

PRACTICAL PAINTING AND COLOUR IN INDUSTRY

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When planning the erection of a building, due thought must be given to many problems and, as is well known, the painting schedule, being one of the last processes, is often skipped or relegated to a position of unimportance. This relegation of what is after all a very important process, often leads to premature paint failure and a dissatisfied client.

It is quite common to hear the remark that the paints manufactured today do not possess or give the same durability as paints manufactured or prepared by the old-time craftsman. This remark is really a mis-statement, as what really should be said is that the paint applied today is not applied with the same care and forethought as the materials applied by the trade in years gone by. The trade is not entirely to blame as modern economics are usually the ruling factor. When erecting a building the foundations naturally play a most important part, and to apply a paint schedule without due forethought to the type of surface involved and the correct choice of primers and undercoatings for that particular type surface, is bound to lead to failure, just as a building erected with no foundations or faulty foundations is bound to give trouble.

The paint industry has made tremendous strides over the last twenty or thirty years and the industry has passed from the craftsman to the scientist. The paints prepared by the old-time craftsmen, although very good for their purpose, could never withstand the stringent conditions met with in modern industry, a classic example being the discolouration of the lead paints in sulphurous or chemically-polluted atmospheres. It could safely be said that if the paints prepared by a tradesman of twenty years ago were applied over the incorrectly or hastily-prepared surfaces of today the disintegration of the paint schedule would be far more rapid than that found with modern paints. The materials available to the old-time craftsman were very limited and to state that he actually made his paint is strictly incorrect. The tradesman in the past used to purchase ready-made ingredients, be they white lead ground in linseed oil, turpentine or varnish, and mix them according to his requirements. The success of his paint schedule resulted more from the care devoted to preparation and application rather than the quality of materials used.

With the modern paint industry the range of materials available for the protection of structures, plant and equipment is wide; all, however, have one thing in common, they are not finished products until they have been applied to the surfaces involved. When preparing the specification for the painting of a modern building it is all too rarely appreciated that

successful painting begins at the drawing board stage. A very large proportion of problems arise because painting is not thought about until the design of a building or piece of plant is well advanced, or indeed until construction is actually started. Common faults are:

- (a) Designs which result in unpaintable items, i.e. back-to-back angles, embedded steelwork, etc., failure to back-prime.
- (b) The fault in design or in the choice of structural materials which impose severe strains on the paint. Examples include poor ventilation, discharge of effluents or corrodants onto painted surfaces, reliance on the use of paint for the interior of vats and tanks, or for high temperature surfaces, etc.

So far as (b) is concerned, it can fairly be said that the paint industry has met the need for suitable paints with considerable success. Nevertheless the initial problem need not always arise and much costly maintenance painting could be avoided if considered at the planning stage. It should be realised that no single type of paint is suitable for all jobs.

When considering the preparation of the surfaces and the specification, due thought must be given to the conditions pertaining and the most suitable paint schedule to offer. Most paint systems consist of primer, undercoat and finish. It is important to think of them as a complete system and not merely as a series of unrelated coats. Consequently the combination of primer, undercoat and finish as recommended by the same maker should be used if best results are to be obtained. For most building operations a detailed specification is drawn up describing the materials and preparatory processes to be used. Yet for many painting jobs, even those involving extensive areas, either no specification is prepared at all, or to quote one authority, the specification is so poorly written or so clouded with contradiction as to defy the interpretive ability of anyone except, and often including, the writer.

A common fault in painting specification is lack of precision in the description of the operations to be performed, or the materials to be used. Some years ago the clause "all materials to be the best of their respective kinds" appeared regularly in painting specifications, similarly the term "thoroughly prepare", without any indication of the standard regarded as thorough, provides little support for the supervisor or inspector and no basis upon which the contractor can estimate the cost of preparation. Likewise it is easy to err in the opposite direction and draft so tight a specification as to make it almost

impossible to carry out work under normal conditions. A frequent outcome of such specifications is that the contractors increase their estimates greatly in order to cover the possibility of being caught out. What is required is a clear, precise and practical specification of the work to be done and the materials to be used. Preferably it should be drawn up by someone who, whilst determined to obtain a satisfactory job, understands the difficulties under which contractors must often work, especially on exterior work or industrial projects. Contractors will appreciate a specification which is workmanlike and that provides a fair basis for competitive tendering. Most specifications will involve three types of clauses:

- (1) Preliminary or general clauses.
- (2) Preparatory clauses.
- (3) Finishing clauses.

The preliminary or general clauses are usually concerned with the scope of specification, supply of material, methods of application, thinning, etc., application conditions, re-coat times, and any special conditions relative to the particular project involved. Successful results in the painting of surfaces depends almost entirely upon the condition of the surfaces to which the paint is applied. The importance of adequate pre-treatment cannot be overstressed as it is essential that surfaces be chemically clean immediately prior to painting. The term chemically clean infers the complete removal of oil, grease, rust and foreign matter and in the case of badly disintegrated existing paint coatings, complete removal to ensure a sound basic foundation for the new paint schedule.

When dealing with the pre-treatment of surfaces, let us first consider the ferrous type metals, or, in other words, iron and steel. These metals are described as ferrous metals in that they corrode by the action of rust or ferrous oxide. Generally speaking, most metals other than the precious metals attempt to revert to their basic components and the function of a paint schedule is to prevent, or at least slow up, this electro-chemical change. The formation of rust could be likened to the common cold. We all know it happens but we have yet to discover a guaranteed cure. Before even considering the application of paint, it is essential that rust and millscale be removed from steel structures prior to painting. It is a well known fact that in the presence of moisture, tiny electrical cells are formed on an iron or steel surface causing wastage at the anode and deposition of ferrous oxide on the cathode which is usually the millscale or the highlights of the surface. This deposition of ferrous oxide or rust is accumulative in action and if paint is applied over rusted surfaces the rusting will continue beneath the film of paint, eventually pushing the paint from the surface and giving premature paint failure.

