments and unaffected by all media. Transparency is not generally considered to be a characteristic of black pigments.[1]

Yellow pigments that are included in the author's palette are various shades of ochre[2] obtained from different parts of the country, Mars Yellow[3] and Cadmium Yellow.[4] All the yel-

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1. Wehlte, op.cit. p. 163-168.
2. Natural powder earth pigments with little variation in composition occur all over South Africa as soft rock or hard earths. The natural product is refined by levigation, grinding and sifting. The author has prepared his own and has bought various ochres from suppliers, ranging from a pale broken yellow through pinkish tints to brown.
3. Stout & Gettens, op.cit. p. 129. "The Mars colours, so-called, are artificial ochres which are made by precipitating a mixture of a soluble iron salt (ferrous sulphate) and alum (or aluminium sulphate) with an alkali like lime or potash. The depth of the yellow colour of the primary product can be controlled by the proportion of alum used. The product is a mixture of ferric and aluminium hydroxides with gypsum (if lime is the precipitant) and, if simply worked and dried, is Mars Yellow. When this Mars yellow is heated, various shades of orange -red, brown, and violet result, depending upon the degree and duration of the heat. The product must be ...

low pigments mentioned are light-fast and permanent. Ochre is moderately transparent, while Mars Yellow is the most transparent, while Cadmium Yellows are transparent in extremely thin layers. Ochres and Mars colours are compatible with all colours but Cadmium Yellows blacken copper pigments like emerald green, azurite or chrome green. Cadmium Yellow has two disagreeable properties in egg tempera. It has a tendency to mold and a refusal to mix with water. It won't form a paste without a lot of agitation. The author recommends wetting it with distilled water in the jar it is stored in, keeping it in a wet state ready for use.

Red pigments are natural red earths known chiefly by their origin. Venetian Red, Pozzuoli Red, being the most common names are varieties of terric oxide (iron oxide)[1]. Manufactured iron oxides, Red oxide, Indian Red, English Red are almost pure iron oxide, while Mars Red

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...thoroughly washed free from soluble salts to be useful as an artist's pigment. The preparation of artificial iron oxide colours of this nature from vitriol was described in the middle XIX century. Although these Mars colours are very homogeneous and fine, they possess no advantage over the natural iron yellows and reds. They are sometimes sold for the natural iron oxides."

4. Ibid., p. 101. Cadmium Yellow with shade descriptions lemon, pale, middle deep and orange. Cadmium sulphide may be made by different methods according to the shade wanted. Supplied by Grumbacher, Rowney, Windsor & Newton

1. Ibid., p. 122. "The iron oxide pigments have had such continuous use in all periods of painting and in all parts of the world that it is unnecessary to go into details concerning their history and occurrence in paintings. Even today they are commercially among the most important pigments. Both the natural and artificial varieties of iron oxide are known by numerous names. Some names show the source; some originally were applied to natural products but are now used for artificial ones; others indicate some very special kind of preparation."

Pompeian Red, Venetian Red contain varying proportions of extenders. Violet iron oxide is called 'caput mortuum'. These colours are permanent, light-fast and compatible with all pigments. Cadmium Red, light, medium and deep : a synthetic inorganic pigment made by several methods, light-fast, compatible with all pigments except copper colours. It is only slightly transparent. Carmine Crimson : a lake pigment - natural organic animal dye. Female cochineal insects (coccus cacti). It is not light-fast. Alizarin Crimson : synthetic organic dye (substitute for madder). This colour is regarded as inadequately light-fast but its cool red qualities are indispensable in glazing techniques. Alizarin Crimson is compatible with all pigments.[2]

Green pigments : Viridian, transparent oxide of chromium synthetic inorganic pigment, (hydrated chromium oxide), light-fast and compatible with all pigments with excellent transparency. Chromium oxide is chemically related to Viridian. If Viridian is heated, it loses its water of crystallization and turns to olive-green; slightly warmer in tone. It

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1. Windsor & Newton, op.cit. p. 24.

2. Stout & Gettens, op.cit. p. 91. "Alizarin was the first of the natural dyestuffs to be made synthetically. Its discovery caused the rapid decline and the almost complete disappearance of the large madder-growing industry in France. The 'alizarin crimson' lake used so extensively in artists' paints is nearly all from this source It is made with aluminium hydrate which gives a transparent lake; different shades of red can be made with different bases. It is more light-fast than natural madder lake because it contains none of the fugitive purpurin associated with alizarin from that source and is among the most light-fast of the organic red pigments."

is perfectly light-fast and also compatible with all pigments. Being an opaque colour, it is of no value in transparent application.

Emerald Green is also an artificial mineral pigment, obtained by precipitation from verdigris and arsenic. It is permanent, light-fast and moderately transparent but cannot be mixed with cadmium colours as chemical reaction will result in the formation of black copper sulphide. This pigment is extremely poisonous.

Blue pigments : Ultramarine Blue Natural (lapis lazuli),[1] this colour is extremely rare and expensive as a dry powder pigment and therefore the use of commercially prepared water-colour is an effective substitute. The transparency of Genuine Ultramarine is excellent and can be regarded as a prototype for all glazing pigments. Its transparency and high price are reasons for its sparing use and application in its pure form. French Ultramarine is an artificial mineral pigment made by calcination of sulphur, sodium carbonate and kaolin by the so called soda process. The manufacturing process is quite complicated and is covered by numerous patents. All shades are absolutely light-fast, being a sulphur compound, ultramarine blue should not be combined with copper and lead pigments like emerald green. In aqueous techniques and in some tempera media it has adequate hiding

1. Stout & Gettens, op.cit. p. 165. "Genuine ultramarine blue pigment is from the semi-precious stone, lapis lazuli, which is a mixture of the blue mineral, lazurite, with calcspar, and iron pyrites."

power.[1] Cobalt Blue is an artificial mineral pigment made by calcination of aluminium hydrate and cobalt phosphate. This colour is light-fast and permanent with a compatibility with all pigments, adequate hiding power and good transparency. Since the peculiar hue of genuine cobalt blue cannot be replaced by any other colour, this pigment, the most expensive of all those commonly used today, is used even in pastel and in the field of applied art. It displays its beauty to the greatest advantage in water-colour, but it is also indispensable in casein, tempera, synthetic-resin emulsions.

Cerulean is a slightly cooler blue than cobalt blue, with a greenish tinge. It is also an artificial mineral pigment produced by calcination of cobalt sulphate with tin salts and silica. It is not quite as transparent as cobalt blue but equally opaque in aqueous tempera media.

Prussian Blue is an inorganic pigment, a complex chemical compound technically, ferric

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1. Wehlte, op.cit. p. 141. "Ultramarine is one of the pigments whose appearance depends to a marked degree on the binding medium, which affects not only the saturation (by virtue of its light refraction) but sometimes even the hue. The principal difference between the delicate, pastellike surface effect and the deep, saturated appearance in highly refractive vehicles is discussed in the section on the optical influence of the media. It is one of the peculiarities of deep ultramarine shades that they are not contained in Ostwald's colour circle. This is due to special circumstances, which are also the reason why deep ultramarine shades cannot be reproduced exactly by even the most efficient colour films, nor by three- of four-colour reproduction processes. Special pigments must be employed to reproduce the shade."

ferrocyanide. Antwerp Blue is a light shade of this pigment. It is a transparent colour with a high tinting strength and light-fast. This colour is generally used as a tinting or glazing colour. The lumps of powder pigment are deep blackish-blue, with a peculiar reddish, metallic lustre. When reduced with white, its value is comparable to pure cobalt or cerulian blue. The author has obtained supplies from various commercial ink and paint manufacturers. Due to its tinting strength, this colour is used as an underpainting base for large areas. Glazes of ultramarine and cobalt blue serve to enrich the otherwise bland appearance of prussian blue.

There are a number of Brown pigments that are extremely useful in underpainting techniques with tempera vehicles. These are derived from natural earths. Raw and Burnt Umber, a colour in its raw powder state varies greatly from cool, slightly olive-green brown to a dull yellowish-brown to deep velvety brown, which is produced by calcination. They are Manganese earths, very common all over the world. All earth pigments are permanent and compatible with all pigments. The dark burnt varieties are fairly transparent. Burnt sienna is a pigment that varies in appearance due to its natural origin and composition; they are turned red by calcination.

The apparent limited range of pigments that have been mentioned offers a wide variety of variations. There are many other synthetic pigments available either through the well known artist's materials manufacturers or many sympathetic industrial manufacturers. They are seductive to the uninitiated enthusiast. The author has established a working procedure and palette with the colours discussed above, that provides scope for a variety of moods and colour registers.

It has been mentioned that although fully light-fast, a pigment can, by chemical reaction with other pigments, quickly discolour even without the influence of certain media. Strangely enough this has never happened in practice. The behaviour of pigments in binding media is in practice far more important than the problem of compatibility between pigments. Many of the problems generally present in pure oil vehicles are avoided through the use of tempera binding media. Even when chemically compatible colours are mixed together one can encounter unpleasant surprises, for compatibility also depends on the pigment's physical characteristics. If red lead is mixed with lamp black, i.e. soot, a pigment twenty times lighter than the former, the heavy red pigment particles will obviously settle out, leaving the light soot floating on top. This may be experienced in practice with grades of umber that have had their colour modified with a black pigment of lower specific weight. Chrome yellow and Prussian blue can also separate in this manner, as can mixtures of cobalt blue and burnt sienna in water-colour, as well as a number of other pigments. Recent research has shown that this is a colloidal phenomenon, and is caused by different electric charges carried by particles of different pigments. Sometimes this effect can be prevented with wetting agents. The amount of medium required for a colour can vary considerably and may range from 15 percent to 200 percent. The more medium the paint contains, the more readily it will crack and an excess will also cause wrinkling. Therefore pigments that have the lowest possible pigment-binder ratio should be used, especially since these often make for better consistency any way. Consistency is understood to describe the condition of a paint when it is ready for application. The choice of certain pigments is a result of experience and depends on the qualities of different batches supplied by the pigment factories. This problem is closely linked with the different characteristics of various vehicles and with variations of quality within any particular type. Two pigments may look alike but their tinting strengths can differ greatly. This is by no means always the fault of extenders, but may also depend on the particle size or the manner of grinding. The tinting power of a pigment can only be seen when the paint is mixed with white. Good spreading power is not only a matter of economics but is of vital technical importance for the cohesion of the pigment and vehicle. The tinting strength of paint is closely connected with its hiding power. This is to a large extent dependent on the structure of the pigment particles. Ochres containing clay have greater hiding power than those containing chalk. Raw sienna, a similar iron hydroxide containing silicates, is less opaque. Hiding power necessarily depends on the vehicle used. This is why in practice different types of pigment are chosen. Pigments like light red not only change their hiding power in different kinds of emulsion but even their shade, a physical consequence of their particle size and dispersibility. Hiding power is of no interest with madder, Prussian blue, viridian, ultramarine, Indian yellow. This applies in principle to all glazing colours. A glaze is a paint layer applied so thinly or containing so little pigment that it is transparent. Light falling on it is reflected by the paint layers beneath. This means that underlying ground or paint layers shine through glazing colours. Some tempera techniques, such as pure egg yolk medium, rely mainly on glazing. Colours can be blended in two fundamentally different ways. One method is to mix together two or three components. Only under a microscope can one then discern the tiny particles of different colours side by side, or intermingled. The eye sees this as a new hue - e.g., blue and green mixed together look green. On the other hand, if a yellow glaze is applied over a blue one, the result, while still green, will give quite a different effect than the colour mixed on the palette from the same components. This is the so-called subtractive mixing method. Hiding power and transparency play an important role when painting with highly refractive media. Certain pigments like madder, ultramarine, or viridian are very transparent by virtue of their crystalline structure. They are therefore called glazing colours. They should, more precisely, be called glazing pigments. But opaque colours can be used for glazing too, if they are mixed with ample medium or diluent so that the ground shines through between the opaque paint particles. The choice of transparent or opaque pigments will depend on the desired effect of the paint layer. The visual appearance of a painting is determined not only by the pigments. It is also influenced to a large extent by the vehicle. It is a well-known physical law that light is refracted when entering a clear substance, i.e., the light rays undergo a deflection, depending on the density of the medium they penetrate. This phenomenon, visible to the human eye, means in practice that there is a discernible difference depending on whether light falling on a coloured area is reflected by the surface of the pigment particles, reaching the eye directly, or whether it has to penetrate a refractive substance first, which encloses the pigment particles or is superimposed over it. When light penetrates a refractive substance it loses intensity, particularly when the subsstance is naturally coloured and therefore acts like a filter. But even when refracted by a colourless transparent medium, light suffers a loss of intensity, which is perceived as a darkening. However, this darkening does not affect the colour in the same way as admixtures of black, but make it appear deeper, more saturated, with a deep luminosity. This may sometimes be an advantage, but it can also mean a loss of a particular colour effect. Pastels contain such a minute trace of binding material that there is virtually no light refraction due to the medium. Light is reflected diffusely directly from the surface of the pigment. In this ideal case, the beauty of the pigments comes into full, unrestrained play. Unfortunately, fresh pastels lack the cement provided by the medium, and therefore the pigment particles are poorly attached to each other and to the support. Tempera vehicles that contain minimum amounts of drying oils in an emulsified state have strong binding action without affecting the colour saturation of the pigment. The degree of saturation has a profound influence on the appearance of colours. This may be demonstrated by the following experiment : pale ultramarine gouache colour is applied to white illustration board, in several layers if necessary to achieve complete opacity. After drying, half of the blue is coated thickly with dammar varnish, which will turn the paint momentarily to a deep, dark shade of ultramarine. This appearance, which at first resembles wet oil paint, will change within an hour. The paint remains considerably darker as a result of the light refraction caused by the deposited resin, but the high saturation disappears just as oil paint sinks in during drying. If half the varnished paint is revarnished until it remains glossy, we shall achieve a permanent saturation. This method is employed when painting in varnished-tempera techniques. This simple experiment clearly shows the paramount importance of the refractive effect of the vehicle remaining in the dried paint. It also serves to explain the difference between egg yolk tempera and emulsion tempera, two widely varying techniques using the same pigments. In egg yolk tempera, extremely thin pigment layers are embedded in a barely perceptible amount of diluted egg yolk or casein vehicle. Although there is no surface gloss, light is still noticeably refracted. By contrast, tempera emulsion painting is a technique using opaque pigment layers Since the proportion of vehicle is appreciably lower than with egg yolk, the paint lightens considerably on drying, so that the finished work sometimes has an almost pastel effect. It should be sufficiently clear from these two examples that the amount of vehicle remaining in the dried paint layer is just as important as the refractive properties of the binding material. The ratio of pigment to vehicle must therefore be taken into consideration. The closer the pigment particles are to each other, the less saturated they will appear. On the other hand, in a paint system with a relatively high proportion of vehicle the pigments will appear more or less saturated. The degree of saturation naturally depends on the refractive index of the vehicle.

