Paints and coatings

Introduction
For hundreds of years people have been finishing the internal and external walls of their buildings with various mixtures or fabrics to decorate, preserve or waterproof them. Very early on, kalsomine (made from powdered limestone) was used to paint interior walls and varnishes and shellac were developed to preserve and decorate timber.

Lacquers, made from resins, came from China originally and became very popular in late seventeenth and eighteenth century Europe for furniture and wall panels. In sixteenth century France, painted hessian was popular as an interior wall finish, later superseded by exotic materials such as brocades. Wallpaper, as we know it, did not become really popular until the middle of the nineteenth century when printing processes made available brightly coloured and patterned wallpapers at prices many people could afford.

These days many coatings and coverings are now made either entirely or partially from plastics.

Today we expect a surface coating or covering to contribute to or provide any or all of the following:

- decoration
- preservation
- waterproofing
- hygiene
- improved lighting
- safety

Surface finishes may only represent up to 5 per cent of the initial building cost but contribute greatly to the maintenance costs of the building. Selection of the correct system and adequate preparation of the surface is, therefore, important.
Paints

Composition

Broadly speaking, paint is a mixture of:
- the binder
- pigments
- additives and extenders
- the medium

Binder

The binder, as the name suggests, binds the other ingredients together, forming a solid, elastic film which must adhere to the surface, sometimes penetrating and sealing it as well. A paint is classified according to the type of binder.

Oil-based paints

These are based on oils which react with the oxygen in the atmosphere to solidify. Straight oil paints based on naturally drying oils, such as linseed oil, are rarely used today and have been largely supplanted by paints modified with synthetic binders called alkyds. These paints are often called enamels or alkyd enamels.

Water-based paints

These binders comprise small globules of resin which are suspended or dispersed as an emulsion in water. As the water evaporates, the globules coalesce to form a solid film. Paints based on this type of binder are commonly known as plastic or latex paints and the resins used include PVA, acrylic, polyurethane or combinations of these. They are often referred to as emulsion paints.

Solvent-based paints

These binders are dissolved in a solvent which evaporates leaving a solid film, such as lacquer and chlorinated rubber.

Chemically cured paints

These are usually two-pack paints and the binder forms as the two compounds are mixed together and react chemically. Once mixed, the paint must be applied within a few hours. Epoxy (epoxide) resin paints are examples.

Pigments

Pigments are used to make the paint opaque, to hide the background, and to provide the required colour. For instance, titanium dioxide is used for opacity and another compound such as iron oxide might be used to impart the colour.
Additives and extenders
Additives and extenders are included in varying quantities and have a great influence on the properties of the paint. The roles of additives and extenders tend to merge but basically they are as follows.

Additives might include fungicides and driers in oil and alkyd paints or dispersing and emulsifying agents in latex or plastic paints.

Extenders are used to achieve the required viscosity, body and surface appearance.

Medium
The medium can either be a solvent in which the binder is dissolved or a dispersing medium in which it is suspended. Examples of solvents include mineral turpentine or benzine derivatives. The dispersing medium most commonly used for plastic and latex paints is water.

Thinning and cleaning up depends on the nature of the dispersing medium. Oil-based paints require turpentine or white spirit whereas water-based paints can be thinned and cleaned up with water. Special solvents are required for other types of paints.

Paint systems
Most paint systems include the following:

- primer or sealer
- undercoat(s)
- finishing coat(s).

The choice of system depends on the nature of the surface to be painted and the finish required (see Figure 1).
Each component of the system performs a particular function but in some cases, as with plastic paints, a paint can perform more than one function. The type of coat selected must be compatible with the *substrate* (background) and with adjacent coats.

**Primer**

The primer can fulfil a number of functions including:

- providing a key to improve the adhesion of the next coat
- sealing porous surfaces which would otherwise absorb part of the next coat and spoil the finish
- minimising ‘bleeding’ of surfaces such as bitumen and timber.

Primers which etch the surface and inhibit corrosion are available for use on metals.

The material used as a primer will vary, depending on the type of base surface.

- *Aluminium* surfaces should be primed with a *zinc chromate* primer. Primers containing lead pigments should not be used for aluminium.
- *Copper* surfaces do not require special primers to prevent corrosion - the blue-green patina is formed during early exposure and acts as an inhibitor for further oxidation. However, if the copper surface is to be painted, conventional metal primers may be used, after the surface has been cleaned.
- *Galvanised metal* may be primed with any good metal primer if it is first treated with the acetic acid wash. Otherwise, a special galvanised-metal primer should be used.
- **Structural-steel** surfaces may require any one of a number of primers, depending on the type of exposure to which the surface will be subjected. **Oleoresinous primer** containing basic lead silicon, chromate, ferric oxide, titanium dioxide, dibasic lead phosphite or carbon black is used for either interior or exterior surfaces under normal exposure conditions. An **alkyd primer**, containing red lead should be used for exterior steel surfaces subject to severe exposure conditions, or for steel that is to be embedded in concrete. Steel which will be exposed to abnormal conditions, such as chemicals, condensation, or high humidity should be treated with a primer with hard-drying characteristics, such as an **epoxy metal primer** containing red lead.