The removal of rust may be effected by any of the following means. The most efficient method of rust

removal is by sand-blasting, flame descaling or other mechanical means. When sand-blasting ferrous surfaces the surfaces are bombarded by particles of sand and there is no doubt, as tests have demonstrated, that this is by far the most efficient method. When specifying the sand-blasting of iron and steel, it is imperative that a clause be inserted that the surfaces should be primed within one hour of sand-blasting. Once sand-blasted, the surface is slightly roughened, which presents a far greater surface area to corrosive elements, and it is imperative that the surface be protected immediately after sand-blasting. Failure to conform to this clause will render the sand-blasting largely ineffective. Descaling and de-rusting by means of the flame descaler is also another very efficient form of mechanical treatment, particularly where large surfaces are involved. The flame descaler works on the principle of the expansion and contraction of steel surfaces when heated. The flame descaler is in the form of a torch comprised of a long handle and a T-piece which is fed by an oxy-acetylene flame and is used with a sweeping motion over the rusted surface. It could be likened to a broom or brush, the bristles of which are composed of oxy-acetylene flame. The torch is passed over the surface and the mill-scale and rust expands at a far greater rate than the bulk steel, and the basic adhesion is broken, rendering the rust and scale easily removable. For best results, the priming coat should be applied to the surface whilst the surface is still warm, in fact it would be advantageous to reheat the surface prior to the application of the primer, should the pre-treatment squad be working at a faster rate than the squad applying the priming paint.

Both of the foregoing processes are readily available in South Africa and, as already mentioned, there is no doubt that they are far and away the most efficient methods of preparing steel surfaces for the reception of paint. Should circumstances prevent the employment of mechanical means of de-rusting, the most effective method to adopt would be to allow the surfaces to weather for a period and then employ manual methods of rust removal, followed by chemical treatment of the surfaces involved. When allowing for the weathering of steel structures, due thought must be given to the presence of mill-scale. This scale forms on the steel immediately after fabrication, and is in one sense a protective coating in itself. It is, however, rather brittle and does tend to crack during the normal expansion and contraction of the steel and is cathodic to the under-lying steel surface, which results in the formation of rust at the cracks in the mill-scale and these centres of corrosion spread, usually under the mill-scale eventually pushing it from the surface. When considering the painting of such surfaces it is essential to allow adequate weathering until the mill-scale is fully removed. Once the surfaces have been adequately weathered they should then be treated by the wire

brush and followed with a chemical pre-treatment. At this stage it would be as well to remember that the efficiency of a wire brush is as efficient as the operator using it. Inefficient wire brushing will lead to inefficient cleaning, and if the surfaces are inefficiently cleaned, rusting is bound to continue. No matter how efficient the wire brushing operation, chemical pre-treatment of the surface involved is definitely necessary after wire brushing has been completed.

In certain instances where time is a prime factor and wathering is out of the question, there are proprietary forms of chemical pre-treatment which could be used to remove mill-scale and neutralize or remove rust. These have also proved effective.

Sometimes new structural steel work is delivered onto the site coated with a cheap priming coat with no lasting qualities. These coats are termed "shop-coats" and were originally applied merely to protect the steel in transit or storage. All too often these cheap "shop-coats" are used as priming coats which nearly always lead to premature paint failure. In such cases it is usually advisable to remove this form of primer as it is merely a temporary protective coating with very few of the essential qualities of a true metal primer. The mechanical means of rust removal will usually be quite effective for the removal of these "shop-coats" which are in a fairly advanced stage of disintegration, once the steel work has been erected.

When considering the primers for the surfaces in question, it is most important to realise that primers are best brush-applied. The use of a brush will work the primer well into the pores of the metal, and apart from this fact there is also the question of toxicity to consider as many metal primers are toxic and should never be sprayed. The primers for iron and steel have a definite function and should never be relegated to a position of unimportance, merely because they are not seen once the painting schedule is complete. They are formulated to give basic adhesion to the metal surface over which they are applied, and are also able to conform to the natural expansion and contraction of the surfaces. They are also formulated to prevent the ingress of moisture or water which forms the electrolyte for the electrochemical change necessary for the formation of rust. Another very important function of a primer for ferrous surfaces is the passivation of the surface.

It will be noted that most of these metal primers are in themselves based on metallic-like pigments, or pigments obtained from metallic sources, and their function is to cut down the electrical potential of the surface, or in other words, passivate or inhibit the formation of the electrical cells, hence the name rust-inhibitive primers. The primers found most satisfactory for this purpose are red lead, zinc chromate, or zinc rich primers. Red lead primers have been used

successfully over many years and in fact are still in the forefront of the metal primer field.

There is one point that must be stressed and that is—never be misled into buying on price. The S.A.B.S. have laid down a definite range of lead content for red lead primers, and when specifying a red lead primer for structural steel work, it is advisable to quote an S.A.B.S. specification for the primer to be used. Red lead should be confined to ferrous type surfaces and never be applied over non-ferrous metals. It should also be applied by brush only and never sprayed as it is toxic. It also follows that the primer should be applied over a correctly pre-treated surface and not over rust.

Another primer that has also come to the forefront over recent years is zinc chromate primer, which is yellow in colour, but should never be judged on its efficiency merely by the colour. The various zinc chromate primers available could quite easily vary in colour and yet possess the requisite zinc chromate content for adequate rust prevention. As with red lead it is essential that rust be removed prior to the application of zinc chromate primers and that the surfaces be free from dirt, grease and any foreign matter. They have an advantage over red lead primers in that they can be applied by spray, being non-toxic, but as already mentioned brush application is preferred to ensure that the primer is brushed well into the steel surface. From exposure tests it has been determined that the most efficient type of primer to use on the coastal belt in South Africa is of the red lead type, whilst in inland and in drier atmospheres very good results have been obtained from zinc chromate primers. This is mentioned in passing as an obvious question is "what is their relative efficiency?"

Zinc chromate primers may also be applied to non-ferrous metals as a priming coat whereas red lead should be restricted to the ferrous metals only. The actual passivation or rust inhibition of a zinc chromate primer compared to a lead primer is very debatable, both having given excellent results. There is one very important point that must be made and that is, the number of coats of primer to employ when specifying for the painting of iron and steel. When viewing a steel surface under a microscope, it will be noted that the surface is not absolutely smooth, but made up of minute hills and valleys or contours. When applying one coat of primer over a surface of this nature, there is a distinct possibility that the highlights in the surface will protrude through the priming coat leaving potential centres of corrosion. Wherever possible, two coats of primer should be specified to ensure maximum protection and film build.