The preceding section on pigments, with the considerations for the relationships of binding mediums to various colour particles, serves to conclude the technical aspects of the definition for 'The nature of Tempera'. It is hoped that the cumulative facts of each section provides a clear perspective to the complexity of such a definition. The structure was conceived to link the various components by implication, the anatomy of different types of tempera painting being explicitly devided into supports, grounds, binding media and pigments. The progression is also clearly illustrated in the diagrams figures 1-5.

AESTHETIC AND TECHNICAL ADVANTAGES

AUTOBIOGRAPHICAL NOTES
PERSONAL PREFERENCE
NOTES ON THE PRACTICAL COMPONENT
SUPPORTS AND GROUNDS
BINDING MEDIA PIGMENTS
COMPOSITIONS

The aforegoing sections on the technical aspects serve to establish a base and framework through which the aesthetic principles of tempera painting can function. The historical background and thoughts on the rediscovery of the technique also serve to place the author's attitudes and personal preference for tempera painting technique into perspective. Traditions are perpetuated not only for the sake of tradition but for the regeneration of specific technical and aesthetic advantages inherit to the medium. The following section is an attempt at investigating these aesthetic and technical advantages, through an analytical study of the works presented as the practical component of this submission. The structure of this section will be similar to the main body of the essay, namely : 1. Historical background and discovery, where the author's first contact with the reality of the medium is related. 2. The selection of supports, this section deals with the reasons for personal preference in the choice of supports and the subsequent treatment of them in preparation for the exhibition of the works. 3. Grounds; the effectiveness of modern technological substitutes for old traditional materials is investigated. 4. Binding media; the economical considerations together with purely practical aspects of a painter's personal aesthetic bias, are documented. 5. Pigments; a resistance to the seductive range of pigments and ready prepared paints is examined in the light of economic, technical and aesthetic advantages. The premise that a unity of colour order and aesthetic content can be achieved through a limited range of pigments is also explored. 6. Compositions, colour order, contrasts and content are examined by way of reconstructive analysis, where the aesthetic advantages and the physical nature of tempera painting techniques are established. 7. Empirical data about the practical work is provided as documentation for the submission.

The historical background to a personal involvement with tempera painting could simply be seen as the culmination of a series of co-incidental events. But in retrospect the influence of these events significantly affected an attitude towards technical matters of painting generally. The smattering of technique received at school level could hardly be counted as significant, and the limited experience at Art School can be regarded as a negative influence rather than fundamental to further development. The necessity for learning about techniques and methods of painting was not overlooked as much as it was avoided. A number of questions arose out of this academic impasse. What is the importance of painting technique today? Is its value only historic-scientific, or should it still be considered as a classroom subject? Can technique really advance the process of artistic creation, or does it, on the contrary, interfere with it? Should we concern ourselves with it, or is the knowledge of technical possibilities only a burden, hindering our intuitive work? There were times when to ask these very questions would have been unthinkable. In the present artistic climate, however, they are quite justified. Every teacher of art is familiar with the contemporary situation regarding the technique of painting and is aware that relatively few students are seriously interested in the subject.

The author's academic background in the initial stages was limited to a short period of eighteen months in the diploma course of Commercial Art (Graphic Design)[1] and subsequently a five year apprenticeship as a photolithographic artist in the printing industry. The formal instruction was limited to technical aspects of the (industrial) graphic arts.[2] Interest in painting as a career remained ever present as a pipe dream, stimulated by parental activity in the arts as a periforal interest at first and later more actively as a paying hobby. A chance meeting with the painter Robert Broadly[3] initiated a significant chain of events. His sympathetic attitude resulted in leaving a studio-easel, oil paints and brushes to the author after vacating his studio in Cape Town. Amongst the studio equipment and material were several packets of dry pigment, remains of which are still in possession of the author. During the course of the first year of study at art school,

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1. Michaelis School of Art, U.C.T. Academic Year 1962, 1st year Student Diploma Course in Commercial Art; 1963, half year incomplete course. (Author's note.)
2. National Printers Diploma 1964-68, Photolithography, Cape Town Technical College. (Author's note.)

3. Berman, E. Art and Artists of South Africa. p. 74.

the author initiated experiments using egg yolk medium with water-colours as pigment, at the suggestion of the drawing lecturer Melville Summers[1] but due to the lack of technical guidance the experiment was doomed to failure. A single work is known to be in existence and is included in a German art collection.[2] The recollection of the technical difficulties with the ground dissolving under the aqueous washes of water-colour and egg medium served to frustrate further attempts. Many of the inadequacies caused by insufficient knowledge served to affirm the rejection of egg tempera as a medium for effective artistic expression. The oil paints received from Broadly were soon used up. Paintings done between 1957 and 1967 were all oil on canvas or panel.[3]

After this period oil paints were replaced by acrylics, soon a preference for aqueous media became evident. These washes of colour applied as scumbles and also rubbed on with rags, developed into a working method. The atmospheric effects of dry brush and patination with glazes were partly derived from a personal admiration of the work of Douglas Portway[4]

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1. Berman, op.cit. p. 232.
2. Collection Mrs. I.Brinkmann, Munich. (author's note)
3. Cape Art '67 Catalogue S.A. Association of Arts.
Adler Fielding Gallery 17-10-67 Oliver Kerr, Sunday Express 29-10-67; H.E.W. Rand Daily Mail 25-10-67.
4. Berman, op.cit. p. 348-349. "In the works of 1962-68 he gave no tactile body to the paint, yet he achieved a remarkably responsive texture by rubbing in thin layers one upon the other and scratching, sgraffito-like through the viscous surface to expose the underlying pigment." As a scholar and student the author frequently visited the National Gallery to study the paintings; the proximity of the author's home in the city centre made this an almost daily occurrence. (author's note)

and partly as a result of gradually increasing myopia.[1] Compositions were made up of large simple areas of subtle chromatic tones where colour played a secondary roll with accents and focal points achieved by strategically placed colour areas. An exhibition of paintings in this vein was held in Johannesburg in 1970.[2] The quick drying advantages of aqueous media in creating tonal and textural gradations were of primary importance in the choice of the medium. A second exhibition of acrylic paintings was held in Pretoria prior to departing for Belgium in August 1971.[3] Soon after returning to South Africa in 1972, work proceeded on the preparation for an exhibition in Cape Town. It was at this exhibition that contact was made with a Zimbabwian painter, Francois Roux,[4] who introduced egg tempera to the author. Samples of pigments and a demonstration in the preparation of grounds and emulsions given then, formed the basis for the present document. The author discovered

1. Trevor-Roper, P. World through Blunted Sight. p. 32-33. "This 'peripheral' type of imagery is quite familiar to us but usually taken for granted and rarely analyzed, while those who are short sighted, it is the sort of view they always have without their glasses. It is also that employed artists who aim primarily for effects of mass, line, colour and symbolism. This imagery was triumphantly exploited by most of the artists who came to be called Impressionists."

2. Sarah Hassel Gallery, July 1970. Richard Cheales, The Star, July 16, 1970 "Diaphanous and ethereal are the kinds of words that spring to mind when seeing the colour-gentle compositions of Leon De Bliquy..." H.E.W. Rand Daily Mail, 10 August 1970; Kenelin Everard, The S.A. Financial Mail, 7 August 1970.

3. S.A. Association of Arts, Pretoria, July 1971 - Phyllis Konya, The Pretoria News, July 1971.

4. Francois Roux, South African born artist, son of a missionary couple, lived in Zimbabwe, imigrated to South Africa. (author's note)

in egg tempera the ease and convenience of an aqueous media, offering similar working facilities to be found in acrylics, with the added possibilities of using locally found pigments, that have unique physical characteristics.

In 1975 the author returned to Belgium with a second research scholarship.[1] A study of tempera painting techniques was initiated, consultation with an expert in painting technique and restoration techniques, Prof. Van der Spiet, lead to the acquisition of additional pigments and other materials from a specialist supplier in Antwerp,[2] the compilation of a bibliography and the collection of copious notes on the subject. A first hand study of Flemish Primitives and some contemporary tempera paintings[3] provided the author with the stimulation and conviction to pursue the development of a personal technical approach to painting. The result was an exhibition of works in which the acquired knowledge was applied. These works were documented in a film made by Belgian Radio and Television, and a subsequent publication.[4] Since then a process of technical refinement has lead to the ex-

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1. Cultural exchange scholarship awarded by Dept. National Education in collaboration with the Ministry of Culture and National Education of the Kingdom of Belgium. Academic year 1975-76.
2. See footnote "In de Balans" p. 129.
3. Corn, M.W. The Art of Andrew Wyeth. p. 80.

4. B.R.T. (Belgian Radio & Television) Cultural programme 'Dag aan dag' Sunday June 6, 1976. Made by Promofilm Brussels. Beelden, S.A. Embassy Magazine June July 1976 XXI n°6/7 p. 9. "Zuid-Afrikaanse schilder te Sint-Amands." 'Die By' Bylae tot die Volksblad, Saturday 21 August 1976. "Kovsies kry kleurryke Lektor" Lind Dietrich

ploration of a variety of aesthetic advantages of each tempera system chosen by the author. The historical significance of the practical submission and the subsequent change in title of the essay,[1] clearly establish a link and a logical conclusion to an evolutionary process of discovery and aesthetic maturity through the academic investigation of technical advantages. The practical components of this submission[2] are linked to each other through the aesthetic relationships of colour refraction on pigment granules. Pastel drawings on paper produce effects of colour saturation unequalled by any other medium. Egg yolk tempera affords the use of transparent glazes without the impediment of binding media that reduce the refractory index of pigment granules. Tempera emulsions are binding media that afford flexibility to paint layers as well as providing the advantages of aqueous media, without sacrificing the above mentioned refraction of colour.

Considerations for the selection of suitable supports for specific practical reasons are related to the following factors : size, weight, tensile strength, type of ground to be applied, and the type of medium to be used. To the uninitiated these factors sometimes may

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1."Selected aspects of colour contrast, an aesthetic, historical and technical survey." 3-5-1982.

2. Exhibition King George VI Art Gallery November 1983. (see catalogue enclosure at the end of this essay.)

seem quite obvious and irrelevant, but practical experience has shown that the incorrect combination of these variables can have disastrous results in the final product. Cracking of paint layers, grounds as well as the flaking off of the whole picture surface. With the number of available types of supports, grounds and binding media, the number of possible variations are considerable. On the other hand the number of suitable practical and wholely compatible combinations are actually quite limited.

Plywood panels were selected as supports for the outsides of the outer panels of triptychs n° 12 and n° 13, as well as the six composite panels of n°14. The outsides of the triptychs were designed to protect the backs of the outer leaves, and to effect a greater continuity between inner and outer images. These plywood panels are of commercial grade 4mm 3 ply 7400x700mm, covered with a fine iron on architects backing linen. The main consideration here was rigidity and light weight. The fine linen surface finish provides a sympathetic transition between outer and inner surfaces. The six plywood panels of n° 14 are S.A. Pine 4mm 3ply, 1200x1200mm, supported with outer backing frames and centrally placed cross pieces, for greater stability. The main reason for the implementation of rigid supports in this case was to avoid the problems of expansion and contraction encountered in canvasses of this dimension. In order to attain a large surface area, sections were designed to be linked up with a system of screws through the supporting battons on the backs of the panels. The visual impact of large surfaces of highly refractive colour areas was the main aesthetic principle behind the premise for this experiment. Practical considerations of weight and smoothness of surface were also critical to the choice of rigid panels, which afford greater manipulative procedures.

Architect's backing linen : $\pm$ 33 threads per centimetre warp and weft. The threads are fine bleached linen woven to produce a cloth something like fine bed linen or shirt material. This fabric is backed with a heat sensitive adhesive (probably a mixture of gum arabic and colophony resin). The fabric is placed adhesive side down on the surface of the rigid support, a warm iron is passed evenly over the entire surface of the support until adhesion is complete. An overlap is usually allowed for to ensure a neat edge to the panel.

Cotton canvas : (cotton duck) medium, 50 picks per inch or 17 threads per centimetre. The inclusion of a single example of cotton canvas for n°9, serves both as a control for stability and the particular textural responses offered by a fine close weave. The closeness of the weave and density of the thread influence the textural appearance of the surface of the canvas, which results in the ground taking on a certain flatness of texture.

Fine flax linen canvas : 20 threads per centimetre, plain weave, already prepared with a half chalk ground. Only one work out of the series, n°1 was done on this type of canvas.

The fine close weave and evenly applied ground accented the broad application of paint in strokes of soft brushes, and subtle scumblings of glazes. The slight surface texture heightened the execution of large simple forms.

Coarse flax linen canvas : 6 double threads per centimetre, hop sack weave; all the remaining paintings of the series employed this canvas. This particular type of canvas with a double thread interface has a texture that receives the isolation layers and the ground most effectively. This choice of support has a specific character, ease of handling and compatability with the preparations chosen for the various tempera media.

Treatment of supports : The plywood panels on the triptychs were accurately cut to size and carefully sandpapered to remove any surface roughness, ensuring that all edges were slightly rounded to accomodate the adhesion of the Architect's backing linen. The surfaces were carefully dusted prior to application of Nitrocellulose sealer. After application of the linen 2 coats of PVA sealer were applied in succession, subsequent ground layers were applied. Plywood panels n° 14 : the supporting battons were glued in position (no nails were used, to avoid possible rust marks). The surfaces of the plywood panels were slightly roughened with a rasp to affect maximum adhesion of the ground. A single coat of Nitrocellulose sealer was applied to the surface of the panels prior to laying the ground. All flexible supports with the exception of the ready prepared canvas were treated with two layers of PVA sealer prior to the application of the ground.