- **Asphalt** and asphalt-coated surfaces require a primer which will prevent asphaltic materials from bleeding into top coats. **Shellacs** provide an adequate seal but produce a brittle film to which subsequent top coats may not adhere successfully. An alternative is to use a **ready-mixed aluminium** prime or a **latex emulsion sealer**.

- **Concrete** surfaces should be sealed against water penetration from below before they can be painted successfully. All concrete floors less than two-years old or floors which have been trowelled smooth with a steel trowel should be etched with acid before painting. A solution made up of one part concentrated **muriatic acid** and three parts water may be used. This type of treatment provides for better adhesion of paint and also neutralises the alkalinity of the surface. Following this, the prime coat should be an **alkali-resistant chlorinated rubber paint**.

- **Concrete-block** surfaces, dry and alkali-free, which are to be painted, require a **latex filler** type of primer. If the blocks show alkalinity, an **alkali-resistant primer** should be used.

- **Plaster and stucco** surfaces that are dry and non-alkaline may be primed with a **latex emulsion sealer** or an **oleoresinous primer sealer**. If the surfaces are slightly damp and known to be alkaline, a synthetic **alkali-resistant primer** is used.

- **Wood** surfaces require any one of the several different types of primer, depending on the type of wood and on the final finish to be applied. These include:
  - **alkyd enamel undercoat** for wood that is going to be finished with paint or enamel
  - the **appropriate stain** for a hard, close-grained wood to be stained
  - an **alkyd glass varnish** reduced 50 percent with mineral spirits for a natural or stained finish on soft, coarse-grained wood
  - a **natural-paint woodfiller** for a natural or stained finish on hard, open-grained wood (for example, oak or ash), if the wood is to be filled. If the wood is not to be filled, then the primer will be a **processed oil** such as boiled linseed oil or tung oil
- processed oil for wood floors with a natural or stained finish, if the wood is close-grained. If the wood is open grained, the primer will be a natural paint woodfiller
- a first coat of a polyester epoxy clear gloss finish for a natural finish with extreme durability on open- or close-grained wood
- an alkyd enamel reduced 25 percent with mineral spirits for an opaque enamelled finish on close- or open-grained wood.

- Brick and stone surfaces may require a clear surfacing material to prevent moisture penetration, preserve the original colour, or to facilitate future maintenance. In such a case, a clear silicone finish will normally be used.

Undercoats
Undercoats must cover the original colour of the surface and fill in any small depressions.

Finishing coats
Finishing coats provide the final colour and texture and offer the final protection against weather, chemical and mechanical damage. Finishing coats are available in gloss, semi-gloss or satin, flat or matt and in various textures.

- gloss is highly reflective, resistant to moisture and easy to clean but shows up surface irregularities
- semi-gloss is less reflective and shows fewer surface imperfections
- flat has low light-reflection, is usually permeable to moisture and tends to collect grime more easily.

Different types of paint
Alkyd paints
Alkyd paints are so called because of the synthetic alkyd resin used in the paint formulation. Alkyd resin is obtained by combining an alcohol and an acid. Alkyd paints are produced by combining a drying oil, such as linseed oil or dehydrated castor oil, with glycerine (the alcohol) and phthalic anhydride (the acid).

The glycerine neutralises the phthalic anhydride and the fatty acid in the oil. The ester molecules which form as a result of this neutralisation then polymerise to form the paint body.

Styrenated oils are also used sometimes to produce paints that possess fast-drying and excellent adhesion characteristics. Such a formulation also has fairly good alkali resistance. In these cases the regular drying oil is either emulsified with the styrene or dissolved in it.
Alkyd paints in general have mild alkali resistance but excellent water resistance. They also have the ability to produce lighter colours and retain colour better than paints with natural drying oils. Their speed of curing is at least equal to the curing of oil-based paints. Because of its excellent weathering ability, alkyd paint is particularly useful for porch and deck enamel and paints for other such exposed conditions. With modifications, it is used in making white baking enamel, such as is used on stoves and refrigerators. Non-yellowing white finishes are obtained using soybean and castor oil in the alkyd, but linseed oils give faster drying times and tougher films.

Alkyd resins are also used as modifiers in other types of paints. They usually produce greater permanence and better adhesion properties. They may be mixed with latex paints, up to 20 to 50 percent alkyls. Altogether some 50 types of alkyls are used in paint manufacture.