Another interesting development in the metal primer field has been the zinc rich primers. These primers are comprised of zinc dust usually of a very high percentage of the total paint, somewhere in the region

of 85 per cent. They are applied by brush and protect the steel by sacrificial corrosion or cathodic protection. Zinc rich primers for maximum efficiency should be applied over a sand-blasted surface. If the surfaces are not adequately de-rusted prior to the application of zinc rich primer, their efficiency is lost and it would be advisable to use red lead in lieu. When the surfaces are sand-blasted however, and a zinc rich primer applied, the best results will be obtained. The zinc rich primer should be applied at a film thickness of at least 4-mils, this film thickness being fairly easy to obtain due to the high viscosity of the primer which should be applied as supplied. The choice of the most suitable metal primer for ferrous surfaces will undoubtedly be governed by the project involved.

To pass on to non-ferrous type surfaces, the one most commonly met in modern building practice is galvanised iron. Surfaces of this nature are known to the trade as "greasy metals". They are not in actual fact greasy or at least they weren't until the fabricators started to grease the sheets after galvanising for storage purposes, but were termed by the painter "greasy" in that they were difficult surfaces to paint, due to poor paint adhesion. This poor adhesion was due to the formation of an oxide film on the metal to which the paint adhered and which gave no basic paint adhesion to the actual metal. The old fashioned method being to use a mordant solution which was usually comprised of copper sulphate (known to the tradesman as "blue stone"), sulphuric acid and water. These mordant solutions were swabbed over the surface and, the zinc coating was blackened, or in effect partially destroyed merely to provide a surface suitable for the reception of further protective coatings.

Another common method employed was to allow the zinc galvanised surface to weather. This also in effect partially destroyed the protective coating of zinc. The chief failing with this latter method was that many areas were inaccessible to the weather and were never adequately conditioned for the reception of paint. A typical example of this is the underneath surfaces of galvanised iron verandah roofs. The most effective method now available for the pre-treatment of galvanised iron prior to painting is the wash or self-etch primer. These primers are formulated to function both as a pre-treatment and as a priming coat and are marketed in the form of a double pack, one tin containing the actual primer and a bottle or jar containing an acid diluent. The acid diluent and primer are mixed in equal proportions and applied by brush or swab. This dual function of pre-treating and priming gives a considerable saving in processing and labour costs when considering a complete paint schedule.

When considering galvanised iron, another point that arises is the protection at the laminations of the sheeting. Corrosion usually starts at the laminations

on a galvanised iron roof due to a bi-metal corrosion and takes the form of "white rust". This could be prevented to a large extent by priming before fixing, or at least applying a sandwich coat of primer between the laminations.

The wash or self-etch primers have also been found very effective on iron and steel. The acid diluent has a phosphatising effect which goes a long way towards the prevention of rust formation. If used on iron or steel however, it is recommended that the wash or self-etch primer be followed by a further coat of zinc chromate primer. This is to ensure an adequate film thickness of primer to prevent the protrusion of the highlights of the surface through the primer coatings.

Self-etch primer, or wash primer as it is sometimes referred to, is semi-transparent and should be applied as a wash coat. Never attempt to obtain full obliteration with these primers, as thin coats are preferable. This primer may also be used over aluminium or any of the other non-ferrous metals which previously gave trouble with paint adhesion and had to be treated with deoxidants, mordant solutions, or manual abrasion. When discussing this matter, due thought should be given to the fact that the chief cost in painting is not the materials involved but the labour, and extensive manual abrasion is a far more lengthy process than merely applying a coating of wash primer, plus the fact that the latter is far more efficient.

With regard to the pre-treatment and priming of plaster, cement and asbestos surfaces, it must be realised that no finish will give optimum results if applied to walls which are habitually damp. Apparent dryness is often misleading and, as there is a high alkaline content present in all mixtures containing cement or lime, it is essential that they be dry and adequately sealed before painting. The Building Research Institute gives some very interesting figures regarding the quantity of moisture in new building structures; rough estimates suggest that average brickwork may contain up to 30 gallons of water per cubic yard when first laid, and that a similar amount will be present in a cubic yard of fairly dense concrete. A bungalow of 25,000 bricks could easily hold up to twelve tons of water and it is ridiculous to expect a thin film of paint to hold back this water during the drying out process. The water soluble alkaline salts present can also give trouble if paint is applied over these surfaces, in that they will destroy the paint medium by a process known as saponification.

The first consideration therefore, when painting surfaces of this nature, is to ensure that they are dry. Where painting has to commence before the structure is thoroughly dry, the only finishes that can possibly be used to date are the water emulsion paints. The water paints allow the surfaces to "breathe", i.e. will allow the moisture present in the surface to dry out without adversely affecting the paint. In fact, the

water paints are formulated with this end in view and the colouring matter is designed to be alkali-resistant to prevent discolouration from the harmful alkaline salts. Even if water paints are used, there is a possibility for the water soluble alkaline salts present in the building structure to be brought to the surface in solution, and when the water dries off, these salts are precipitated in the form of a white crystalline deposit on the surface of the water paint. This is usually easily removed by washing down with clean water although instances have arisen where even the water paints have been affected by efflorescence.

In the case of patent plaster such as Keene's or gypsum types, the age of the plaster is not so important as the texture. The surfaces are sometimes trowelled so smooth, compact and hard as to be almost marble like in texture, in which case the sealing coat will not grip unless this factor was taken into account by the manufacturers of the sealer when formulating. It is usually advisable to specify that these types of plaster be left to dry as long as possible before the priming coat is applied. This may vary from a few days to several weeks, according to the age and structure of the building and general conditions.

Generally speaking, it is unsafe to apply paint to cement or concrete surfaces until a natural ageing period of six to twelve months has elapsed. There is a great danger of paint failure if surfaces of this nature are painted before this natural ageing period. Where, by force of circumstances, the full natural maturing period cannot be allowed, and decoration within a short period of rendering or casting is essential, it is possible by the use of an alkali-resistant primer to provide a reasonable margin of safety. Whilst it is not possible to guarantee results in this particular instance the highest confidence may be placed in this particular type of primer wherever the presence of destructive alkaline agents in cement or concrete have to be contended with.

