JOURNAL

OF THE

OIL AND COLOUR CHEMISTS' ASSOCIATION

Vol. 53 No. 3 March 1970

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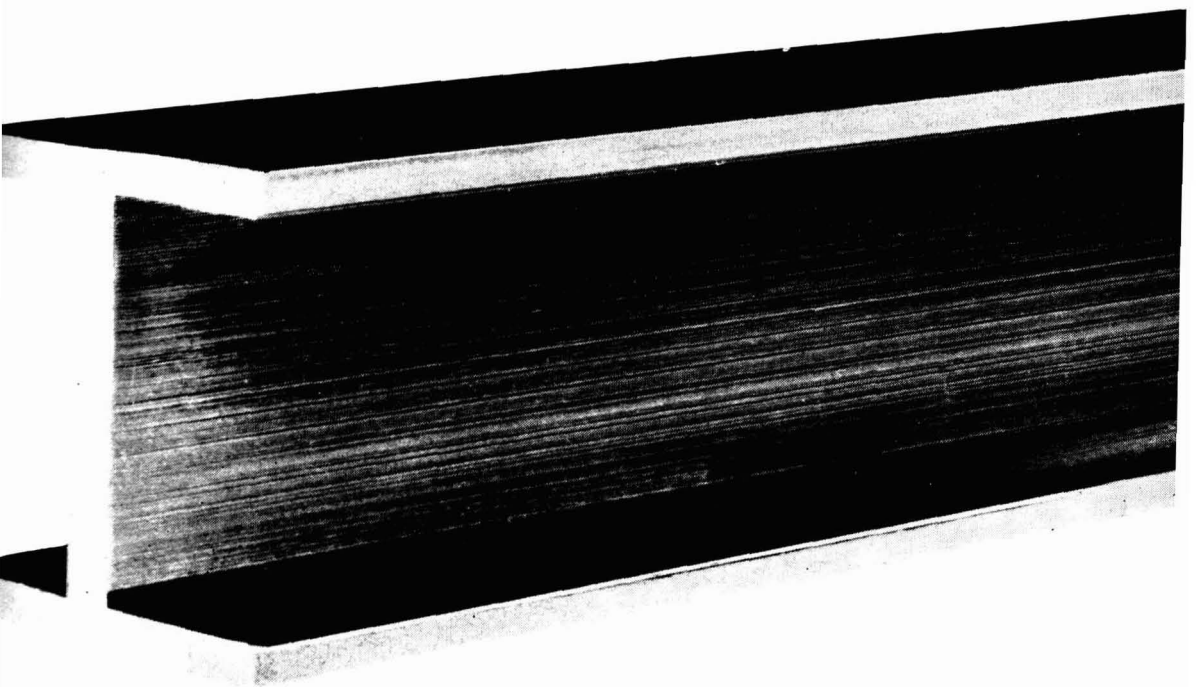

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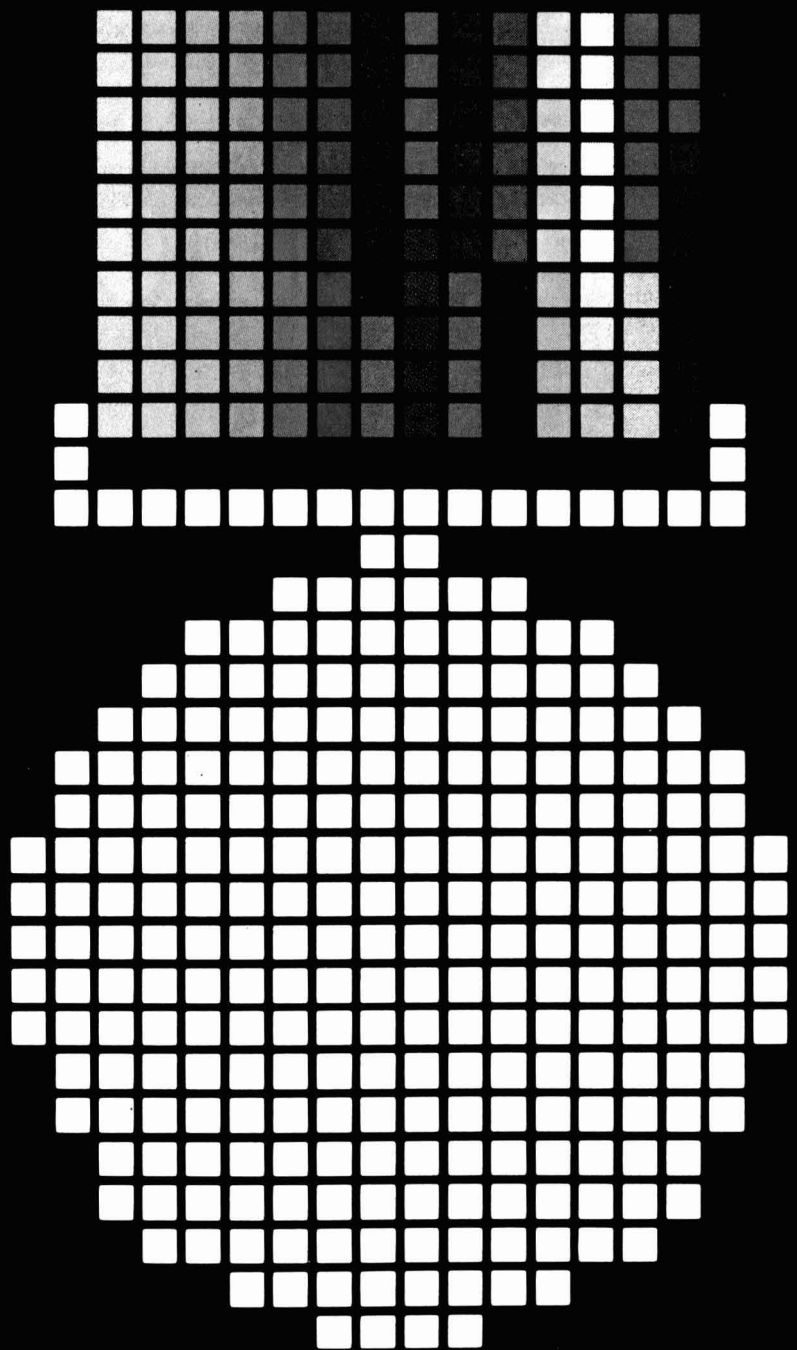