**Resin-emulsion paints**

Resin-emulsion, or latex, paints are those in which the vehicle is a synthetic-resin emulsion, usually, made from one of four basic resin types:

- butadiene-styrene
- polyvinyl acetate
- epoxy resin
- acrylic resin

The body of these paints is usually titanium dioxide or lithopone, and soybean proteins are added to the formulations, with butadiene-styrene and polyvinyl acetate added to increase consistency and stability.

Preservatives must then be added to prevent the proteins from allowing micro-organisms to form. Extenders such as china clay may also be used. Pigments are more restricted than for oil paints because the emulsion is alkaline in nature. Pigments usually used include titanium white, lithopone, cadmium yellow, cadmium red, talc, mica, silica, lampblack, and some hydrocarbon colours. The thinner is water, and to it must be added a dispersing agent to keep the pigment and other materials suspended in the emulsion. These emulsion-based paints tend to foam, so a defoaming agent, usually tributyl phosphate, is added. Finally, methyl cellulose is added to improve the flow qualities of the paint.

Polyvinyl acetate emulsion produces a much tougher skin than the butadiene-styrene types and so can be used as exterior as well as interior paint. Neither of these types of paint can be applied to a glossy surface, and, in addition, both must be protected from freezing. Acrylic- and epoxy-resin-emulsion paints require no oxidation to form a film and remain flexible after drying. They exhibit great resistance to weathering and no tendency to lose
their adhesive qualities or colour with age. They contain no protein and therefore are not subject to deterioration. However, they are more costly than other emulsion paints.

**Metallic paint**

Metallic paint consists of a metallic pigment and a vehicle. The pigment is very fine flakes of aluminium, copper, bronze, zinc, or tin. The pigment is suspended in a natural or synthetic varnish, a quick-drying lacquer, special bronzing lacquer or bituminous-based vehicles, depending on where the paint is to be used.

Spraying is the best method of applying metallic paints as it permits the spreading of a uniform film and encourages even depositing of the metallic flakes. Metallic paints are used for many decorative purposes, in particular it makes an excellent primer for exterior paints of other types.

**Luminescent paint**

Luminescent paint is made by adding fluorescent and phosphorescent pigments to any one of a number of drier-free vehicles, including alkyd marine varnish, spirit varnish, or quick-drying lacquers. Colour may also be incorporated into luminous paints.

Luminescent paints may be used in residential buildings to produce special effects. They are used in hospitals, schools, factories, hotels and other buildings because their unique quality helps provide maximum safety.

**Fire-retardant paint**

Fire-retardant paint does not make a building fireproof, but it does make it more difficult for a fire to spread. Some fire-retardant paints accomplish this by the fact that they have an inherent, slightly insulating effect; others by the fact that they are non-combustible. Another type releases a vapour, usually water or carbon dioxide, when heated and thus tend to smother the fire in the immediate area. These are called non-intumescent fire-retardant coatings.

Others, intumescent coatings, may have some of the same values as the non-intumescents but also have an added insulating effect. When a surface coated with an intumescent paint is exposed to heat or fire, it puffs up and forms a thick, insulating crust which greatly retards the penetration of heat to the coated surface. This crust is composed of tiny air cells which build up to a thickness of about 75 mm.

A variety of these paints are available, with a vinyl, alkyd, polyurethane, epoxy or solvent base. Both opaque and transparent products are manufactured in flat, semi-gloss, gloss, or satin finishes. They may be applied by brush, roller or spray over a variety of surfaces such as wood, paper, acoustic tile, concrete, stucco, plaster, conventional paint, enamel or
Varnish. Drying time to a dust-free condition will vary from thirty minutes to two hours, depending on the particular product.

The degree of fire retardancy resulting from the use of these paints depends on the thickness of the paint film applied, and care should be taken to follow the manufacturer’s directions when applying such a product. Coverage will vary from 3.5 to 12 square metres per litre, depending on the particular type of paint used and the kind of surface to which it is applied.

**Polyester-epoxy coatings**

The need for heavier-bodied paint materials, particularly for use on masonry and concrete walls, for greater protection under a variety of extreme conditions, and for greater versatility has led to the development of polyester-epoxy coatings which contain a much higher percentage of solids than conventional paints. The coating system consists of a high-solids vinyl filler material, to be applied directly over a concrete block or other masonry surface, and a high-solids, pigmented polyester-epoxy topcoat.

The filler material may be applied by brush, roller, or spray at a thickness which will give approximately 400 µm (microns) of dry film. The top coating, available in either semi-gloss or gloss finish in approximately ninety different colours, will add another 150 µm of dry film to the coating.