With the exception of n°1 (a ready prepared canvas) all supports received the same ground. A commercially prepared coating product with a PVA binding medium marketed under the names Liquifill or Filler Coat has proved to be stable and sufficiently flexible for the preparation of canvasses. The viscosity was varied with the addition of water to facilitate application by means of paint brushes in the case of fine textile surfaces or by means of palette knives and spatulas for the plywood and heavy textured linen. In the case of the plywood panels without the linen face, surfaces were sandpapered to a smooth plaster-like finish. The advantages of this substitute for traditional grounds made with organic binding mediums and emulsions is that it is water soluble and dries irreversibly water-insoluble. Synthetic dispersion grounds dry without surface tension. Absorption can be regulated very easily. Filler coat has a built in fungicide and antibacterial preservative, ensuring a good shelf life. Finally, an important advantage of synthetic-resin dispersion ground, is that they do not yellow. Filler coat can be used for any painting medium quite successfully. The heavy linen canvas texture was partly filled in with the palette knife application, resulting in a thoroughly worked surface with an 'organic' handcrafted texture. Absorbancy for individual canvasses were regulated by the application of dilute PVA sealer, Nitrocellulose sealer or dilute tempera emulsions. These sealing procedures will be related to in the discussions of individual paintings.

Three types of tempera media were used in the series of paintings : diluted and pure egg yolk, whole egg and dammar emulsion, whole egg and synthetic resin varnish emulsion. Egg yolk medium was exclusively used for the six plywood panels n°14, on which the ground was left unsealed for maximum absorption. Large quantities of colour were mixed and applied quite thinly with a maximum concentration of pigment to medium proportion, so that the absorbent ground could draw the paint into the receptive surface. A solid foundation of sufficiently bound underpainting was thus established on all the panels, allowing for additional layers of egg medium and pigment to be washed on at a later stage. The main advantages of egg yolk tempera are textural effects and luminosity. From the perusal of the practical work of this submission it will become evident that the author is fascinated by texture he love of the grain, defects and irregularity of materials such as rock, sand, bone, etc. Egg tempera is an ideal method to render these qualities, through dabbing, splattering and scraping with a razor blade. Rough textures, that is the look of texture, and not the rough quality of paint on canvas or panel. These are the advantages over acrylics that dry fast and form a rubbery plastic-like finish that does not allow any manipulation of textures such as scraping and sandpapering. No other medium can match the beautiful luminosity of egg tempera. Exactly how it differs from the luminescent qualities of oil and acrylics is hard to explain. To say that an egg tempera painting has a shimmering or glowing quality accented by jewel-like tones is an imprecise description but it might give an idea of the characteristic. It really must be seen to be appreciated. The luminosity of egg tempera is enhanced, rather than diminished, by repeated layers of transparent colour. Should an area of paint dry without this life-giving quality all that needs to be done to restore it is to apply another glaze. Technical advantages of egg yolk tempera are firstly its quick-drying quality and secondly the adaptability for the inclusion of pigments retrieved from natural sources. Egg tempera dries to the touch within seconds, this facilitates the build up of form by the application of a succession of glazes. The emulsion made with a whole egg and natural dammar resin varnish, p. 128, was used for the painting on flexible supports where rich saturated colour values with transparent glazes came into effect. The works where natural earth pigments and more opaque applications are evident, are representative of the more bland binding properties of synthetic resin varnish emulsion. The technical advantages of tempera emulsion mediums are their ability to accommodate blending or wet in wet techniques for a short time before drying occurs (here oil has an added advantage but extended work periods are not as effective as emulsion tempera). Aesthetic advantages are primarily the minimal effect of binder on pigment towards colour refraction, as with most aqueous media.

Tempera painting techniques in a certain sense revive the importance of pigments as an essential part of a paint system. The free availability of various manufactured paint 'media' is almost taken for granted. Dry pigment powder has almost become a rarity and suppliers are hard pressed to carry stocks, commercial demand for them being almost non-existent. The author has had on occasion to purchase a full range of dry pigments from an art material supplier.[1] Most of the colours are more of a curiosity rather than truly functional in the day to day working method of the author. Pigments that form the basis of most of the author's work and specifically those paintings that constitute the practical component of this submission are a variety of natural ochres, iron oxides, chrome oxide (opaque),hydrated chrome oxide (transparent), black oxide and titanium dioxide.[2] Pigments

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1. Dry pigment : Burnt Sienna, Burnt Umber, Alizarin Crimson, Prussian Blue, Cadmium Red Deep, Cadmium Red Deep medium light, Cadmium Yellow medium pale light, Cadmium Orange, Ivory Black, Thalo Green, Thalo Blue, Viridian, Rose Madder, Mars Red, American Vermillion, Zinc White, Titanium White, Lemon Yellow, Raw Umber, Raw Sienna, Mars Violet, Venetian Red, Cerulean Blue, Cobalt Blue, Cobalt Violet, Chromium Green Oxide, Lamp Black, Yellow Ochre, Thio Violet. p. 06 EVE p. 74 catalogue.
2. All these pigments are purchased in 500 grams packets from hardware shops and paint suppliers. A brand name most common is Viking packed by Prolux Paints Cape (Pty)Ltd., Dorchester Street, Paardeneiland, Cape.

that are difficult to procure in the 'raw' state are permanent blues such as ultramarine and cobalt blue. These are imported from England or Europe.[1] Supplies of Prussian blue have been obtained from a local paint manufacturer. Reds and Cadmium yellows are used in minimal quantities, their purity, stability and permanence is critical in any painting and therefore only reliable products are used; these also have to be imported.[2] In certain cases dried up tubes and jars of aqueous medium paints such as water-colour, gouache, poster paints and even broken bits of pastel have been ground up to make perfectly adequate pigments for tempera vehicles. Practical and technical advantages in this respect are numerous and economically quite obvious. The most important advantage being that aqueous media can be converted to irreversible drying paint systems by the addition of egg yolk or emulsions. A particular advantage in the use of 'bulk' pigments is the coarseness and irregularity of the granules, a physical characteristic that is indicative to the building up to textures previously mentioned. The body of tempera paint is thus also improved without additional fillers. The aesthetic advantages are coupled to the coarseness and irregularity of pigment grains. Blues seem to have greater refraction indices when the pig-

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1. L. Cornelissen and Son, Artists Colourmen, 22 Great Queen Street, Covent Garden WC2B 5BH
Windsor & Newton; 'In de Balans', Grote Markt, Antwerp, Belgium.
2. Author's note : The range of 2 oz. bottles of the reds and yellows of pigments has lasted the author since 1976. Alizarin Crimson, Cadmium Red and Yellow are still half full.

ment grains are larger, fine pigments on the other hand offer greater transparency. Ready prepared egg tempera paints are available in tubes,[1] these differ to other manufactured paint systems in that they employ an egg emulsion medium with a drying facility much like gouache, poster paint or casein tempera. The essential aesthetic advantage of the author's particular application of coarser pigments is the immediate tactile response in varying the amount of pigment to binder relationship without creating a diluted wash effect. Absorbancy of initial applications of underpainting can be regulated this way in order to provide foundations for subsequent applications. Large areas of ochre, red iron oxide, chrome oxide, or black tempera underpainting form the basis of a unity in colour order throughout the series. The natural harmony in earth pigments provides a common link in the colour compositions, where more 'active' colours (red, yellow, blue) can function as contrasting elements to accentuate the content of the paintings. The natural earth pigments act as neutral entities in individual works as well as being an underlying factor in the series. It is the author's assumption that the bulk application of raw natural pigments

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1. Rowney Catalogue, op.cit. p. 15. "Rowney egg tempera is made from a formula based on a method used in the 19th century using traditional pigments dispersed with an egg yolk and linseed oil emulsion. It is being used extensively by restorers, conservators and specialist artists. It can be used on a wide variety of grounds including walls, canvas, hardboard, paper, ivory, gesso primed boards, etc. It dries quickly and should be used in thin glazes using only water to reduce its strength. It is an ideal underpainting for oils and is waterproof when completely dry."

bound in a tempera medium is the cardinal essence to the feeling of texture in the works. The specific quality of manipulation of the formal aesthetic elements such as colour, tone, form, composition and line are definitely linked to the nature of tempera painting as it is manifested in culminations of supports, grounds, media and pigments. It will be seen that each work illustrates a particular variation through the selection of the above variables.

The series of paintings and drawings that constitute the practical submission was conceived as a unit statement, with various sub-structures that relate to literary sources, physical realities of natural phenomena and artistic inspiration. A modular landscape format 900x1400 mm was selected to accommodate various aspects of landscape phenomena. Natural elements, air, earth and water reflect contrasting compositional dynamics. Organic v. inorganic, plant v. animal and male v. female concepts contribute to the overall continuity of the theme. Most of the paintings are composed on a linear rhythmic principal where the eye is lead over the surface of the painting through gradations of tone and colour. Spacial effects or perspective is relatively suppressed. This composition device can also be explained in terms of the author's myopic condition. "Both the myopia and hypermetropia of an artist will have a direct influence on the optimum distance for viewing his work.

Artists who record on their rectangles of canvas a relatively small view, normally use a simple geometrical perspective, the laws of which remain approximately accurate only for such a 'narrow-angled' span."[1]

The square formats of n°1 and n°15 serve as balances at either end of the landscape series with two additional focal points in n°12 and n°13, having the square as a primary module, with the possibility of extention to the landscape format by unfolding the outer wings. The modular convention in the series is extended to the composite arrangement of six squares that make up n°14. These paintings were intended to consolidate all the elements reflected in the individual components in the series.

The logical order in the arrangement of the works in series was initiated with the first work produced in chronological order. N°1 "In the beginning..."[2] was painted prior to the inception of the idea for the series. This painting in itself represents the conclusion to a series that marked the author's transition from living in a semi-desert environment to

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1. Roper, op.cit. p. 35.

2. Elytis, O. The Sovereign Sun 'Body of Summer' "A long time has passed since the last rainfall was heard Above the ants and the lizards Now the sky burns endlessly The fruit trees paint their mouths The pores of the earth very slowly open And beside the trickling and syllabic waters A huge plant stares straight into the sun." Exhibited Staff Exhibition PE Technikon School of Art and Design lecturers, 1980. Author's collection. "Green blood and bulbs golden in the earth" Collection King George VI Art Gallery.
The Holy Bible - King James version. p.5.

life at the coast.[1] N°1 (1500x1500mm) is composed with intersecting s-curve planes. The movement originates from a spherical form in the lower centre of the composition. The dominant colour contrast is blue and orange with subtle mixtures of chromatic greys derived from these complementary tones. The focal point is being accentuated with a brilliant white shell form, centre bottom. In this painting the effects of glazes on a fine canvas heighten the subtle transitions that are possible with this technique. The almost magical blue in the background illustrates the specific advantage of tempera vehicles in the maximum exploitation of colour refraction.

N°15 "Green blood and bulbs golden in the earth" (1500x1500mm - practical examination November 1983). This painting was designed to conclude the series. In employing the same compositional convention as the work that initiated the series, a logical link was forged. In inverting the axis and adopting a shift in complementary contrasts it would be seen that the chromatic greys form the necessary link. Yellow and purple are thus brought to-

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1. Berman, op.cit. p. 109. "But following his move to Port Elizabeth, shells and ocean debris picked up on the beach provided a new source of imagery, out of which a new series, on the theme of Metamorphosis and Genesis developed."
Major works in the series :
1980 Genesis I Author's collection- R.S.A. 1981 Durban.
1981 Genesis II Berman p. 109.
1980 Still life 'Decomposing Forms' Pretoria Art Gallery
1982 Marine Genesis & Shell Forms- Collection Shell Corporation of S.A.

gether through an interchange of chromatic subtleties. The focal point being accented in the eye of the turtle is also significantly black, thus complementing the white egg form of n°1. The beginning and end of the series are represented in the above two paintings. Paintings that explore the landscape elements in the Genesis theme have a biblical origin; the titles of n°s 2-9 are taken from the Book of Genesis.

N°2 "God created the heaven..." (900x1400mm) was composed with complex backward and forward movement of forms, a directional accent from left to right is achieved through tonal gradation. The dark curved horizontal landscape is more of a linear device than a spacial reference. The diagonal movement is accented by planes receding at an angle to the picture plane in n°3 "...and the earth," originates in the horizontal movement of the landscape line of n°2. These two paintings complime one another in terms of structural dynamics and colour values. Paint application, surface texture of grounds and type of pigments serve to support the hypothesis that tempera techniques have extended aesthetic and technical advantages. Manipulative characteristics of the components add a distinctive 'matier' to tempera paintings.

N°4 "And the Spirit of God moved on the face of the waters", is very simply composed with a spiral that occupies two thirds of the rectangle, the linear convention creates a receding horizontal plane with undulating surface movement. Randomly splashed highlights of white spots and calligraphic brushstrokes of transparent and opaque white embellish the linear movement. An interplay of blues varying in saturation provide a simple foil to the activity of line and movement. The contrast of transparent and opaque pigments serves to heighten the ethereal quality of the substance, water, and the associated spiritual quality of the symbol.

N°5 "Let the earth bring forth grass,..." The spiral forms in this painting are haphazard and express the apparent random structure of organic growth, as opposed to the physical realities of gravitational effect. The linear movements taken up by the root forms are brought to a focus on the centrally placed seed form which in turn initiated further movement across the composition. Light-dark contrasts are employed to accent the tactile and tangible forms. Colour is limited to ochre and green oxide to eliminate compositional complexity.

N°6 "...and the tree yielding fruit", is an example of a composition where the complexity of the linear spiral convention, coupled with spacial and colour juxtaposition are brought together. The device of diagonal tensions serves to unite a fragmented composition. The conveying diagonals from opposing corners are accented with an orange sphere, establishing a focal point and centre for the expanding spiral. Tensions between red and green, orange and blue are neutralized to a certain degree by the enveloping rich earth colours. The variation in size of spherical forms as well as their relative temperature value effects a forward and backward spacial movement.

N°7 "...and let them be for signs, and for seasons" In this composition the diagonal is once again a device to effect tension. The elements water, earth and air are brought into powerful confrontation through atmospheric effects, light-dark, red-green, blue-orange, yellow-purple, complementaries combined to achieve an oscillation between seasons and metaphysical elements that could result in the manifestation of animal life.

N°8 "...Let the earth bring forth the living creature..." The textural elements in this painting are the primary compositional devices, dynamics of diagonals and other linear conventions are hardly significant. The landscape format with the high horizon are simple spacial devices designed to accent the textural contrasts. Tonal gradations serve to make the highlights in the organic forms more dynamic. A close harmony of earth pigments with the fusing effect of splatter techniques establishes a paradox between atmosphere and tactile sensuality through an association of ideas. The blue in the sky is functional in that it offers an additional association of air symbolized in the feathers.