When reviewing this subject, the painting of damp surfaces in an old building can often give trouble. There are frequent instances where the ground level has been raised above the level of the damp proof course giving interior wall surfaces that are habitually damp. Surfaces of this nature are virtually impossible to paint unless the source of damp is cured. Asbestos sheeting also comes into the category under review and, when painting surfaces of this nature, an alkali-resistant primer should always be applied prior to finishing coats. Water paints may be applied direct to asbestos surfaces, as from a painting point of view the composition of asbestos sheeting is closely allied to cement. When specifying for the painting of asbestos, due thought should be given to back painting. Likewise the painting of the interior surfaces of gutters, etc. A coat of black bituminous paint on the inner sides of gutters would do much to prevent paint failure due to moisture being drawn through the

gutter by the heat on the exterior surface from the sun, which could give rise to blistering of the paint film. To summarise, when specifying for the painting of cement or plaster surfaces, they must be thoroughly dry and if damp, only water paints applied.

Regarding the painting of wood surfaces, as with plaster, the first consideration should be moisture content. At one time timber was seasoned before being incorporated into buildings, modern practice is to kiln dry, which is quite effective and has been found to be just as reliable. Before attempting to paint any particular type of timber, the surface should be perfectly clean and free from dust and dirt. Surfaces should be sand papered smooth and dusted off. All knots and resinous parts should be given two coats of knotting. There is a high percentage of resin present in the knots in most timbers and this resin is soluble in the solvents and media of paint. Resinous exudations from timber, or a brown stain showing through cream coloured enamels due to failure to adequately seal back with knotting is unfortunately quite common. Knotting is usually a spirit or alcohol soluble gum and the resin in the knots is insoluble in the solvent of the knotting. Likewise the spirit soluble gums are insoluble in the mediums and solvents used in the paint, and we thus have a sandwich coat of an insoluble sealer between the resin in the knots and subsequent paint coatings. Two coats of knotting are recommended, and the knotted area should be feathered off by brushing away from the centre, thus ensuring that there is no sudden step up in the painted surface.

Although there are many types of timber, for painting purposes they could be categorised under two types, namely hardwoods and softwoods. The most suitable type of primer to use on hardwoods would be the orthodox pink primer type based on red and white lead. This primer should be applied by brush only and brushed well into the surface. The red lead content in the primer is in itself a natural drying agent and will ensure the tenacity of film so important when dealing with the priming of wood.

The function of all wood primers is to ensure maximum adhesion between the surface being painted and subsequent paint coats, and also to satisfy the porosity or prevent suction of the wood surface involved. For the softer type timbers a primer containing aluminium is recommended—this type of primer being particularly effective over resinous type timbers such as oregon pine. With this latter type timber the overall grain is high in resin content and sometimes tends to bleed or show through subsequent paint coats, an overall coating of knotting is not recommended as a priming coat as it lacks flexibility of film. Primers containing aluminium do have a sealing effect over this resinous bleed. The treatment to Kiaat and Teak sometimes calls for specialised treatment in that the woods tend to exude a greasy content which can

sometimes have an adverse effect on the drying of orthodox priming coats. Should trouble be experienced in this respect, a wash down with acetone or some other strong solvent, followed by a sealing coat or priming coat of gold size, which is a short oil quick-drying varnish, will be found effective. The solvents remove surface greases and the quick-drying primer allows the sealing coat to dry before the drying is adversely affected by greases or oils that percolate to the surface. Back-priming is most important when considering the painting of woodwork. Preferably all woodwork should be primed before fixing so that areas butted to wet masonry are protected from the ingress of moisture which could lead to subsequent blistering on the faces. To summarise on wood primers; they should be specially formulated for the job; cheap flat whites and substitutes should never be used; ensure that tops of doors and areas butted to wet masonry are primed, and always apply wood primers by brush. Failure to prime woodwork will result in the mediums of the under-coats and finishes being absorbed into the timber leaving finishing coats in an underbound state which will seriously detract from their durability and could easily result in flaking of the entire paint schedule.

It will be noted that up to this stage in the paper brush application has been advocated. This in no way infers that spray painting or the application of paint by roller is inferior to that of the brush, merely that the type of coating discussed requires brush application for optimum results. The use of rollers or spray painting is quite permissible for undercoats and finishes, remembering of course, that with spray painting in the trade it is very difficult to ensure maximum exhaust for spray fumes or masking such as is needed on windows, likewise with a roller the cutting in or painting of straight lines is not practicable and the brush is still the best tool to use. The roller and spray are however, considerably quicker than the brush when painting large areas, and the texture given by the roller or the spray is more pleasing to the eye than brush application, particularly if the brush application is of inferior quality.

In the foregoing the majority of surfaces liable to be encountered in general building practice have been covered, but all the surfaces referred to have been new. Old painted surfaces also present problems and should be dealt with as follows. Should the old paint be in an advanced state of disintegration, it will require to be stripped. There are two methods available to the tradesman, the first and most economical being the blow-lamp. The flame from a blow-lamp is played over the paint in question until it is destroyed by heat and is then removed by means of stripping knives and sometimes a plumber's shavehook. This method is, by far, the most effective, but has certain disadvantages. When removing paint by means of a blow-lamp, or burning-off as it is known in trade

terminology, the fire risk must be considered. When burning-off windows, due care must be taken to protect the glass by means of a metal template. If the blow-lamp flame is allowed to play on the glass, the glass in that immediate area expands at a far greater rate of expansion than the surrounding areas and the glass cracks and breaks. Likewise to burn-off existing pigmented finishes with a view to staining and varnishing woodwork, the blow-lamp would present difficulties as it does tend to char the surfaces, particularly if the old paint is tough and hard.