This coating system creates a tough, long-lasting finish which is highly resistant to water, grease, and many chemicals and which can be cleaned with harsh caustics. For this reason it is ideally suited to areas of heavy traffic such as schoolrooms, corridors, kitchens, cafeterias and laboratories.

A similar top-coating material is available for a clear finish, in either gloss or semi-gloss. It is to be used over previously painted surfaces or to preserve the natural appearance of wood, brick, or stone. One or two coats may be required, depending on the porosity of the base and the degree of gloss required.

Both filler and top coating require overnight drying time before applying a second coat and approximately two weeks for complete cure.

Another system consists of a two-component coats epoxy-resin product, which cures as a continuous film at room temperature. The film combines the characteristics of coal-tar pitch with the chemical resistance of epoxy resin, to provide good immersion and environmental resistance to both fresh and salt water. It is also highly resistant to many organic and inorganic acids, bases and salts, and to most petroleum products as well as to hydrogen sulphide liquors and sewage effluent. However, special equipment is required for application, and workers must be carefully protected against fumes, overspray or spills.
Another epoxy-based protective material consists of a two-coat system in which the base or primer coat contains a high ratio of metallic zinc to the resin binder. Properly applied to a sand-blasted steel surface, the coating deposits a film containing up to 93 percent metallic zinc by weight. The application of the clear top coat may be delayed up to three months to help complete stabilisation of the base. The resulting film provides protection for steel surfaces similar to that obtained by hot-dip galvanising.

Still another specialty coating is made, containing chlorinated rubber. It is applied as a three-coat system to produce a film about 200 µm in thickness. Such a paint is useful in conditions of high humidity, in cold storage plants, or to control corrosion in many industrial situations, such as pulp plants and sewage treatment plants. It is also useful as a vapour barrier on masonry surfaces. It should not be used in situations in which the coating will be in contact with animal or vegetable fats and oils. The recommended thinner for such a product is xylol, a derivative of benzine.

Varnishes

Varnishes constitute a group of more-or-less transparent liquids which are used to provide a protective surface coating in much the same way as paints do. At the same time they allow the original surface to show but add a lustrous and glossy finish to it.

All varnishes have basically the same components as paints, body, vehicle, thinner, and drier. However, varnishes may be divided into three groups, depending on the type of material used to form the body. These groups are:

- natural-resin varnishes
- modified natural-resin varnishes
- synthetic-resin varnishes

Natural-resin varnishes

The body of this group of varnishes is made from natural resins obtained from certain trees. Some of the resins are from living trees, while others are fossil resin. Among the resins used are Congo copals, kauri gum from New Zealand, boea resins from the East Indies, Philippine manila resin and Pontianak resin from Borneo. Some of these must be heat treated to produce an oil-soluble gum, while others are naturally soluble in oil. Resin, a by-product from the distillation of turpentine, is also used to make varnish.

The vehicle used in varnish is one of a number of drying oils, the same oils which are used in the manufacture of oil-based paints.
The resin is dissolved into the oil, and the mixture is heated to temperatures ranging from 260 to 315°C, depending on the amount of gloss required. Varnishes made from a combination of oil and natural resin are known as oleoresinous varnishes.

The best thinner for varnishes is turpentine, a distillate of gum from a group of pine trees. It evaporates slowly and gives varnish brushing and flowing qualities that no other solvent can give. It also aids oxidation of the drying oil by absorbing oxygen from the air and passing it on to the oil. Mineral spirits, benzene and naphtha are also used as thinners.

Driers used in varnishes are essentially the same those used in paints, namely organic salts of various metals. They speed the drying of varnishes by acting as a catalyst to the oxidation process.

Varnishes are often classified as long-oil, medium-oil, and short-oil varnishes, depending on the amount of oil used per unit of solid resin.

Long-oil varnish contains from 180 to 455 litres of oil per 45 kg of resin. The result is a varnish which will produce a tougher, more durable and elastic film but which takes longer to dry and produces only moderate gloss. Marine and spar varnishes belong to this group. Tung oil is the oil most commonly used in these varnishes, since it is particularly impervious to water.

Medium-oil varnishes contain from 55 to 182 litres of oil per 45 kg of resin. They dry faster and have a harder film than long-oil varnishes but are not as impervious to water. Floor varnishes belong to this group.

Short-oil varnishes contain from 23 to 55 litres of oil per 45 kg of resin. They dry quite rapidly and form a hard, brittle film which will not stand much rough usage. Rubbing and polishing varnishes belong to this group. They can be rubbed and polished to a high gloss or to a stain finish, depending on the finishing procedure.