N°10 and N°11 respectively are the sets of outer panels of n°12 and n°13. N°10 is made up of two separate panels that together form a square, the panels are visually linked by a diagonal deviding the square from the top right corner to the bottom left corner. The top left half of the diagonal area is dominantly light while its opposing triangle is dark. Compositionally the unit is subdivided in a system of diagonals fragmenting the composition but providing dynamic structural form. The ochre earth colours are complimented by blue, an equilibrium of balance between light and dark ensure an element of stability to the composition. This stability and equilibrium is also the principal compositional concept in n°11. The diagonal geometric forms are replaced by shapes related to a circular organic form where red and green are dominant with ochre, white and black contributing to the structural dynamics of form. Both sets of outer leaves to the triptych are intended to express aspects of duality in the act of creation. The first n°10 representing God and Man while the second, n°11 embodying Male and Female.

In n°12 "Adam", the compositional dynamics of inorganic structures are carried through, with contrasts of light and dark natural earth pigments combined to recall a response to primordial colour sense. Thin glazes of blue over certain transparent white scumbled areas are intended to provide the necessary foil to an otherwise intense overpowering mood of texture.

N°13 "Eve", is also a continuation and extension of the Yin-Yan motif on the outer leaves. Red and green oppose each other with yellow ochre providing the neutral zone for complimentaries to interact dynamically. The combinations of green and red pigments through a system of under- and overpainting exploits the full potential of complimentary colours without the sometimes unavoidable neutrality of chromatic greys. The yellow ochre also assures a warmth and a rich harmony between plant and human form. The dark male figure in "Adam" has a sombre brooding presence while the "Eve" is intended to reflect a light vibrant mood. The two paintings are constructed on the principles of contrasting compositional dynamics. They are intended to differ in every way and yet to complement each other. The hypothesis behind the structure of the exhibition as sketched in the introductory paragraph of this section has thus been substantiated. Whether the paintings are regarded to be successful can only be determined by outside viewpoints. The intention of the author was to explore technical and aesthetic advantages of the medium. A factor which is of vital importance to any artist whether in an academic situation or not, is the rare phenomenon of artistic inspiration. It is on this note that the composite assemblage of the six panels n°14 "Genesis" and the six pastel drawings are represented. These works were not 'pre-meditated'. Spontaneous enjoyment of medium, colour and image synthesize to express all the random thoughts and actions of the painter.

The author submits that some things are best left un-said or un-written, leaving the painter to discover his own majic in the limitless resourcefulness of his own creativity through the mystery of his chosen medium.

CONCLUSION

This investigation may not present clear cut conclusions of a purely academic nature but a wealth of aesthetic and technical advantages have been discovered and documented both in this essay and in the practical component of the submission. The overwhelming cumulative evidence gleaned from various literary as well as archeological sources points clearly to the fact that the traditions of portable panel painting can be traced to ancient times, and are common to many cultures. The fact that egg tempera as a medium shares a similar historical significance is also quite clearly documented. The history of tempera painting can be followed through the very materials that constitute the medium. Pigments are synonymous with man's spiritual and material existence. By means of their dominating agency in the diffusion of myths, rites and mysteries of ancient metallurgy and alchemy, they have played parts of such continuity and expanding diversity as to have rendered some unique amongst all minerals, in moulding mankind's existence. They continue to guide and control, carrying information and acting as cultural catalysts. In referring to the materials associated with tempera painting the questions of craftsmanship and tradition come to the foreground. Those artists who propagated the skills learned by experience and handed down through time by previous generation, were cumulatively responsible for the refinement attained at the height of tempera painting development. Subsequent authors who attempted the recording of recipes, techniques and methods of preparation, could not be expected to engender the kind of perfectionism perculiar to the working methods of master craftsmen. Human failing and the limitation of the written word in matters of craft can so easily be misinterpreted. But the visible evidence of the masterly crafsmanship of Botticelli manifests the reality and the true lasting qualities of egg tempera. With the advancement of technological knowledge and scientific discovery came many innovations in painting media. Strangely enough this phenomenon also bears witness to an unfortunate decline in craftmanship. Therefore it can be deduced that there is a correlation between the limitation of media and the development of traditions of crafsmanship. The question could well be asked whether the painters of the 'Trecento' and early 'Quattrocento' conceived the limitations of egg tempera as restricting. Many authorities on egg tempera believe that the medium does not suit a naturalistic approach. But the painter who masters the use of glazes should have no trouble creating marvellous naturalistic effects. There are however several limitations to egg tempera, some are real, some are subjective and other are imaginary. The real limitations are that egg tempera paint cracks off if improperly applied, it is hard to blend because it dries quickly. Impasto is not a characteristic of tempera. Pigments mixed with egg yolk must be applied thinly or they will crack and fall off. Colours generally dry much lighter than oil or acrylic, egg tempera dries to a matt, flat-looking finish and this tends to make the medium more linear. This could be seen as a subjective limitation, these qualities may seem like weaknesses to some but the author has concluded in his practical submission and the discussion on the paintings that these very limitations are significant to the aesthetic and technical advantages of the medium.

EMPIRICAL DATA AND FORMULAS

N° 1 (catalogue)

Title :	"In the beginning"
Source :	Elytis O., "The Axion Esti" p. 17. "In the beginning, the light and the first hour when lips still in clay try out the things of the world." "The body of summer" Elytis O., The Sovereign Sun p. 75.
Size :	1500 x 1500 mm.
Medium :	Egg and Dammar Resin Varnish emulsion.
Support :	Fine plain woven commercially prepared canvas, supplied by Van Mulder de Knibber.
Ground :	Half chalk ground, prepared by the supplier.
Treatment :	Thin washes Hypla-acrylic underpainting and yellow ochre underpainting
Pigments :	French Ultramarine, Yellow ochre, Cadmium orange, Terra vert, Titanium white.
Finish :	Grumbacher Acrylic Varnish Matt.
Provenance :	Underpainting 'The plumed serpent', exhibited Club der XII Selection Royal Academy Antwerp, 1976. Myths and Poems, one man exhibition Goodman Wolman Gallery, Cape Town, 1980. Overpainted Egg Emulsion tempera, Port Elizabeth 1981. Exhibited Staff exhibition P.E. Technikon 1981. Everard Read Gallery, Johannesburg.

N°1 In the beginning 1500 x 1500 mm.
Egg tempera emulsion on canvas.

N° 2 (catalogue)

Title :	God created heaven.
Source :	Genesis King James version.
Size :	900 x 1400 mm.
Medium :	Egg and dammar resin emulsion throughout.
Support :	Course hopsack weave Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application, finished with fine sandpaper, glazed with a diluted emulsion medium and Red iron oxide as a toned ground.
Pigments :	Red iron oxide, Black iron oxide, French Ultramarine, Cobalt blue, Prussian blue, Titanium dioxide.
Finish :	Varnished with synthetic resin varnish.
Provenance :	Private collection Mr. Werner Loewenstein, Port Elizabeth.

N°2 God created the heaven 900 x 1400 mm. Egg tempera emulsion on canvas.

N° 3 (catalogue)

Title :	...and the earth.
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Synthetic resin varnish and egg yolk emulsion throughout.
Support :	Heavy hopsack Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Rough spatula application sealed with a thin wash of dilute yellow ochre in the above emulsion medium. Sandpapered to reveal maximum texture effect.
Pigments :	Various natural earth ochres.
Finish :	No surface finish.
Provenance :	Collection of the author.

N°3 ...and the earth. 900 x 1400 mm. Egg tempera emulsion on canvas.

N° 4 (catalogue)

Title :	And the Spirit of God moved on the face of the waters.
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Egg and dammar resin varnish emulsion, in combination with Rowney's acrylic washes.
Support :	Heavy hopsack Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application, sanded and brush finished with thin layers of diluted filler coat. Transparent nitro cellulose sealer, one coat. Substrata charcoal drawing fixed with diluted egg emulsion.
Pigments :	French Ultramarine, Cobalt blue, Prussian blue, Viridian green, highlights Cadmium red and yellow.
Finish :	No final finish.
Provenance :	Collection of the author.

N°4 And the spirit of God moved on the face of the waters. 900 x 1400 mm.
Egg tempera emulsion and acrylic on canvas.

N° 5 (catalogue)

Title :	...Let the earth bring forth grass,...
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Egg and dammar resin varnish emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application. No isolation. Waterproof black ink drawing defining forms. Sandpapered areas to highlight selected surfaces.
Pigments :	Transparent ochre, Chrome oxide, Transparent and opaque Titanium oxide Black iron oxide.
Provenance :	Collection of the author.

N°5 ...Let the earth bring forth grass,... 900 x 1400 mm. Egg tempera emulsion on canvas

N° 6 (catalogue)

Title :	...and the tree yielding fruit,
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Egg and dammar resin emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application, sanded and finished with thin brush application of diluted filler coat.
Pigments :	Full range listed in the section on pigments.
Finish :	Synthetic resin varnish.
Provenance :	Collection of the author. Exhibited Everard Read Gallery, Johannesburg 1985. Cover picture on catalogue.

N°6 ...and the tree yielding fruit, 900 x 1400 mm. Egg tempera emulsion on canvas.

N°7 (catalogue)

Title :	...and let them be for signs, and for seasons.
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Synthetic resin varnish and egg emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application with brush finish.
Pigments :	Various ochres, Black and Red oxides, Chrome greens and Cobalt blue.
Finish :	No finish.
Provenance :	Collection of the author.

N°7 ...and let them be for signs, and for seasons. 900 x 1400 mm. Egg tempera emulsion on canvas.

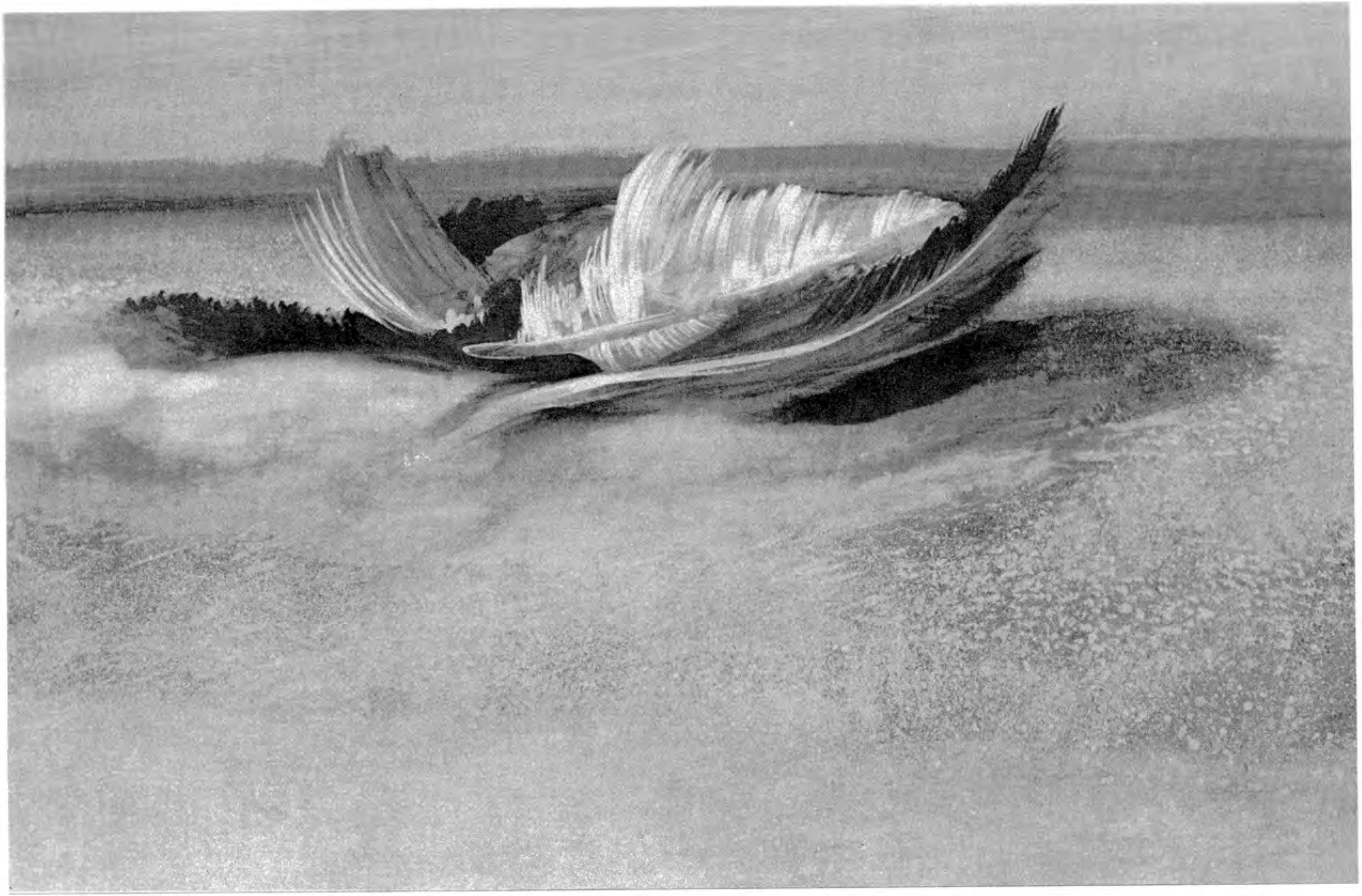
N° 8 (catalogue)

Title :	...Let the earth bring forth the living creature...
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Egg and dammar resin varnish emulsion with acrylic highlights.
Support :	10 oz. Cotton Duck, plain weave.
Ground :	Filler Coat.
Treatment :	Thin spatula applications finished with brush applications.
Pigments :	Ochres, Titanium oxide, Black and Red oxides, Cobalt blue.
Finish :	No finish.
Provenance :	This work was used as a surface for a commission from Anglo American Corporation. The new work is titled 'The federation and after'. Existing painting was used as an underpainting for the new work. Collection Anglo American Corp., reproduced in the book on Mr. H. Oppenheimer's retirement.

N°8 ...Let the earth bring forth the living creature... 900 x 1400 mm.
Egg tempera emulsion on canvas.