Where circumstances do not permit the use of a blow-lamp, paint removers are available which are supplied in liquid form and are applied by brush to the old paint and left for five minutes or so until the old paint lifts and then stripping is effected by means of stripping knives. When using paint remover it should be remembered that a wax is incorporated by the manufacturer to facilitate use on vertical planes and that this wax must be removed from the surface after stripping of the old paint is complete. Should this wax be left on the surface it would seriously affect the drying of subsequent paint coatings. It is also possible to prepare a paint remover based on caustic solutions, but these type removers or strippers are dangerous in use and are not recommended. The caustic-type stripper is harmful to the human skin, will tend to raise the grain of wood, will also affect subsequent paint coatings unless thoroughly rinsed off with clean water, and can also actually attack aluminium or magnesium alloys.

Before leaving the pre-treatment of surfaces, mention should be made of a process which is sadly neglected in modern painting practice. This process is the washing down of old painted surfaces prior to re-coating. In some instances existing paint coatings are merely washed as a form of renovation, the finish being quite suitable to be left in its existing condition. Where surfaces have to be repainted, for best results washing down is essential as it is a waste of time to apply new paint over a surface that is dirty, greasy, or showing evidence of excessive chalking. There are many detergents available ranging from weak solutions of soft soap, proprietary brands of detergent, Lissapol N, Teepol, to stronger solutions of washing soda or sugar soap, the choice of the correct detergent being governed by the particular job in hand. The detergent should be applied at the base of the work and process carried out from bottom to top. This will prevent unsightly streaks or discolourations which could easily result if the detergent was allowed to run down in isolated rivulets over dry surfaces. Once the detergent has been applied and the surface has been scrubbed or washed, it should be finally well rinsed down with clean water and dried off prior to repainting.

In the presentation of this paper, an attempt has been made to keep to a logical sequence by starting

from the pre-treatment of surfaces up to the final finish. We have at this stage reached the priming coat after having adequately prepared the surfaces. The next stage in the operation could be termed "making good." Making good on metal-type surfaces is seldom encountered in decorative practice. It is quite a problem, however, when discussing industrial finishes which are not in the scope of this paper. For making good on wood, however, there is a definite system to adopt. In nearly all painting specifications prepared by the architectural profession, the following clause is inserted which is seldom adhered to. The architect states: "All woods to be knotted, primed, stopped and filled." The contractor usually gets to the stopping stage, but knife filling is very seldom used today, although for a correctly painted wooden door, knife filling is absolutely essential. Making good on woodwork is carried out in two processes, namely stopping and filling. The stopping process which should always follow the primer coat is for the making good of large indentations, nail holes, screw holes, etc., and the finest stopper to use is one concocted of white lead, whiting and gold size. Paint manufacturers do, however, supply proprietary brands of knifing stopper which should always be used in preference to linseed oil putty.

Wood surfaces must be primed before they are made good. Likewise wood sashes should also be primed before glazing. This is to prevent the absorption by the timber of the binders of the fillers or stoppers used.

Once the stopper is dry, the next process should be to knife-fill. Most foreman painters have their own pet theories and concoctions regarding knife filling, and can usually be relied on to prepare a knife filler for filling the minor indentations or grain pores in the wooden surface. Proprietary brands are available, however, their function being to present a smooth, contour-free surface for the reception of the undercoat and finishing schedule. On composition boards or hardboards, knife filling is seldom necessary, all that is required is a sealer to stop porosity and a hard stopping for nail holes or screw holes, etc. On plaster surfaces, making good sometimes presents quite a problem. As a general rule you could consider any plaster defect, up to two feet square in area, a painter's problem. Any defect larger in area than two square feet should be passed to the plasterer for rectification.

Cracks in plaster surfaces should be cut back in the form of an inverted "V" and brought to a level surface. Most making good on plaster—at least major making good—is done before the application of the primer coats. The cracks or defective areas are wetted-in after having cut back in the form of an inverted "V" with a hacking knife, and then filled to a level surface with either Keenes cement, a pro-

prietary filler, or a filler that has been concocted by the decorator. After the initial priming coat has been applied, minor defects are sometimes obvious which are easily made good by knife filling. Plaster surfaces that have hair-cracked, or air-cracked as it is sometimes called, present a greater problem. For exterior surfaces showing this form of crazing, there is literally no remedy other than chipping and re-skimming. Even the most flexible type paint coating could form only a temporary cure as, if these cracks are bridged by a paint coating, the paint coating must at some time become embrittled and lose flexibility, finally cracking, allowing moisture to penetrate with subsequent paint failure.

For interior air-cracked or crazed surfaces, however, there is a cure available and that is to use lining paper which is readily available in Southern Africa. Lining paper is supplied in rolls of approximately thirty feet long and twenty-one inches wide. It is hung in exactly the same way as wall paper and the joints are butted and not lapped. Correctly-hung lining paper will effectively cover a hair-cracked surface and allow a certain amount of movement beneath the paper coating which is able to stand up to these stringent conditions far more effectively than if the wall was merely coated with paint. It was the practice in years gone by to line an interior wall even although no sign of crazing was evident but merely to ensure that the surface would not show this defect in years to come. After the application of lining paper, water paint may be applied direct and, in the case of flat oil paints and enamel, an alkali-resistant primer should be the first coat. Correctly butted lining paper will not show joins, giving a perfectly smooth finish.

Once surfaces have been brought to the made good stage, they are now ready to receive undercoats and finishes. The purpose of an undercoat is to give build to the paint schedule and, in some cases, hiding power or opacity. An undercoat should be formulated to give maximum adhesion to the primer and subsequent paint coatings: in other words, give good intercoat adhesion. They may be applied by brush or spray, provided they are lead-free. If containing over 5 per cent of soluble lead, however, they should be applied by brush only.

The colour of the final coat of undercoat should always be close to that of the finish, but with enough difference for the operative to distinguish the two easily while working. An exact match between undercoat and finish will often give rise to misses or holidays in the finishing coat, particularly when work has to be done in artificial light. When a dark finishing colour with good opacity or hiding power is being used, some latitude may be permitted in the choice of undercoat shade, for instance a grey undercoat may be used for black or dark green. Undercoats should be compatible with each other and with the

primer and the finishing paint. For this reason, when a proprietary finish is specified, it is desirable also to specify the undercoating and where possible the primer recommended by the makers. The use of too soft an undercoating under a hard-drying finish is very likely to lead to cracking and premature paint failure. Undercoats should also dry hard and facilitate light rubbing down between coats, and it will generally be found that in a planned paint schedule the coatings vary in flexibility of film from a fairly rigid coat to a final elastic coat in the finished or final coating.