Modified natural-resin varnishes
This group of varnishes is made with a natural resin which has been altered by chemical action. Common resin is heat treated with glycerin to form an ester gum, and this gum is used as the body for the varnish. Generally speaking, this type of varnish is less expensive than oleoresinous varnishes.

Synthetic-resin varnishes
Synthetic resins are those produced by the plastics industry and include nitrocellulose, phenolics, amino resins, alkyd resin, a number of vinyl resins, polyethylene, polystyrene, silicone, acrylic resins and epoxy resins. Some of these are thermoplastic, and some are thermosetting. Many varnishes made with plastic resins reach their greatest potential only when baked.
The vehicle for synthetic-resin varnishes is often the same type of drying oil used with oleoresinous varnishes. However, synthetic drying oils have been developed, and in baking varnishes, liquid alkyd resin may be the vehicle. Due to the great variety of resins used in synthetic varnishes, a wide range of solvents is required. Some are the same as those used in other varnishes. Coal-tar derivatives and high petroleum fractions are also used as solvents. Driers are the same as those used for other types of varnish.

Enamels
When pigment is added to a varnish, the result is an enamel. Any of the varnish types can be used, and the durability of the enamel depends to a large extent on the quality of the pigment. Since varnishes do not contain the opaque body material which paints do, enamels do not have high covering power, for best results they require an opaque undercoat. Baking enamels, made with synthetic resins, are used on most household appliances, curtainwall panels of various kinds, aluminium shingles and siding, and various interior and exterior trim materials.

Shellac
Shellac is the only liquid protective coating containing a resin of animal origin. The resin comes from the lac insect of India and Southeast Asia, and is deposited on the branches of trees.

The resin accumulations are collected, crushed, cleaned, and dissolved in alcohol to produce orange shellac, so called because of its colour. By bleaching the resin, pure white shellac is produced.

Various grades of shellac are made by varying the amount of resin dissolved in a unit of solvent. These grades are known cuts, a 1.8 kg cut has a shellac content of 480 grams/litre of lac resin.

The alcohol used is usually special alcohol. It consists of a mixture of 455 litres of ethyl alcohol and 23 litres of methyl alcohol.

Shellac dries quickly, is easy to apply, and produces a tough, elastic film on wood, metal, glass, cork and leather. However, it should not be used on work exposed to outside conditions except as a sealer over knots and sap streaks under exterior paint.

Shellac finds considerable use as a seal coat over stains and fillers and is sometimes used as a complete finishing material by itself. This latter treatment, known as French polish, consists of many layers of shellac applied one over the other, using a linseed-oil-soaked application cloth.
The main disadvantages of shellac are that it will discolour under strong sunlight, and water containing alkali causes it to soften and whiten. The surface must be dry before shellac is applied and water should never be used to polish shellac.

Lacquers

The material which we know today as lacquer is a comparatively new product made from synthetic materials to take the place of varnish for clear finishes. Most modern lacquer is based on nitrocellulose used in combination with natural or synthetic resins and plasticisers. These ingredients are dissolved in a mixture of volatile solvents which evaporate, leaving a film to form the protective coating.

While nitrocellulose alone will produce a clear film, it has poor adhesion, poor durability, and poor flexibility. As a result, natural or synthetic resins are added to nitrocellulose to improve adhesion and hardness and to give the lacquer gloss and film thickness. These resins include cellulose acetate, ethyl cellulose, alkyd resins, vinyl resins, epoxy resins, acrylic resins, polystyrenes, and many others.

Plasticisers counteract the tendency of resins to be brittle and allow lacquer to flow out on application. They also contribute to the body of the lacquer and its durability.

The solvents used are quite complex since no single solvent will dissolve all the lacquer ingredients. In many cases from six to ten solvents are blended to produce a material capable of dissolving all the ingredients present. These solvents are usually grouped according to their boiling point into low, medium, and high boilers. The boiling points of each of these is about 100°C, 127°C, and 177°C, respectively. The proper blending of solvents affects setting time, flow, gloss and freedom from bubbling in lacquers. The commonly used solvents include ethyl-, butyl-, isopropyl-, and amyl-acetate; acetone and diethylene glycol.

In addition to these ingredients, thinners are mixed with lacquer just before application. The purposes of this are to:

- reduce the consistency for spraying
- control the rate of drying
- reduce the cost of lacquer

They include a group of alcohols, ethyl, butyl, amyl, and isopropyl, and a number of hydrocarbon mixtures such as toluol, benzol, and xylol.

When another class of materials, pigments, are added to clear lacquer, the result is lacquer enamel, available in a wide range of colours.