N° 9 (catalogue)

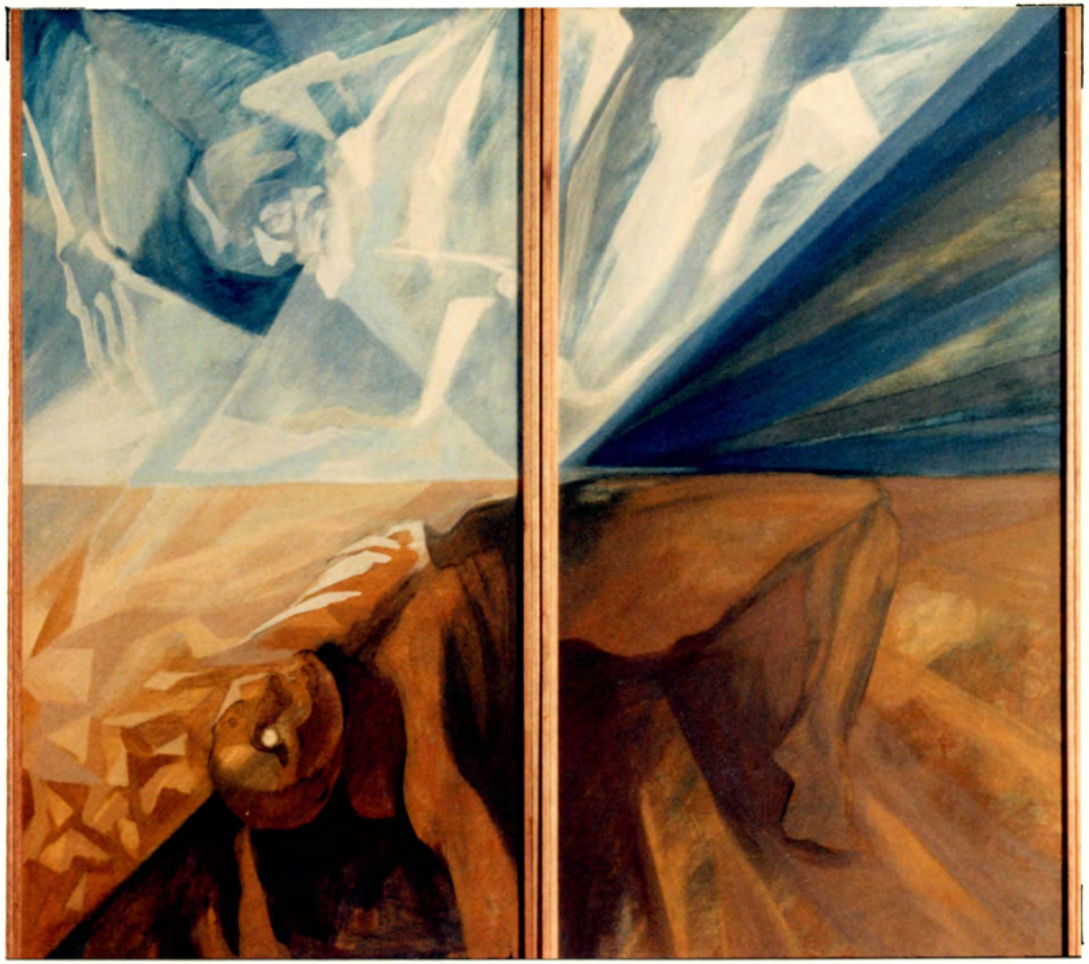
Title :	...after his kind
Source :	Genesis.
Size :	900 x 1400 mm.
Medium :	Egg and synthetic resin emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Treatment :	Smooth spatula application.
Pigments :	Ochres, Red and Black iron oxide, Titanium dioxide.
Finish :	No final finish.
Provenance :	Collection Mr. and Mrs. Anthony Adler, Port Elizabeth.



N°9 ...after his kind. 900 x 1400 mm. Egg tempera emulsion on canvas.

N° 10 (catalogue)

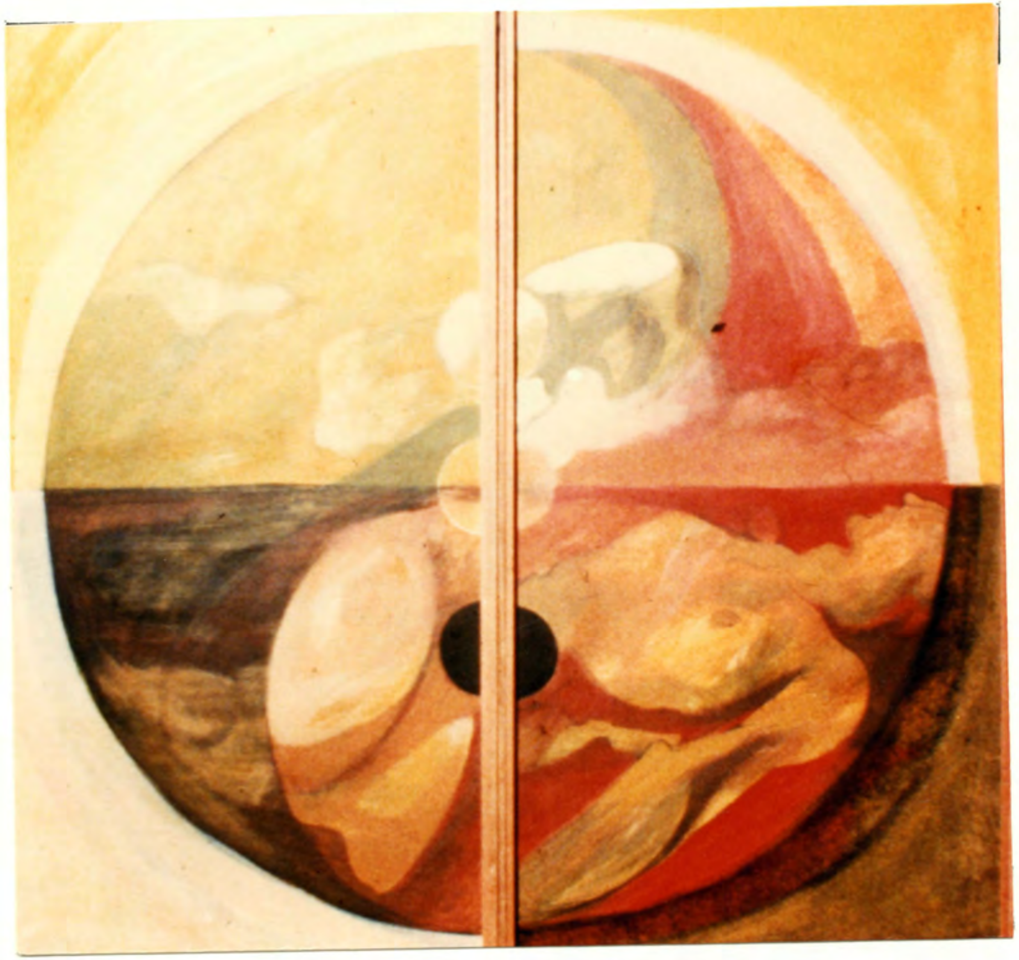
Title :	...Let us make man in our own image...
Source :	Genesis.
Size :	Two panels 1400 x 700 mm (outside of retable)
Medium :	Egg and synthetic resin emulsion.
Support :	Architects backing linen ironed on plywood panels.
Ground :	Brush application of low viscosity filler coat.
Treatment :	Isolated with diluted P.V.A. sealer.
Pigments :	Charcoal, Titanium white, Yellow ochre, Prussian blue.
Finish :	No final finish.
Provenance :	Collection of the author.



N°10 ...Let us make man in our image... 2 panels 1400x 700mm.
Egg tempera emulsion on linen faced plywood panels.

N° 11 (catalogue)

Title :	...male and female created He them.
Source :	Genesis.
Size :	Two panels 1400 x 700 mm.
Medium :	Egg and synthetic resin varnish emulsion.
Support :	Architect's backing linen on plywood panel.
Ground :	Brush application of diluted low viscosity filler coat.
Treatment :	No isolation.
Pigments :	Green oxide, Red iron oxide, Cadmium red, Yellow ochre, Cadmium yellow Titanium oxide.
Finish :	No finish.
Provenance :	Collection of the author.



N°11 ...male and female created He them. 2 panels 1400 x 700 mm.
Egg tempera emulsion on linen faced plywood panels.

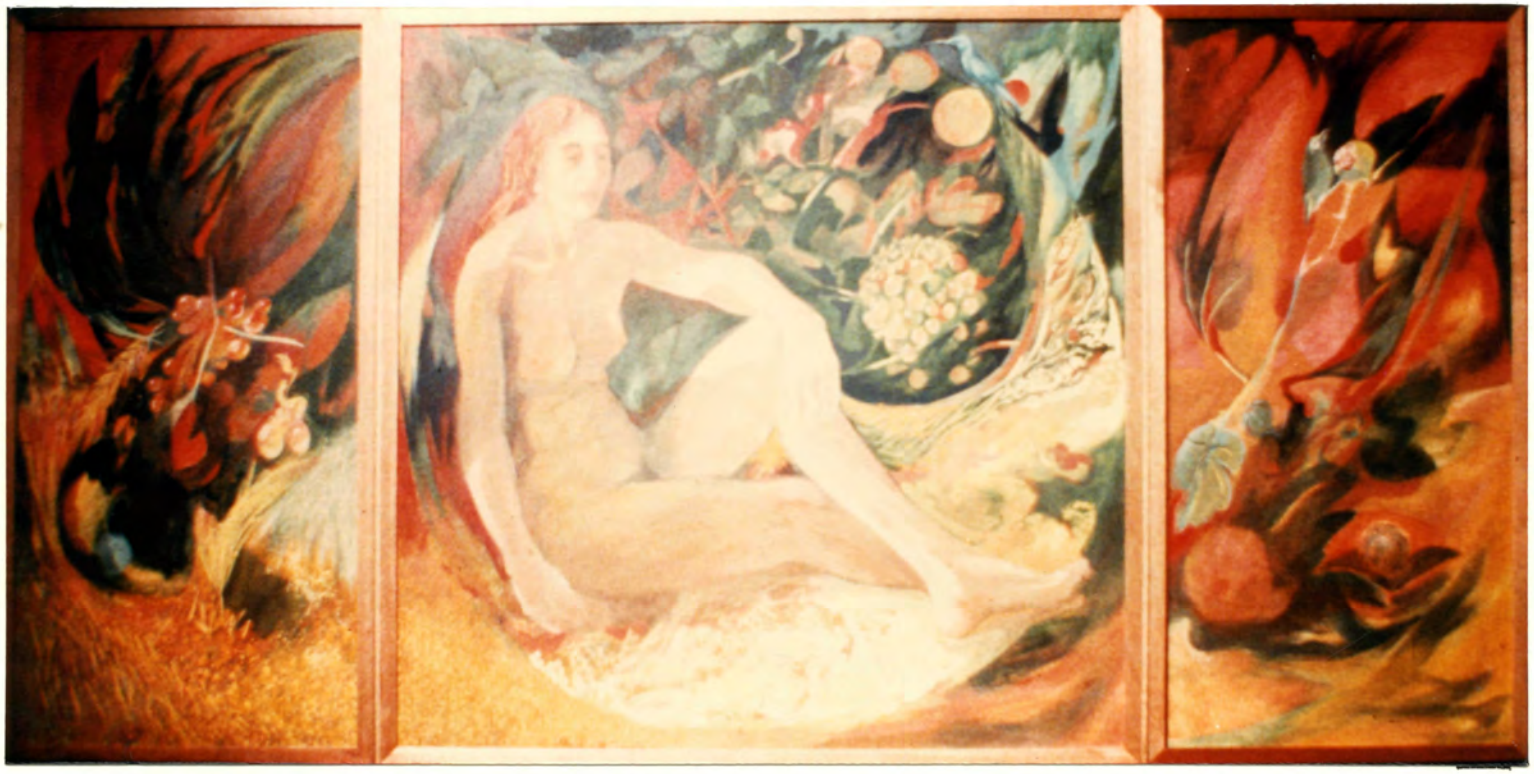
N° 12 (catalogue)

Title :	Adam
Source :	Genesis.
Size :	Two panels 1400 x 700 mm, hinged from a centre panel 1400 x 1400 mm.
Medium :	Egg and synthetic resin varnish emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Ground :	Liquifill smooth spatula application, sandpapered.
Treatment :	No isolation.
Pigments :	Red iron oxide, Black oxide, Cobalt blue.
Finish :	No finish.
Provenance :	Collection of the author.

N°12 Adam Triptych, centre panel 1400 x 1400 mm. Two hinged panels 1400 x 700 mm.
Egg tempera emulsion on canvas.

N° 13 (catalogue)

Title :	Eve
Source :	Genesis.
Size :	Two panels 1400 x 700 mm, hinged on a centre panel 1400 x 1400 mm.
Medium :	Egg yolk and dammar resin varnish emulsion.
Support :	Heavy hopsack weave Flemish linen canvas.
Ground :	Filler Coat.
Treatment :	Smooth spatula application, sandpapered.
Pigments :	Yellow ochre, Chrome green oxide, transparent and opaque, Cadmium red and yellow.
Finish :	No finish.
Provenance :	Collection of the author.



N°13 Eve Triptych, centre panel 1400 x 1400 mm. Two hinged wing panels 1400 x 700 mm.
Egg tempera emulsion on canvas.

N° 14 (catalogue)

Title :	Genesis
Source :	A combination of Elytis' Poetry and Biblical references.
Size :	Six panels 1200 x 1200 mm, mounted in pairs to form a triptich 2400 x 3600 mm.
Medium :	Egg yolk tempera.
Support :	South African pine plywood panels, reinforced with square pine wood battons.
Ground :	Plain gesso ground.
Treatment :	Spatula application, sanded to a smooth finish.
Pigments :	Various pigments.
Finish :	No varnish.
Provenance :	The six panels were originally a series entitled 'The death and regeneration of the Mantis child'. Exhibited in S.A. Artists exhibition in Rhodesia (now Zimbabwe) National Gallery Salisbury and Bulawayo, 1977. Also in S.A. Association of Arts, Pretoria, 1977. One man exhibition Goodman Wolman Gallery, Cape Town, 1980. Top right panel collection Anglo American Corp. and H. Oppenheimer retirement publication. Five remaining panels collection of the author

N°14 Genesis Six panels 1200 x 1200 mm. Mounted in pairs to form triptych 2400 x 3600 mm.
Egg tempera on plywood panels.