To summarise, the chief functions of an undercoat are to obscure the primed surface, to provide a fresh surface of uniform texture and of a colour approaching that of the finishing coat, and to provide sufficient build or thickness of paint to protect the material painted, according to the conditions of exposure when used in conjunction with a suitable finishing coat. The application of finishing coats presents a more complex problem in that the application procedure varies with the type of finish in question. The final coat in a paint system is intended to provide the particular colour and degree of gloss or texture required. With water paints, for instance, it has become a generally accepted practice that they be switched with the tip of a brush in a basket-like pattern which dates back to the days when the tradesman concocted his own distemper from whiting and glue size. These old-type water paints dried with a perfectly matt surface but did not possess particularly good flow and the painter would work from the source of light, brushing into the wet area with diagonal strokes to diffuse the light pattern on the contours of the water-painted surface. Modern water paints, however, do possess very good flow and this method of application is not so essential. It has been accepted as general trade practice, however, and is still adopted. In modern practice it is quite usual to use the roller for the application of water paints or flat oil paints. The slight stippled texture is certainly advantageous and is in fact much quicker than an operative following the brush-hand with an even hair stippler. When dealing with flat oil paints the old fashioned theory of flat on flat still holds good with many finishes marketed today. There are flat oil paints available, however, that will permit re-coating and still give good intercoat adhesion and ease of brushing. The main reason for not putting a flat on a flat in years gone by was the difficulty in keeping what the painter termed a "wet edge." The older-type materials tended to dry rather quickly and, unless the edge was kept moving, lines, polishes or shears were the result.

It is quite a common practice these days to apply a gloss coating over a gloss. This is due to the advent of the modern synthetic or alkydized enamel paint which does permit re-coating. There is a slight bite

from the solvents which provides an adequate key. The length of this paper will not permit a detailed description of all the various types of finishing coats available, but in general practice the main ones used are orthodox oil and varnish paints, synthetic paints, emulsion paints and distempers. Tremendous strides have been made over the last twenty or thirty years with the finishing paints available today, particularly in the water paint sphere. The term "synthetic" now loosely given to a wide class of paints is rather misleading as it can be applied to paints of a very wide variety. The term has become general, however, and no really satisfactory alternative has been put forward. The term synthetic is misleading for the following reason:

With the introduction of these modern enamels the association in the minds of the public for the word "synthetic" was artificial. It was thought that they were mere chemical imitations of the natural resins, but this is strictly incorrect, as with the introduction of the synthetic resins, the paints of today possess far greater durability and their quality is far more consistent, being absolutely trouble-free when viewed against paints manufactured on the older fossilized natural resins which tended to vary in physical state and chemical constitution.

In the water paint field we have progressed from the size and whiting distemper stage through the powder distemper stage to washable water paints, some based on emulsions of drying oil or varnish, some on synthetic emulsions and finally to water paints that are suitable both for interior and exterior use. These latter finishes, particularly the P.V.A. group, or the latex paints as they are sometimes described, give astonishingly good durability when applied on exterior surfaces, and have the added attraction in that they dry with matt to semi-matt finishes.

There is no doubt that with the limited scope of this paper, many questions on finishing coats, their types and finishing schedules, likewise on painting faults; their tracing, classification and correct rectification methods, have yet to be dealt with. For a very detailed survey of some of the common complaints associated with painting, attention is drawn to the United Paints Limited publication *Good Painting of Buildings*.

VITAL COLOUR IN INDUSTRY

The word "vital" is most apt when coupled with colour, particularly when thought is given to the fact that colour is light and that without light life as we know it would be virtually impossible. Everything seen by the human eye is coloured and every sensation of colour owes its reality to light. The importance of colour cannot be over-stressed, particularly when viewed in relation to its application to industry, as

we are all directly influenced to a greater or lesser degree by the colour of our surroundings.

Much has been written in recent years on the subject of colour and there is still a great deal to learn in this respect. To use colour correctly, however, there are certain guiding principles or fundamentals which are based on natural phenomena and which, coupled with a careful study of the project involved, can materially assist us in choosing colour plans suitable for all individual projects. Quite obviously there can be no mathematical formula which would suit all projects as the many factors involved have a direct bearing on our eventual choice, but the following points, if given careful consideration, will serve as a useful guide.

Firstly, to place colour correctly it is necessary to have some idea of its basic nature and how it is actually seen. We are all familiar with the classical experiment of Sir Isaac Newton who demonstrated that white light is composed of varying wave lengths of light which, when separated, give us the spectrum or rainbow colours in the natural sequence of violet, indigo, blue, green, yellow, orange, red. This phenomenon is often seen in the form of the rainbow or on the bevelled edges of cut glass. By the addition or subtraction of these varying wave lengths of light it is possible to ensure the production of any desired hue.

The interpretation by the eye of the message it receives is a very complex process and is difficult fully to comprehend. We can only accept available theories which assume that there are different receptors in the eye, each of which is susceptible to varying wave lengths of light which are transmitted to the brain as sensations of colour. The assessment by the brain of the pleasantness or otherwise of the sensation of colour received is even more difficult to understand, but quite obviously these different processes are so inter-related that any scientifically-planned attempt to derive the maximum benefit from colour must take them into account. When viewing various coloured surfaces the message of colour conveyed to the brain is governed by the ability of that surface to absorb or reflect back the basic components of white light. Thus a surface absorbing the blue wave lengths of light and reflecting back the reds and yellows would appear orange and *vice versa*, thereby covering the whole range of hues visible to the human eye.

Once having established in our minds the basic nature of colour and how it is seen, the next problem is the actual placing of colour to suit the individual project to hand. There are various systems available to help us in this respect, the most widely used being the Munsell system. This system is based on what is commonly known as the chromatic colour circle. This colour circle or colour wheel is quite simple to prepare by placing the three primary colours, red, yellow and

blue, triadically around the circumference of a circle. The spaces between the primary colours should then be filled in by inter-mixing the primaries giving a complete circle of colour in the natural sequence of violet, indigo, blue, green, yellow, orange and red.