Today a wide variety of clear and coloured lacquers are manufactured to meet a great many special purposes. These include:
• **clear gloss** lacquer, a clear lacquer that dries to a glossy finish in 1 to 4 hours that may be rubbed and polished with oil or water

• **clear flat** lacquer, similar to gloss lacquer except that it dries without gloss. It is often used to produce satin effects

• **tinting** lacquer, this is a concentrated coloured lacquer mixed with clear lacquer to produce lacquer enamel

• **brushing** lacquer, a slow-drying lacquer formulated specially for brush application

• **bronzing** lacquer, this is a clear lacquer into which are mixed metallic pigments to produce metallic effects

• **shading** lacquer, a slightly coloured lacquer used to produce wood-colour effects on furniture

• **water-white** lacquer, this is an exceptionally clear lacquer that produces a protective coating of greatest transparency over pale finishes

• **dipping** lacquer, this is designed for application by the dip-tank method and is available both clear and in colours.

### Stains

Stains are materials used to apply colour to wood surfaces. They are intended to impart colour without concealing or obscuring the grain and not to provide a protective coating. They may be used to accentuate the colour contrast of a wood grain, to even up colour differences or to imitate expensive wood colours on surfaces which lack desirable colour or grain. There are a number of types of wood stain available, based on the kind of solvent used to dissolve the colouring matter.

These are:

- water-soluble stains
- spirit-soluble stains
- penetrating oil stains
- non grain-raising stains
- pigment wiping stains

### Water stains

Water stains are synthetic dyes, many of which are coal-tar derivatives manufactured in powder form and in various strengths. They are dissolved in hot water at a specific rate in grams per litre (ounces per gallon), depending on the depth of colour required.

Water stain is easy to apply by brush, sponge, dipping or spray, it is non-fading, non-bleeding and it gives deep, even penetration. However, it has a tendency to raise the grain.
of wood, thus roughening the surface and necessitating careful sanding. Water stain will air-
dry in about twelve hours or may be force-dried in from two to four hours.

**Spirit stains**

Spirit stains are made from dyes which are soluble in alcohol and are manufactured both in
powder form and in ready-mixed liquid form.

This type of stain produces the brightest and strongest colours but is most susceptible to
fading. It also tends to bleed and to raise the grain of wood. Because they dry rapidly, spirit
stains are usually applied by spray. Because of their high penetration quality, they are often
used for refinishing, repair work, and for staining sap streaks. Drying time is usually from 15
minutes to two hours.

**Penetrating oil stains**

This type of stain is made by dissolving oil-soluble dyes in coal-tar solvents such as toluol,
benzol, or xylol and further thinning the vehicle with common petroleum solvents. Although
they are available in powder form, oil stains are usually produced as a ready-mixed liquid.

Stain is easy to apply by the sponge, spray or dip method, but the surface must be wiped
after application to remove excess stain. Oil stains have a tendency to bleed into finish
coats and are not as light-fast as water stains but have no tendency to raise the grain.
Drying time varies from one to 24 hours.

**Non-grain-raising stains**

This type of stain is made using light-fast dyes which are soluble in such substances as
glycols, alcohols and ketones. It is designed to produce all the advantages of the stains
previously mentioned with none of their disadvantages.

Non-grain-raising stains have moderate penetration, do not raise the grain of wood and dry
in from 15 minutes to three hours. They do not run or bleed and, because of their fast-drying
properties, are usually applied by spraying.

**Pigment wiping stains**

Stains of this type are made from translucent mineral pigments ground into a drying oil.
They are applied by brushing or swabbing the surface with a cotton cloth and are allowed to
set for various lengths of time after application.

They have good light resistance, no tendency to raise the grain, and good colour uniformity.
However, they lack the staining capacity of many other stains and, because they are not as
transparent as some others, tend to obscure the fine grain of the wood.
Fillers

Fillers are finishing materials which are used on wood surfaces, particularly those with open grain, to fill the pores and provide a perfectly smooth, uniform surface for varnish or lacquer. Filler is also used to impart colour to the wood pores and so emphasise the grain.

There are two general types of fillers:

- **paste fillers**, which are used on open-grained woods
- **liquid fillers**, for close-grained wood

Paste wood fillers consist of a base or body, pigment, non-volatile vehicle and thinner. The body is generally a translucent, inert material (such as silica, some silicates, and carbonates of calcium and magnesium). The body will fill the pores without staining the wood. Colour pigment is usually umber, sienna or similar colours which will give the filler the desired colour. Sometimes a small quantity of dye solution may be used. The vehicle is a vegetable oil or special varnish with japan driers. Thinners are similar to those used in varnishes.

Filler is applied by brush, by spray, or by dipping and must be thinned to the proper consistency for the method of application used. It is then wiped off, across the grain, before it sets on the surface. Liquid filler is generally a varnish with a small amount of body material added. It is used on medium, close-grained woods in essentially the same way as paste filler but has much less filling capacity.
Choosing a paint system

The nature of the substrate

The substrate is the surface which is to be painted.