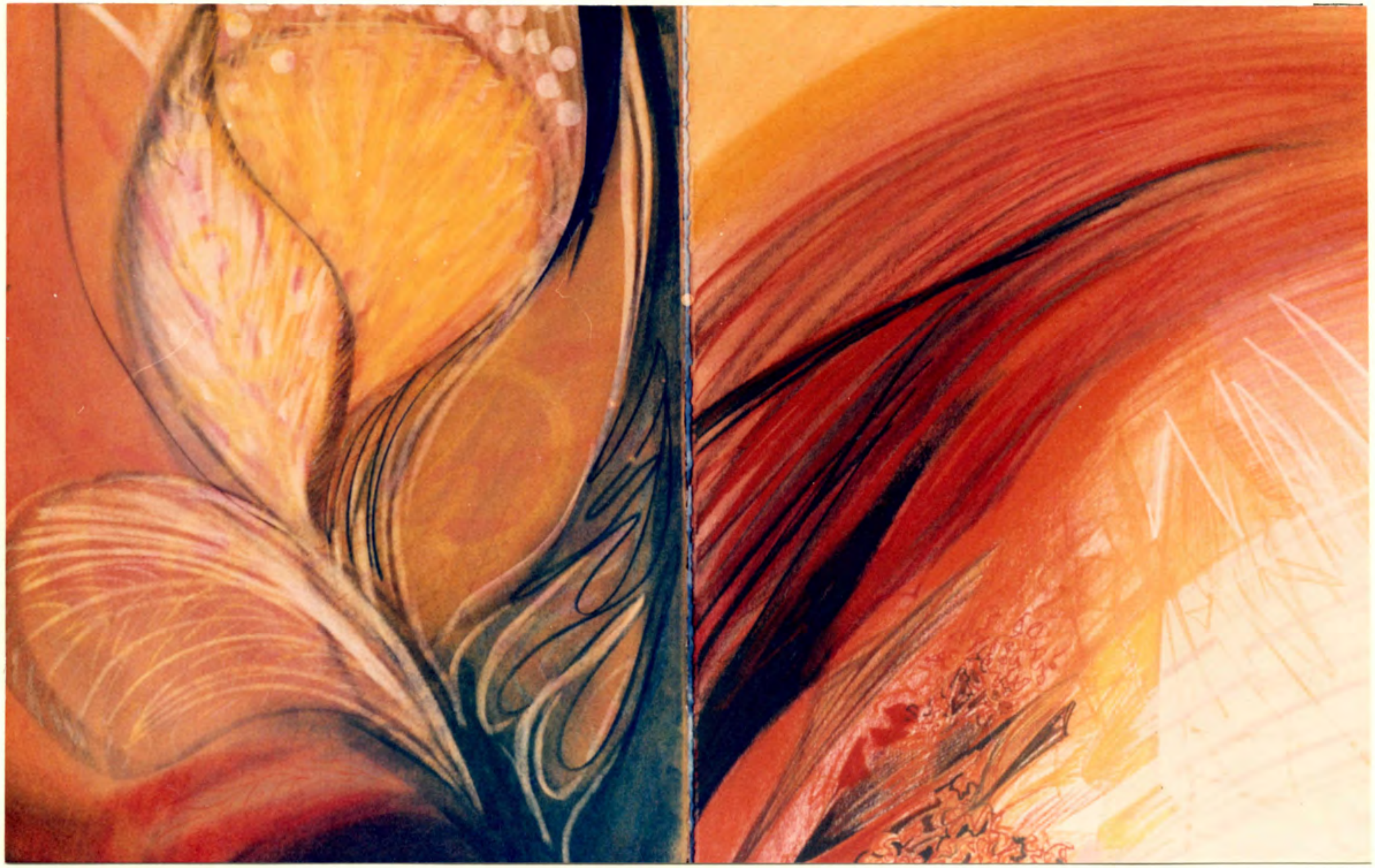
n° 15 (catalogue)

Title :	"Green blood and bulbs golden in the earth..."
Source :	Elytis O., The Axion Esti p. 17.
Size :	1500 x 1500 mm.
Medium :	Egg and synthetic resin emulsion.
Support :	Course hopsack weave Flemish linen canvas.
Ground :	Filler Coat, synthetic resin dispersion binding medium.
Treatment :	Palette knife application sanded to a smooth finish.
Pigments :	Yellow ochre, Red iron oxide, Carbon black, Cadmium yellow, Cobalt violet.
Finish :	Unvarnished.
Provenance :	Examination piece, Permanent collection King George VI Art Gallery.

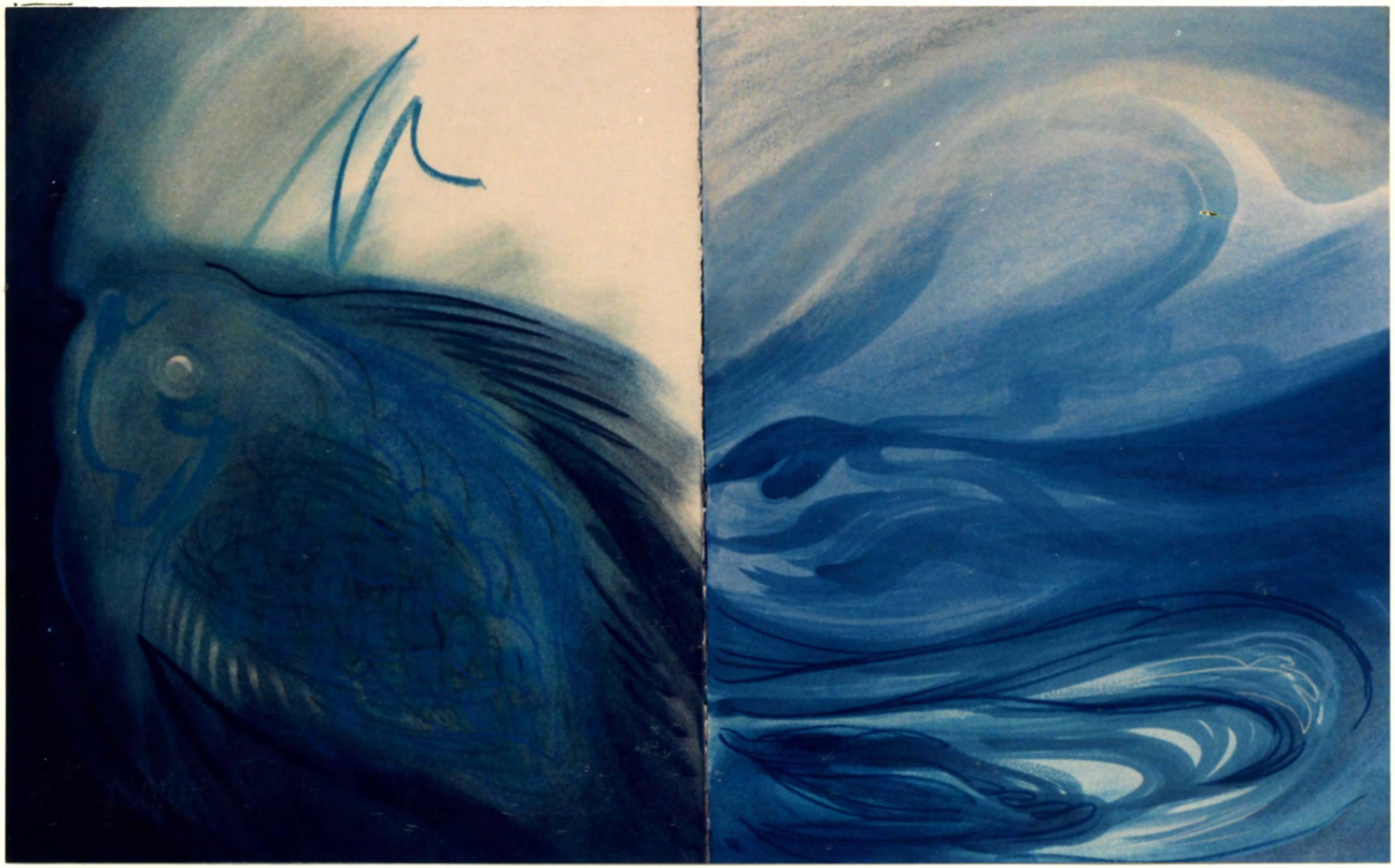
N°15 "Green blood and bulbs golden in the earth"...
1500 x 1500 mm. Egg tempera emulsion on canvas.

N° 16-21 (catalogue) Drawings

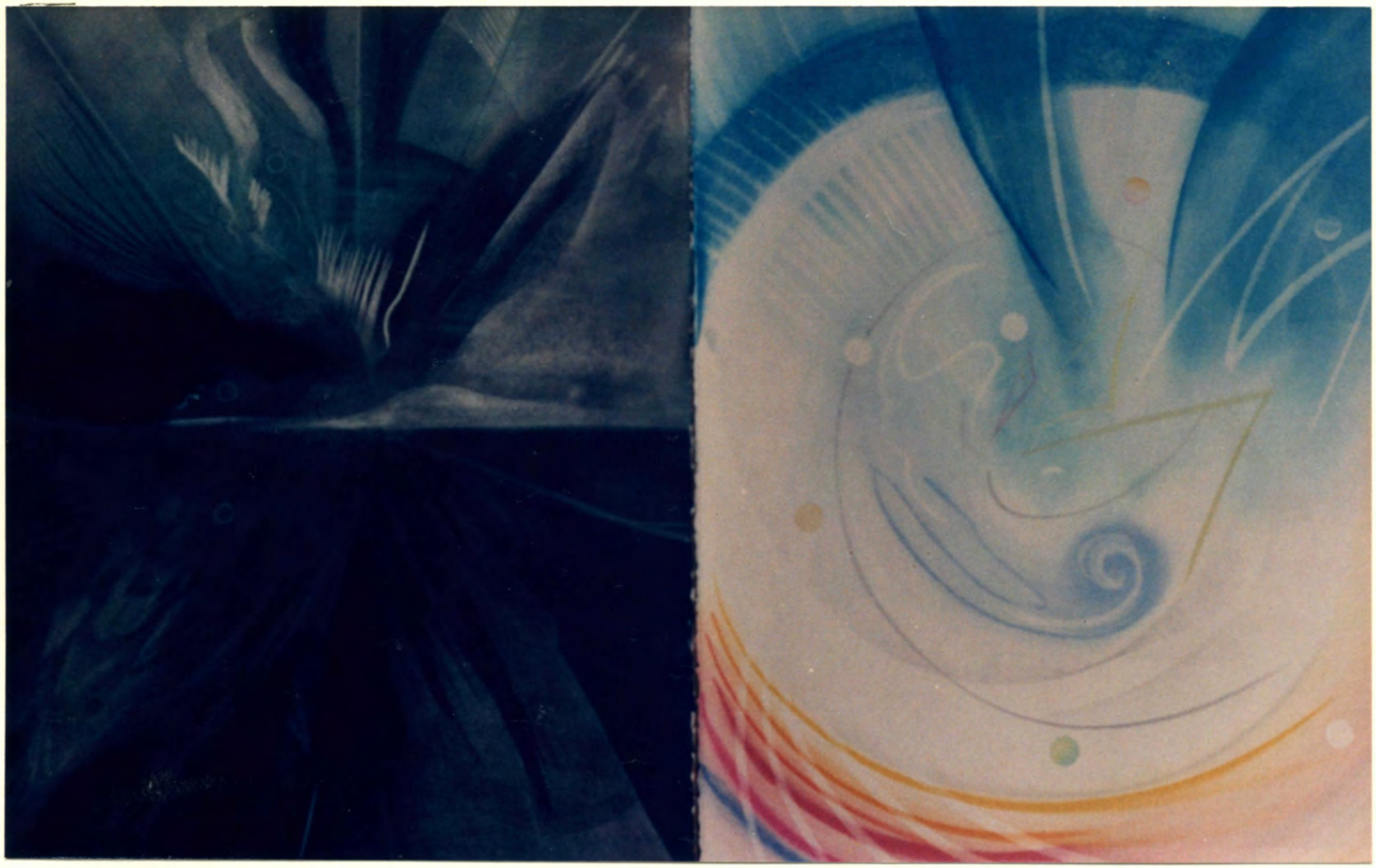
Title :	Earth, Water, Air, Fish, Birds, Plant.
Source :	The dynamic element and associated life forms; the author's abstraction.
Size :	770 x 570 mm.
Medium :	Assorted pastels, ink and mixed media.
Support :	Arches Rives BFK handmade paper.
Ground :	No ground.
Treatment :	Fixed with aerosol Artists fixative.
Pigments :	Assorted available pastels.
Finish :	Fixed with Aerosol Artists fixative.
Provenance :	Collection of the artist.



N°16 & 17. Plants and Earth, 770 x 570 mm, diptych. Pastel and mixed media on paper.



N°18 & 19. Fish and Water, 770 x 570 mm. diptych. Pastel and mixed media on paper.



N°20 & 21. Birds and Air, 770 x 570 mm. diptych. Pastel and mixed media on paper.

FORMULAS

COLLAGEN GLUE SOLUTION (GLUE SIZE)

Animal collagen glue makes a very strong glue solution, which can be used not only as a size, but also as a very quick drying ground when mixed with dry pigments and fillers. Ingredients : collagen glue, powdered, beads, granules or sheets, 70 grams; water, 1 liter Animal hide glues - rabbitskin, cowhide, parchment, etc.- are normally sold in dry form, in sheets, pieces, pearls or coarse powders. Soak the powdered glue for half an hour - the thick pieces should remain overnight in the water - then warm in a double boiler until the glue dissolves.

Keep the solution warm enough to make sure the glue remains completely dissolved, but never 'cook' it over direct heat. Brush the glue solution thoroughly into stretched linen or cotton canvas or panels. Let the size dry completely before applying any ground.

CASEIN SOLUTION (cf., p. 65.)

Hard and moisture-resistant, casein solutions are useful both for sizing and for making a quick-drying, tough ground. They are excellent for sizing wood or Masonite panels. Ingredients : casein, powdered, 2 parts; water, 16 parts; ammonium carbonate, 1 part. Buy freshly manufactured casein and avoid using old material, for casein loses strength with the years. Sift the casein slowly into half of the water, stirring to get rid of the lumps. When smooth, add the ammonium carbonate and stir; allow the mixture to stand for half an hour or more before you stir in the remaining water.