By the use of the colour circle we are quickly able to determine the complementary relationship of the various hues simply by referring to the hue shown diametrically opposite on the circle. When placing colour in industry the use of complementary colours must be given very careful thought. When the eye has been concentrated on a coloured surface and is then transferred to another surface the shape of the object, but in a lighter tone of its complementary colour, remains visible. The background colour to machinery and equipment, therefore, should be carefully chosen so as to encourage the eye to adjust itself more quickly to normal seeing conditions. If wrongly used a complementary can be over-powering, but if correctly chosen can either impart a sparkle or relief in a monotonous scheme to very good effect. An interesting experiment that is easily conducted to demonstrate the phenomenon of complementary colour is to stare at a bright purple hue for approximately fifteen seconds and then transfer the gaze to a white background. It will be noted that an illusion of yellow appears and this illusion is commonly referred to as "after-image."

To employ the chromatic colour circle the following descriptive names and their meanings will be found of assistance.

Monochromatic Colour Scheme. Is composed of a scheme of tints or shades of one hue. That is to say one colour, but employed in various weights or values. This type of scheme is easily planned but can be rather monotonous if unrelieved by a complementary. A common example is the white ceiling, cream walls and buff or brown woodwork that is so often seen.

Analogous Colour Schemes are those chosen from a limited sector of the chromatic colour circle, each hue having a common primary. This type of scheme gives colour harmony, but is also considerably enhanced by the introduction of a complementary colour.

Complementary Schemes are obtained by selecting hues diametrically opposite on the colour circle. Inter-mixing of the two selected hues produces what are known as complementary greys. Complementaries need careful placing and the resultant effect is one of sparkle.

Triadic Colour Schemes are produced by selecting hues placed equidistant around the chromatic colour circle, the primary colours red, yellow and blue being a typical example.

Once having mastered the technique of applying the chromatic colour circle to our planning we are

now in a position to choose the right hue or colour, but at this stage we are presented by full and unadulterated hues or rainbow colours which quite obviously require considerable modification before they can be happily adopted in a correct colour plan. Our planning should now be taken a step further by a perusal of the following references, which will also do much to clear our minds regarding some of the confusing terms used to define colour.

Hue. Hue is the term given to describe the actual colour, for instance red, yellow, blue, etc.

Tone, Value or Weight. These terms are used to define a colour when viewed in a light to dark scale. For instance a pastel green could be described as being a light green or a high tone or value.

Chroma. This term is also described as saturation or intensity and is used to define the purity of the colour.

Tint. Tint is sometimes used to describe a lighter weight or value of a full hue or colour. Thus reduction with white would be a tint.

Shade. Shade is the direct opposite of tint and is used to describe darker tones of a full hue.

We can now utilize the colour circle and couple or modify our choice by introducing various weights or values together with varying colour intensities. The next factors to consider are those that have a direct bearing on the colour choice for individual projects. Firstly we must consider the nature and degree of both artificial and natural lighting available. Obviously, if a factory or project is dark and lacking in natural daylight our colour choice must veer to light values or pastel colours, unless of course the use of darker tones is desirable for functional purposes. Due thought must also be given to the fact that the light rays emitted from sources of artificial illumination are substantially different from those given from natural daylight. When choosing the colours for walls and ceilings we would be well advised to view them under the light of conditions prevailing.

Once having mastered the foregoing points we would do well to bear in mind the following principles of colour that also have a very direct bearing on correct planning.

Juxtaposition. Unless isolated for some specific purpose no colour is ever seen alone, but is affected by colours in juxtaposition or in the near vicinity. Therefore, it is of little use selecting any single hue until fixed colours, such as floor coverings, machine colours have been considered in relation to it.

Advancing Colours. The warmer hues, such as reds, yellows, oranges, etc., are generally known as advancing colours in that they do appear to bring surfaces forward.

Recedent Colours. These colours are usually associated with the cooler hues, such as the blues and greens and when viewed in bulk appear to recede.

Neutral Colours. Greys and near-greys are neutral and are useful as background colours, especially to objects which require to be emphasised.

To summarise on these principles it will be readily realised that a correct colour plan should be prepared with due thought being given to existing coloured fixtures to ensure correct juxtaposition of colour for surrounding areas and after due thought being given to the actual dimensions of the premises concerned. By the correct use of advancing or recedent hues an illusion of space can be created. A typical example of the latter being factory premises with low roofing, usually supported by a maze of roof trusses, which can be most overpowering and depressing to the unfortunate individuals employed therein.

Let us now consider the advantages to be gained by correct colour planning. Firstly, it abolishes both gloom and glare, thus minimising eye strain and subsequent fatigue. There is little doubt that if the eye is tired or over-strained the work and general morale of the worker must be affected. By the use of a pipe identification code and a safety code for machinery, emphasis is placed on potential danger points and hazards and general maintenance on plant is considerably assisted by easy identification. There is also no doubt that a well-planned scheme of colour provides an incentive to good housekeeping in the plant with a proved lowering in the rate of accidents, absenteeism and labour turnover. All of these latter advantages to be gained by the use of colour are particularly relevant to the sugar industry and there is evidence of an increasing interest among South African industrialists regarding the scientific application of colour and light to factory premises. It must be realised, however, that the haphazard use of colour can be just as detrimental as the use of no colour at all and that for correct colour planning each project should be viewed as an individual problem and careful consideration should be given to the foregoing points and their relationship to the project in question, as it would be misleading merely to state or to give a series of colours supposedly suitable for all factory premises.

Mr. Rault stated that the appearance of refined sugar in the factory was not shown up in its true light, an excellent white sugar having apparently a yellowish tinge on discharge from the centrifugals. This gave visitors to the factory the wrong impression so he wished to know if it would be possible to counteract this by a suitable painting scheme.

Mr. Smedmor replied that one colour that should not be used in this connection was blue. Pastel shades such as cream were much more suitable.

Mr. Sexton asked if there was any protective coating which could be used to prevent the corrosion

of the casing of a cast iron fan, through which air contaminated with nitrous and sulphur fumes is passing.