Alkalinity, porosity and loose particles on the surface to be painted can affect the adhesion and durability of a paint system.

Materials such as concrete, cement render, mortar and solid plaster contain small amounts of alkaline materials (mainly from the lime) and some paints, such as the alkyd enamels, are susceptible to alkali attack, which causes breakdown of the film. The gloss and semi-gloss enamels are more susceptible than the flat enamels and must be separated from the substrate by an alkali sealer.

Gloss and semi-gloss alkyd enamels are also adversely affected by porous surfaces which absorb the medium and binder unequally. The use of a suitable undercoat will prevent unequal absorption of the finishing coats. Plastic or latex paints are not affected by porous surfaces because the globules of resin are not absorbed but sit on the surface.

Loose surface material can reduce adhesion. Enamel paints tend to penetrate the loose material and bind it together but plastic or latex paints just tend to sit on the surface. For this reason, loose material should be removed with a brush or scraper before painting with a plastic or latex paint. If the surface is particularly loose, treatment with a 15 per cent solution of phosphoric acid may be required.

Recommended paint system

In addition to consideration of the nature of the substrate, the choice of a paint system ultimately depends upon:

- the performance specification
- whether you require a fully impervious surface or a porous surface finish which can breathe
- whether you require a high wear, abrasion resistant surface
- whether the surface is to be washable
- whether the surface is inside or exposed to weather and pollution.

Special paints

A variety of paints for special purposes are available, including the following:
- water-resistant paints
- chemical-resistant paints
- fire-retardant paints
- heat-resistant paints
- fungus-resistant paints
- anti-condensation paints
- luminous paints
- fluorescent paints
- phosphorescent paints
- radioactive paints

- low-odour paints
- quick-drying paints
- stoving paints
- insecticidal paints
- permeable paints
- floor paints
- multi-colour paints
- textured paints
- metallic paints

As with all paint systems, it is best to seek the advice of the manufacturer for special requirements and, having selected a manufacturer, it is wise to choose your entire system from your chosen brand to avoid incompatibility between coats.

**Applying the paint**

On site, paint can be applied by:

**brush** which provides the best adhesion, desirable in priming coats, but skill is required to avoid brush marks.

**roller** which is much quicker but provides a slightly stippled surface finish; edges must be finished with a brush.

**spray**
- equipment is expensive but can be economical on very large areas
- can be used to achieve metallic and graded effects
- the only suitable method for quick-drying paints; the hot spray process reduces the viscosity of a paint without the addition of a solvent.

In the factory, paint can be applied by:

- dipping smooth—this is rapid and economical, producing a very smooth finish
- flow coating—paint is hosed onto the surface
- roller coating (by machine)—used for continuous lengths.
Preparation of surfaces

One of the most common causes of breakdown of painted surfaces is inadequate preparation of the substrate. Sometimes brushing is adequate but in other cases dirt must be removed by washing and scraping, using suitable solvents for oils and stains.

Previously painted surfaces might simply require priming, filling and rubbing down but where a perfect surface is required paint can be removed by burning off and scraping, using solvent and chemical removers or by steam stripping. Water-soluble paints, such as tempera, must be removed before painting as they prevent the formation of a key.

When to paint

Generally speaking, it is best not to paint in wet, damp or foggy weather or below 4°C, in direct sunlight or in dusty conditions. Humid conditions delay drying of ordinary paints.

Each coat should be thoroughly dry before the next is applied.

Good ventilation is required to assist drying and sometimes to remove noxious fumes.
Clear finishes

Clear finishes are used to enhance the natural appearance of the substrate and in many cases waterproof and protect it as well. They may or may not include some colour pigment and, depending upon the type of compound, may be available in gloss, semi-gloss or matt finishes.

In general, clear finishes lack sufficient pigment to filter out damaging ultraviolet light and are therefore much less durable than paints in exposed conditions. Consequently, the choice is limited for external conditions.

Interior clear finishes have been formulated specially to suit the substrate. We will deal with them according to the nature of the substrate.