Plywood or wood panels need only sanding, but Masonite panels should be brushed liberally with alcohol and dried before applying the size. Brush the casein solution onto the panels, applying the solution to the front, back, and sides. When the size has dried thoroughly, use this same solution to make the ground.

Casein glue can also be made from fresh fat free skimmed milk cheese (homogenized). Ingredients : homogenized skimmed milk cheese (fat free), 4 parts (by volume); unslaked lime, 1 part (by volume). Directions for manufacture : mix the above ingredients thoroughly and dilute 1 part to 1 part water. Use as previous formula.

RECIPE FOR WHITING OR CHALK GROUND (cf., p. 85.)

The support should be sized with 60:1000 size solution containing 10 percent alum (i.e., 10 percent of the dry weight of size), 1 part champagne whiting, 1 part zinc white. Size solution 60:1000 containing 10 percent alum in a quantity sufficient to produce a brushable consistency.

In all the recipes for grounds, "one part" means one part by volume. Paint to be applied with a roller may be a little thicker. It must be stressed again that the alum should always be completely dissolved in part of the total amount of water. The ground is made in the following manner : white pigment and filler are first mixed together dry, and the size is then added carefully under constant stirring. The amount of size should be increased gradually to avoid lumps. If the size is too hot, the ground may contain air bubbles. Unlike Doerner, the author has deriberately avoided giving quantities for the size solution, since the consistency of the mixture also depends on the moisture content of the whiting and the particle size of the white pigments. Moreover, special methods of application (e.g. paint rollers) require a slightly different consistency. Once the mixture has cooled it will have to be warmed in a water bath before it can be used again. It may then be necessary to add a little water to restore the same consistency, because some pigments and fillers tend to absorb more water while standing.

RECIPE FOR STONE DUST GROUND (cf., p. 86.)

The support should be sized with size solution 60:1000 plus 6 grams of alum or 70:1000 plus 7 grams alum. 1 part stone dust (Jurassic limestone, i.e. dry lithographic stone sludge), 1 part zinc white or lithopone, and size solution of the strength used to size the support. A ground made with stone dust will become rather hard and rough. With coarser particles, which the artist can separate himself with a sieve, one can achieve a slightly sandy texture, which is all the more pronounced if left unsandpapered.

RECIPE FOR GROUND CONTAINING MARBLE DUST (water-insoluble) (cf., p. 86.)

The support should be sized with borax-casein solution diluted with equal parts of water. 1 part marble dust or marble grit, 1 part titanium white, and casein solution (as above) to produce a brushable consistency. A marble ground such as above is less absorbent than a ground made with whiting. It gives the paint a particular brilliance and charm. Since it is insoluble in water, it is particularly suitable for tempera painting. If marble grit is used and the last layer is left rough, one can obtain a fresco effect with casein tempera.

RECIPE FOR GYPSUM GROUND (cf., p. 87.)

The support should be sized with a size solution 70:1000 plus 7 grams alum, 1 part gypsum powder, 1 part titanium white, and size solution (as above) to produce a brushable consistency. Gypsum tends to settle out and has to be stirred frequently during application.

RECIPE FOR KAOLIN CLAY (CHINA CLAY) (cf., p. 87.)

The support should be sized with a size solution 60:1000 plus 6 grams alum. 1 part kaolin, 1 part lithopone, and size solution (as above) to produce a brushable consistency. This will produce a smooth, resilient ground suitable for fine brushwork, (but will also retain its brilliance when used for oil paintings).

RECIPE FOR EMULSION GROUND (cf., p. 93.)

Sizing : 70:1000 plus 7 grams alum, 1 part champagne whiting, 1 part zinc white, and size solution as above, to produce a consistency of thick cream. Then add : 1/2 part boiled linseed oil, and size solution as above, to produce a brushable consistency. The high size content is without danger here, because its tension is counteracted by the boiled linseed oil. One-third of one part of oil added to chalk ground sufficiently reduces its absorbency and solubility, and even this amount may be reduced further. Emulsion grounds brush on more easily than oil-free grounds. On the other hand, they are slightly more difficult to wet-grind and sandpaper, but with skilful brushing this may not be necessary. Hardening with Formalin can be omitted, especially since the oily phase of the emulsion diminishes the efficacy of Formalin to some extent.

RECIPE FOR DISPERSION GROUND (cf., p. 95.)

Sizing with dispersion diluted with water 1:1, lithopone (additions of lime stone or marble dust extend the possibilities of absorption, texture, etc.), and dispersion diluted as above, to produce a brushable consistency. As with emulsion grounds, three to four layers of dispersion ground should suffice to produce a fine, even white surface. This can be reduced to two layers by using a paint roller and a slightly more viscous mixture, or by substituting the opaque titanium white for lithopone. Some grades of titanium white also contain the necessary proportion of fillers.

EGG YOLK MEDIUM (cf. p. 112.)

Egg yolk, mixed with water dries almost instantly. Ingredients : equal parts of water and egg yolk. Separate the yolk from the white. Puncture the yolk and drain into a jar, add water and shake into a pale emulsion. Use enough yolk-water mixture to cause the colour to dry with lustre.

GLAIR MEDIUM (EGG WHITE) (cf., p. 123.)

Place the egg white on a platter and beat until the froth becomes dry. A small amount of liquid will be found at the bottom; pour this into a little jar, for it is the glair. Or, after beating, put the froth into a jar, mix in four tablespoons of water, and decant the liquid after eight hours. The first method yields a viscous medium; the second produces a fluid medium. Grind dry pigments with water to form as much colour paste as you need; be sure to grind well, for this paint is similar to water-colour and needs fine pigment particles. Dip a fine sable brush into glair and pigment to paint on panels; use it to add tiny details wet-in-wet on oil paint.

HARDENING OF A GROUND

It is achieved by a six percent solution of Formalin lightly applied to the horizontally placed surface with a soft-bristle brush or a rectangular sponge. A specially marked brush should be kept exclusively for this purpose, because any brush that is also used for priming is certain to harden irremediably in time. In order to expose all ground layers to the action of Formalin, one can harden the size coating of the support and the final ground layer. However, if lower layers soften during the priming of large areas, causing the brush to drag and making an even application difficult, one may at any time harden each layer as necessary. It is best accomplished when the support is lying on the floor. It is advisable to leave the room before the gas affects the mucous membranes of the eyes. However, if treatment is carried out in the open, the vapour disperses before it can take effect. This slightly unpleasant task can easily be done just before one normally leaves the studio. The gaseous formaldehyde reacts overnight, and in the morning the room can be thoroughly aired. However, on no account should size or gelatin supplies be left exposed in the room, for these would harden on the surface and thus become insoluble. There is so far no chemical that can reverse the tanning action of Formalin. Once a ground has been hardened with it, it can no longer be washed off and can be removed only with sandpaper. It must be admitted that Formalin slightly reduces the elasticity of the ground.

WHOLE EGG AND DAMMAR RESIN EMULSION (cf., p. 128.)

A little dammar resin helps toughen egg film during its tender early months. After it has completely polymerized, egg becomes one of the toughest, most insoluble substances known. Ingredients : whole egg (4 parts), dammar varnish (1 part), water (12 parts). Take a jar and break the egg into it; cap the jar and shake until the egg is mixed. Add the varnish to the contents and repeat the process; finally add the water. After shaking thoroughly, strain the emulsion through two layers of cheesecloth into another jar. One egg makes about one half pint of emulsion. With a painting knife or a palette knife, grind as much dry pigment as you need for one painting session. As you paint, combine the pigment paste with more emulsion. Paint on a gesso panel or canvas. Egg-resin also makes an excellent underpainting vehicle.

A stock solution of emulsion that can be diluted with water as desired can be prepared in the following way. Whole egg shaken up constituting 1 part (by volume), add 1 part (by volume) dammar varnish, shake up well to emulsify. A thick viscous emulsion will result. Pigment can be ground or mixed with this solution and thinnned with water as desired.

NITRO CELLULOSE SEALER (cf., p. 79.)

Dilute the commercial consentrated product, 1 part Nitro Cellulose to 5 parts Industrial Lacquer Thinnners. Apply evenly as required as a sealer for support and ground surfaces to reduce absorbency.

POLY VINYL ACETATE SEALER

Dilute commercially prepared consentrate 1 part P.V.A. Sealer to 1 part water to reduce gloss and apply as an all-purpose sealer.

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WINDSOR & NEWTON *Notes on the Composition and Permanence of Artist's colours, Primers, Oils, Solvents, Media and Varnishes.*
London, (recent, undated).

EXHIBITION CATALOGUE

LEON DE BLIQUY

KING GEORGE VI
ART GALLERY
1 PARK DRIVE, PORT ELIZABETH

KONING GEORGE VI-
KUNSMUSEUM
PARKRYLAAN 1, PORT ELIZABETH

COVER ILLUSTRATION:
OMSLAGILLUSTRASIE:
No./Nr.6

GENESIS

AN EXHIBITION OF PAINTING AND DRAWINGS
SUBMITTED FOR THE MASTERS DEGREE IN FINE ART
AT RHODES UNIVERSITY
PRESENTED BY THE KING GEORGE VI ART GALLERY PORT ELIZABETH

'N TENTOONSTELLING SKILDERYE EN TEKENINGE
VOORGELE VIR DIE MEESTERSGRAAD IN BEELDENDE KUNS
AAN RHODES UNIVERSITEIT
AANGEBIED DEUR DIE KONING GEORGE VI KUNSGALLERY PORT ELIZABETH

NOVEMBER 1984

FOREWORD

A sad reality in the history of art is the record of man's inability to adapt to the new and different, with the result that recognition often comes too late in the artist's life to be of benefit, or worse, it is posthumous. Today many of the barriers of conservatism in established institutions have been broached; consequently the artistic public is rewarded with fresh new imagery and ever-extending boundaries of expression. Art must be seen and music heard, for both the eye and the ear need time to adjust before appreciation is achieved. The more frequently we are exposed to the new, then the more critical will be our consideration and evaluation. The fresh stimulation of negotiating new paths in art is a powerful force to creative experience. The rewards of understanding, however, do not come easily, but like many learning processes, once the door is opened, the horizon is limitless.

This Gallery has presented many talented workers to our South African public by providing a venue in our midst where art can be viewed objectively, and where the artist and the interested spectator can examine different subjects, styles, techniques and periods both old and new.

This exhibition is based upon a story as old as man himself; it has been told a thousand times in a thousand different ways; it is a theme that has taxed the greatest artists and finest creative minds of our civilisation. It has stimulated the senses of thinking man for almost as long as he has inhabited the earth, has lifted his mind to soaring heights of wonder, is a cornerstone of the world's religions and every man has lived through the questions, the doubts and the explanations of the story of Genesis. Genesis is our own personal, private world, be it myth or reality.

Leon de Bliquy explores this with us in his new paintings.

Clayton Holliday

Clayton S. Holliday
DIRECTOR

INTRODUCTION

This series of paintings was conceived as an academic exercise and is a synthesis of the progression in a creative experience. The evolution of the form and structure of the series can be traced through literary sources and other related influences. A concern for the metaphysical is the linking factor, and the effect of different stimuli culminates in a unified series of contrasting images.

The poetry of Odysseus Elytis has been a source of inspiration since my first contact with his work in 1968. A group exhibition entitled "Picture Poems" held at the Artists' Gallery in Cape Town in 1969 included my triptych with hinged side panels inspired by Elytis' "The Mad Pomegranate Tree". His poems became an increasingly important spiritual influence in my creative thought and two further exhibitions were based on modern Greek poetry. The content of his poems led me to discover the riches of visual imagery in Greek mythology.

An investigation into African mythology and folk-lore introduced me to Bushman legends, and the wealth of that imagery inspired the series "Death and Regeneration of the Mantis Child" and a further exhibition entitled "Myths of the Rain."

With the accent on the phenomena of life, death and regeneration in these myths, my interest turned to the poetry of Federico Garcia Lorca and Uys Krige's Afrikaans translation of "The Lament for Ignacio Sanchez Mejias". These inspired an exhibition with dramatic and deeply symbolic imagery.

It was my intention to produce a series of paintings using Bushman myths for an M.A., but Elytis' Nobel prize for literature in 1979 focused my attention on his epic poem, "Axion Esti", where many of the primitive mythological elements are expressed through metaphysical content. The first part of the three part structure in the poem formed the basis of the idea for the present series. Biblical references also clarified the literary significance of the Genesis theme, whether Bushman, Greek or Hebrew. The Genesis in the Elytis poem expresses the poet's own spiritual awakening and the idea inspired me to attempt a series of paintings which would be a synthesis of my work. This seemed ideal for an academic project which would form a foundation for further developments. Although the idea for the series is largely derived from the Elytis poem, much of the content is a reflection of the structure in the Biblical account of Creation.

VOORWOORD

'n Tragiese werklikheid in die kunsgeskiedenis is die rekord van die mens se onvermoë om by die nuwe en anderse aan te pas, met die gevolg dat erkenning dikwels te laat in die kunstenaar se lewe geskied om voordelig te wees of, erger nog, postuum geskied. Vandag is baie versperrings van konserwatisme in gevestigde inrigtings oorbrug; gevolglik word die kunspubliek beloon met vars nuwe verbeeldingryke en steeds groeiende uitdrukkingsgrense. Kuns moet gesien en musiek gehoor word, want die oog en die oor het albei tyd nodig om aan te pas voordat waardering kan plaasvind. Hoe meer dikwels ons aan die nuwe blootgestel word, hoe meer krities sal ons oorweging en evaluering wees. Die vars stimulering van die oorgang na nuwe kunsrigtings is 'n kragtige mag tot skeppende ondervinding. Die loon van begrip geskied egter nie maklik nie, maar soos baie leerprosesse, is die horison onbeperk sodra die deur geopen is.

Hierdie Kunsmuseum het baie talentvolle werkers aan ons Suid-Afrikaanse publiek bekend gestel deur 'n plek in ons midde te voorsien waar kuns objektief besigtig kan word en waar die kunstenaar en die belangstellende toeskouer verskillende onderwerpe, style, tegnieke en tydperke, hetsy oud of nuut, kan ondersoek.