Mr. Smedmor replied that there were two chemical resistant finishes available which have proved to be highly efficient in this respect. One is based on chlorinated rubber and the other on epoxy resin. It has been generally found that the material based on chlorinated rubber has greater acid resistance than the material based on epoxy resins. On the other hand epoxy resins have proved to be more resistant to alkaline attack than finishes based on chlorinated rubber. For the job in question the best procedure to adopt would be, thoroughly de-rust and prime with a quick drying red lead primer, cover with two coats of a chlorinated rubber based enamel.

Prof. Warren asked if silicones could be used effectively for primers on cement.

Mr. Hamilton answered that silicones cannot be used as primers for cement. Depending on the starting materials, a range of silicones may be produced, but it is important to realise that they are condensation polymers, and do not dry or set by either oxidation or ethylenic polymerisation. The silicone used for waterproofing cement and concrete remains fluid after application, and indeed, one of the virtues of this class of material is extreme resistance to oxidation. Attempts to apply paint over material treated with silicone would lead to extremely severe adhesion problems.

Mr. Barnes enquired of the use of paint in relation to termite and other insect infestation of wood.

Mr. Hamilton replied that some protection against insect attack is given by coatings poisonous to the insect in question. Thus paints have been developed with insecticidal properties. These depend on the development of crystals of the insecticide on the surface of the paint. Ordinary paint would be expected to confer negligible protection.

Mr. Barnes wished to know the advantages of painting exposed asbestos cement sheeting:

- (a) On or near the coast.
- (b) In inland industrial areas.
- (c) In country districts away from the coast.

Mr. Smedmor replied that although asbestos sheeting is non-corrosive, it does tend to become embrittled with age. It is also rather porous in nature so a paint schedule would render the surface more water resistant. In inland industrial areas there is very often pollution of the atmosphere and normally the asbestos surfaces are quite dirt retentive and painting renders them less so. In country districts away from the coast, the asbestos surface is highly

retentive to air-born fungus spores. A paint schedule can often obviate this trouble. Apart from all of the foregoing, there is also the aesthetic decorative view-point.

Mr. Russell enquired if one could use red lead on weathered galvanised iron when rust is already formed on the iron.

Mr. Smedmor stated that under no circumstances should red lead priming paints be used on galvanised iron. Should red lead be used in this respect it is quite liable to promote corrosion rather than inhibit it. The correct procedure to adopt for work of this nature is to de-rust rusted areas by manual abrasion and pre-treat where necessary with a rust neutraliser or rust remover. The surfaces should then be primed with zinc chromate primer.

Mr. Barnes wished to know if metallic compound paints which change colour with changes of temperature would be of interest to engineers.

Mr. Hamilton said that paints showing colour changes at a fairly well defined temperature have been on the market for many years and have been used to coat bearings, journals and the like as a visual safeguard against excessive temperatures. It would not be possible to give further information without mentioning trade names.

Mr. Nickson asked the following questions:

What are the special features required in an oil resisting paint?

What would you recommend for an engine crankcase?

What preparation would you recommend?

Mr. Smedmor in reply stated that the special features required in an oil resisting paint are naturally that the dried film should be insoluble in mineral oils. The most suitable material to use for the interior surfaces of an engine crankcase would be a paint based on spirit or alcohol soluble gums. There is an air ministry specification covering this problem which is coded under the number DTD.400. The recommended preparation is to fully degrease the surfaces to be coated by solvent wash and apply the oil resistant finish direct to the metal.

Mr. Lax enquired what primer would be suitable to treat timber impregnated with mineral oil.

Mr. Smedmor answered that as with the former question, the only material to use on a surface of this nature would be a spirit based paint. If any conventional primer were used for this purpose the mineral oil would retard the drying of the primer medium. The surfaces in question should be well washed down with a solvent to remove as much as possible of mineral oil present on the surface and then painted with a spirit based enamel; road line paint being particularly suitable in this category.

Mr. Ashe suggested that as the various paint suppliers submitted different painting schemes for the various factory process liquids, the S.A. Sugar Technologists' Association might, in conjunction with the paint industry, draw up a standard scheme which could be universally adopted by the South African sugar industry.

Dr. Douwes Dekker pointed out that such a scheme had been published by the International Sugar Journal.

Mr. McKenna asked if there was a paint to resist boiling sugar juices.

Mr. Russell said that it was highly doubtful as to whether any finish at present available from the paint industry would give lasting life in this respect. Promising results have been obtained, however, with epoxy resin based paints but they are still in their experimental stages with regard to their use in this respect.

Mr. van Hengel wished to know if the finishes used on the bottom of ships would be of any use in a sugar plant to retard the growth of fungus.

Mr. Smedmor replied that the finishes used for the prevention of the growth of marine organisms on ships' bottoms, contain active poisons which are continually leaching out to the surface of the paint schedule and finishes of this nature would not be suitable for use in sugar factories. These anti-fouling paints require immersion in water within 24 hours of their application to ensure that the surfaces leach out and if left too long, or in other words, if the surface film is formed and hardened, many types do not function so efficiently. There are paints however, in

which are incorporated fungicides for the prevention of fungus growth.

Mr. Collins asked for advice on the correct varnishing procedure for timber.

Mr. Smedmor answered that to obtain optimum results from a varnish schedule, the first coat should be diluted up to 50 per cent with pure turpentine and brushed well into the timber surface. The second coat should be thinned up to 25 per cent and the last coat applied in its ready for use consistency. By adopting this procedure, the elasticity of the individual varnish coatings will vary from a hard non-elastic underlying coat progressively up to a fully flexible finishing coat. During the natural weathering of a correctly applied varnish schedule, the elasticity of each of the coats plays a most important part when thought is given to the fact that the top coat receives full weathering with subsequent embrittlement. If all coatings were of the same degree of elasticity, the breakdown of the varnish schedule would be far more rapid.

Dr. Dodds said that near the sea steel windows soon rusted, even when carefully rubbed down and primed before painting.

Mr. Smedmor stated that steel windows were usually shop-primed. One had to remove this to get down to the metal, then use a pre-treatment primer, no undercoat and two finishes.

Dr. Dodds enquired what could be used to prevent the rusting of chromium-plated motor car parts.

Mr. Hamilton said that the chromium-plating was porous and the only way to protect it was with a wax polish.