Clear finishes for internal timber

The clear finishes currently available include the following:

- Oil seal: a type of varnish, used to achieve a water and grease resistant, non-slip finish for floors.
- Wax polishes: based on natural waxes, such as beeswax, they can be used as complete system or to maintain other finishes. They are relatively soft and more inclined to collect dirt than other finishes; they discolour when wet and will be stained by ink or heat but are less likely to show scratches and easily are repaired.
- Polymer-based emulsions: based on PVA, acrylic and polyethylene resins; they are easy to apply and maintain.
- French polish: based on applications of shellac and linseed oil in successive treatments, requiring great skill for a good finish. They are considered to be the most beautiful finish for internal timber but are extremely expensive and easily marked by water, heat and solvents.
- Cellulose lacquer: based on nitro-cellulose and a plasticiser and showing a similar appearance to French polish but less expensive and easier to apply. It is more resistant to water but eventually cracks and must be completely removed before renewing. Nitro-cellulose is extremely flammable and appropriate precautions should be taken regarding storage and use.
- Short-oil varnishes: have a low oil and high resin content, producing a high gloss but reduced flexibility. They are easy to apply with a brush but they dry slowly, collect dust and crack.
- Spirit varnishes: made with resins, such as shellac, they dry quickly by the evaporation of the solvent. They are cheap but brittle and inclined to crack.
- Synthetic resin finishes: made from plastics, such as phenol formaldehyde resins, urea formaldehydes, polyurethane and epoxides. They are available in one-pack or...
two-pack forms. They are relatively expensive but are very popular because of their ease of application by brush or spraying. They are rapid drying and are extremely hard and flexible, water and chemical resistant and heat resistant. Repairs are difficult because they cannot be removed by normal solvents.

When choosing a clear finish for a timber surface it is important to define your requirements carefully, taking into account the nature of the timber. For instance, the clear finish chosen may actually be harder than the timber substrate and breakdown of the finish has often occurred because an impact has caused denting of the timber below, not the finish itself. The result is a loss of bond between the substrate and the finish. Thus, softer timbers should be finished with the more flexible finishes.

**Preparation of internal timber surfaces**

As with painted surfaces, a good finish can only be obtained with adequate preparation of the substrate. In general, the surface must be clean, firm and dry but additional preparation might include:

- sanding
- stopping or filling

**Clear finishes for external timber**

Clear finishes which will help to preserve the natural appearance of timber in exposed conditions include the following:

- **Preservatives:** These help protect the sapwood and heartwood or timber from attack by fungi and discolouration by moulds.
- **Water repellents:** These are a mixture of linseed oil, paraffin wax and a fungicide, applied by brushing or dipping, especially to end grain. They help preserve the appearance of the timber by reducing surface cracking due to wetting and drying
- **Stains:** Water-resistant stains can provide a degree of ultraviolet filtration change the colour of the timber and revive bleached timber.
- **Varnishes:** The only suitable varnishes for exterior use are long-oil marine and exterior varnishes but these require frequent recoating—less than four coats will be unlikely to last more than a year. While intact, varnishes seal the timber against water but it is desirable to apply a preservative as well.
Sheet coverings

As briefly mentioned at the beginning of the unit, sheet coverings such as wallpapers and fabrics have been used to decorate wall and ceiling surfaces for hundreds of years.

Wallpapers and textiles are still the easiest way to obtain large areas of highly patterned or textured wall surface and in addition can contribute to acoustic modification of the space.

Light-fastness varies and few are suitable in areas receiving strong sunlight.

Types of sheet coverings

Sheet coverings used frequently include the following:

- **Wallpapers**: These can be machine-made or hand-made—the latter being more expensive, with denser colours but some imperfections.
  - **Wood veneer**: This can be mounted on paper, cloth or metal foil backings and is often coated with transparent vinyl.
  - **Textiles**: A wide variety of textiles is available, such as hessian, silk and synthetic fibres, which can be used unbacked in folds or stretched taut on frames or backed with paper, foamed plastic or PVA.
  - **Grass cloth**: This consists of bamboos or grasses held together with thread and mounted on backings.
  - **Carpet**: Stapled to vertical surfaces, carpets can provide a durable, soft finish with excellent sound modification characteristics.
Galvanising

Galvanising is the process of coating steel and iron with zinc to form a protective coating. The steel is lowered into a molten bath of zinc heated to approximately 500°C and emerges with a shiny coating of zinc. The zinc coating acts as a ‘sacrificial’ anode and corrodes to protect the steel. Since its rate of corrosion is slow, the steel can remain protected for hundreds of years, depending on the environment.

Zincalume®

Zincalume® is a newer protective coating and is a combination of zinc and aluminium (45% and 55% respectively), which is applied in a factory process to sheet steel used for roofing and cladding in the building industry.

Powder coating

- One of the most durable protective coatings for steel is provided by applying a polyester powder coating over hot dip galvanized steel to provide a high grade architectural finish to steel items.

- Polyester powders are thermosetting resins that are applied electrostatically to the steel surface and stoved at temperatures around 180°C. This technology produces very uniform coatings that have an attractive architectural finish with excellent atmospheric weathering characteristics. In combination with hot dip galvanized coatings, the powder coated product ensures maximum durability for steel components, which will generally provide 50 year+ rust free life spans in most architectural applications.

More information is available from the web site of the Industrial Galvanizers Corporation.