Hierdie uitstalling is gegrond op 'n storie wat so oud is soos die mensdom self, die is 'n duisend keer op 'n duisend verskillende maniere vertel; dit is 'n tema wat die grootste kunstenaars en die beste kreatiewe denke van ons beskawing getoets het. Dit het die denke van die mens gestimuleer solank hy die aarde bewoon het, sy denke verlig tot stygende wonderhoogtes, is 'n hoeksteen van die wêreld se godsdienste en elke mens wat deur die vrae, die twyfel en die verduidelikings van die Genesis-verhaal geleef het. Genesis is ons eie persoonlike, private wêreld, hetsy mite of realiteit.

Leon de Bliquy ondersoek dit saam met ons in sy nuwe skilderye.

Clayton Holliday

Clayton S. Holliday
DIREKTEUR

1.

INLEIDING

Die uitgangspunt vir die konsep van dié reeks skilderye is verbonde aan akademiese doelstellings, en kan beskou word as 'n sintese van die ontwikkelingservaringe in 'n kreatiewe vormingsproses. Die ontplooiing in die vorm en struktuur van die reeks kan herlei word na letterkundige bronne en ander verwante invloede met 'n verbindende faktor wat geleë is in 'n metafisiese inslag. Verskillende uitwerkings word saamgevat in 'n eenvormige reeks van kontrasterende beelde.

Die gedigte van Odysseus Elytis dien as bron van inspirasie sedert my eerste kontak met sy werk in 1968. 'n Groepstentoonstelling met die tema "Picture Poems", in die destydse Kunstenaarsgalery in Kaapstad, het my triptiek ingesluit, wat deur Elytis se gedig "The Mad Pomegranate Tree" geïnspireer is. Sy gedigte het 'n toenemende geestelike invloed op my kreatiewe denke gehad en twee verdere tentoonstellings was gegrond op moderne Griekse poësie. Die inhoud van sy gedigte het verder gelei tot die ontdekking en waardering van die rykdom visuele beeldspraak in die Griekse mitologie.

'n Studie van mites uit Afrika en veral Boesmanlegendes het die inspirasie voorsien vir die reeks "Dood en Wedergeboorte van die Hottentotsgodkind", en ook vir 'n tentoonstelling met die tema "Mites van die Reën".

Met die nadruk op die natuurverskynsels van lewe, dood en wedergeboorte in hierdie mites, het my belangstelling verskuif na die poësie van Federico Garcia Lorca, en veral Uys Krige se Afrikaanse vertaling van "Die Klaaglied van Ignacio Sanchez Mejias", wat die inspirasie was vir 'n tentoonstelling met dramatiese en diep simboliese beeldspraak.

Dit was my bedoeling om die skilderye vir my meestersgraad te baseer op Boesmanlegendes, maar toe Elytis die Nobelprys vir letterkunde in 1979 ontvang het, is my aandag gevestig op die mitologiese inhoud van sy gedig "Axion Esti". Die primitiewe en bonatuurlike inhoud van die epiese gedig het die oorgang bewerkstellig vir die Genesisgedagte. Die eerste deel van die driedelige struktuur in die gedig vorm die basis van die huidige reeks. Bybelse verwysings beklemtoon ook die letterkundige betekenis van die Genesistema, of dit Boesman, Grieks of Hebreeus is. Die eerste deel "Genesis" in die gedig van Elytis is die digter se uitdrukking van sy eie geestelike ontwaking, en die idee het my aangespoor tot die ontwikkeling van 'n reeks skilderye wat 'n sintese sou wees van die verskeie rigtinge wat teenwoordig is in die ontwikkeling van my werk. Dit was ook ideaal vir 'n akademiese projek wat 'n grondslag sou vorm van verdere ontwikkeling. Die idee vir die reeks is grotendeels afgelei van Elytis se gedig, maar die grootstedeel van die inhoud is 'n weerspieëling van die struktuur in die Bybelse weergawe van die skepping.

BIOGRAPHY

Born 10 October, 1943, in Johannesburg

1962-1966	Studied at the Michaelis School of Fine Art, Cape Technical College and UNISA. Served an apprenticeship as a photolithographic artist.
1967	Awarded a prize for Painting in "Cape Art '67."
1971-1972	Studied lithography at the Royal Academy in Antwerp with a cultural exchange scholarship.
1973	Joined the staff of the Cape Technical College and established a lithographic studio with a press and stones brought from Antwerp.
1975	Awarded a cultural exchange stipendium and a Cape Tercentenary Foundation grant for research in Belgium.
1976	Appointed lecturer in Fine Art at the University of the O.F.S.
1979	Attained B.A. (Fine Art) degree
1980	Joined staff of the Technikon, Port Elizabeth

LEWENSKETS

Gebore 10 Oktober 1943 in Johannesburg

1962-1966	Onderrig by die Michaeliskunsskool, Kaapstad, die Kaapse Tegniese Kollege en UNISA. Dien 'n vakleerlingskap in fotolitografiese kuns.
1967	Verwerf 'n prys vir skilderkuns in "Cape Art '67".
1971-1972	Kursus in litografie by die Koninklijke Akademie voor Schone Kunsten, Antwerpen, met 'n kultuur-verdrag-studiebeurs.
1973	Sluit aan by die personeel van die Kaapse Tegniese Kollege en vestig 'n ateljee vir litografie met 'n pers en stene, saamgebring van Antwerpen.
1975	Verwerf 'n kultuurverdrag-stipendium en 'n toekenning van die Kaapse Drie-eeuefees-stigting vir Navorsing in België.
1976	Aangestel as lektor in Beeldende Kuns aan die Universiteit van die O.V.S.
1979	Behaal die graad B.A. (B.K.)
1980	Sluit aan by die personeel van die Technikon, Port Elizabeth.

Leon de Bliquy is represented in the following public collections:
Leon de Bliquy is verteenwoording in die volgende openbare versamelings:

S.A. National Gallery, Cape Town
Bloemfontein Museum Art Collection
Kimberley Art Gallery (William Humphries)
King George VI Art Gallery, Port Elizabeth
Sterckshof Museum, Antwerp, Belgium
Rembrandt van Rijn Art Foundation, Stellenbosch
SANLAM Art Collection, Cape Town
Cape Town City Library Services
Royal Academy, Antwerp
Rockford College, Illinois, U.S.A.

EXHIBITIONS TENTOONSTELLINGS

1967 "Cape Art 1967", S.A. National Gallery, Cape Town.
One-man show, Adler Fielding Gallery, Johannesburg.

1968 One-man show, Artists' Gallery, C.T.

1969 One-man show, Dorp St. Studio, C.T.
"Art South Africa Today", Durban Art Gallery.
"Picture Poems", Artists' Gallery, C. T.

1970 One-man shows at:
Sarah Hassel Gallery, Johannesburg.
N.S.A. Gallery, Durban.
Stellenbosch Museum Gallery.

1971 One-man show, S.A. Association of Arts, Pretoria.
"Cape Art", Durban Art Gallery.

1972 One-man show, S.A. Assn. of Arts, C.T.
One-man show, Stellenbosch Museum Gallery.
"Club der XII", Royal Academy, Antwerp, Belgium.
"Lithography, Art & Technique, 1850-1950", Museum Sterckshof, Antwerp, Belgium.
"New Cape Art", S.A. Assn. of Arts, C. T.
"S.A. Art", O.F.S. Arts Society, Bloemfontein.

1974 One-man show, S.A. Assn. of Arts, C. T.
"R.S.A. 1974", S.A. National Gallery, Cape Town.

1975 One-man show, Bloemfontein Museum Art Gallery.
"Cape Town Festival Exhibition", C.T.
"Cape Art '75", S.A. Assn. of Arts, Pretoria.

1976 One-man show, Emile Verhaeren Museum Sint Amands, Belgium.
"Club der XII", Royal Academy, Antwerp, Belgium.

1977 One-man show, University of OFS.
"S.A. Art", Bulawayo Art Gallery.

1978 One-man show, Waterkant Gallery, C.T.
"R.S.A. '78", National Exhibition.
"International Biennial of Graphics," B.P. Centre, C.T.

1979 One-man show, N.S.A. Gallery, Durban.
"Myths and Poems,", one-man show, Student Centre, University of OFS.
"Homage Exhibition, Lorca-Uys Krige", one-man show, University of OFS.
14th International Biennial, Monte Carlo, Monaco.

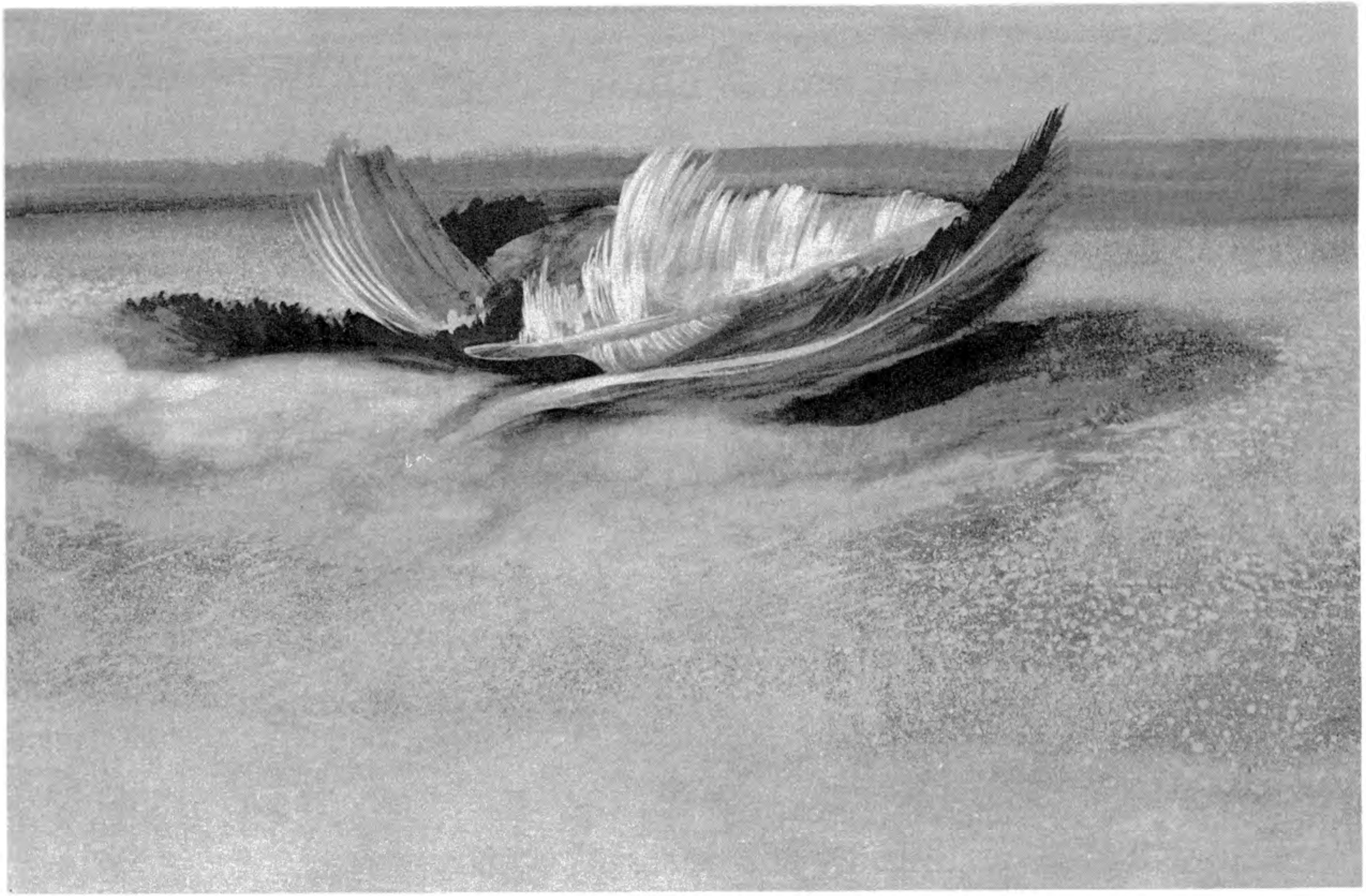
1980 One-man show, Gallery International, C.T.
"Still Life, '80", University of Stellenbosch Art Gallery, Stellenbosch.

1981 R.S.A. Festival Exhibition, Durban.
Rockford International Exhibition Graphic Art, Illinois, U.S.A.

1982 Centenary Exhibition, P.E. School of Art and Design, King George VI Art Gallery, Port Elizabeth.

South African Graphic Art in Germany, S.A. Association of Arts.
"40 Self-Portraits", University of Stellenbosch Gallery, Stellenbosch.

1983 Nine Eastern Cape Artists, Everard Read Gallery, Johannesburg.



CATALOGUE KATALOGUS

CONTENTS - INHOUD

I. Tempera paintings/Tempera-skilderye
nos/nrs. 1-15

II. Drawings/Tekeninge
nos/nrs. 16-21

Dimensions/Afmetings

1 & 15	150 x 150 cm, on canvas/op doek		
2 - 9	90 x 140 cm, on canvas/op doek		
12 & 13	Triptych, canvas and laminated wood panels		
		Centre piece	140 x 140 cm.
		Side panels	140 x 70 cm.
	Triptiek, doek en gelamineerde houtpanele		
		Middelstuk	140 x 140 cm.
		Sypanele	140 x 70 cm.
14	Three panels laminated wood		
		each,	240 x 120 cm.
		in two parts	120 x 120 cm.
	Drie panele gelamineerde hout		
		elk,	240 x 120 cm.
		in twee dele	120 x 120

I. TEMPERA PAINTINGS - TEMPERA-SKILDERYE

1. In the beginning
In die begin

2. God created the heaven
...het God die hemel...

3. ...and the earth.
...en die aarde geskape.

4. And the Spirit of God moved
on the face of the waters.
...en die Gees van God het gesweef
op die waters...

5. ...Let the earth bring forth grass,...
...Laat die aarde voortbring...

6. ...and the tree yielding fruit,
...en bome wat vrugte dra,
waarin hulle saad is,...

7. ...and let them be for signs,
and for seasons.
...en laat hulle dien as tekens
sowel vir vaste tye...

8. ...Let the earth bring forth the
living creature...
...Laat die aarde lewende wesens
voortbring...

9. ...after his kind
...volgens hulle soorte

10. ...Let us make man in our own image...
...Laat ons mense maake na ons beeld.

11. ...male and female created He them.
...man en vrou het Hy hulle geskape.

12. Adam

13. Eve /Eva

14. Genesis

15. "Green blood and bulbs golden
in the earth"...
(Genesis, Odysseus Elytis)