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JOURNAL OF THE OIL & COLOUR CHEMISTS' ASSOCIATION

Vol. 53 No. 3 **March 1970**

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JOURNAL of the OIL AND COLOUR CHEMISTS' ASSOCIATION

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Published by

OIL AND COLOUR CHEMISTS' ASSOCIATION
Wax Chandlers' Hall, Gresham Street, London EC2

J. Oil Col. Chem. Assoc. 1970, 53, 181-191

Transactions and Communications

Phenomena associated with metal-paint coating interfaces

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Summary

As a result of observations made during studies of ships' bottom paints, several hypotheses are suggested to explain phenomena observed. One of these is the concept of a concentration of water at the steel/coating interface; this has been called the "water rich layer". It is suggested that this layer adversely affects the adhesion of the coatings and provides a relatively conductive path for ionic current between anodic and cathodic areas. This concept is also applied to the explanation of the corrosion of coated steel exposed to atmosphere. Hypotheses are presented to explain the inhibitive effect of aluminium and some other metallic pigments on the adhesion-destroying reactions which affect some coatings on steel protected cathodically in sea water.

Key words

Types and classes of coating
primer
ship bottom paint
vinyl coating

Prime pigments and dyes
aluminium pigment
red lead pigment

Process and methods primarily associated with service or utility
corrosion

Phenomènes associés avec les interfaces métal-peinture

Résumé

On propose de diverses hypothèses pour expliquer les phenomènes observés lors des études sur quelques peintures pour carènes de navires. Une de ces hypothèses comprend le concept d'une certaine concentration de l'eau à l'interface acier-revêtement, que l'on appelle la Couche Riche en Eau. On suggère que cette couche exerce une influence adverse sur l'adhèrence des revêtements, et qu'elle fournit, pour le courant ionique, un trajet assez conducteur entre les zones anodiques et les zones cathodiques. On applique également ce concept à l'explication de la corrosion, pendant l'exposition à l'atmosphère, de l'acier revêtu de peinture. On présente des hypothèses pour expliquer l'effet inhibitif de l'aluminium et d'autres pigments mètalliques sur les réactions qui détruisent l'adhèrence de certains revêtements sur l'acier, protégé cathodiquement, pendant l'immersion en eau de mer.

In Verbindung nit Metall-Anstrichfilm Grenzflächen Stehende Phänomena

Zusammenfassung

Als Ergebnis von Beobachtungen beim Studium von Schiffsbodenfarben werden verschiedene Hypothesen vorgebracht, um die beobachteten Phänomena zu erklären. Davon ist eine die Vorstellung von einer Konzentration von Wasser unter der Stahl-Anstrich Grenzfläche; dies ist die "Wasserreiche Schicht" genannt worden. Es wird nahe gelegt, dass diese Schicht die Haftung der Farben nachträglich beeinflusst und einen verhältnismässig gut leitenden Pfad für jonischen Strom zwischen anodischen und kathodischen Stellen liefert. Dieselbe Vorstellung wird auch auf die Erklärung der Korrosion gestrichenen und der Atmosphäre

ausgesetzten Stahles übertragen. Hypothesen, um die inhibierende Wirkung von Aluminium- und einiger anderer metallischer Pigmente auf die Haftung zerstörenden Reaktionen, denen manche Anstrichmittel auf kathodisch geschütztem Stahl in Seewasser zum Opfer fallen, zu erklären, werden vorgetragen.

Явления связанные с поверхностями раздела красочных покрытий на металле

Резюме

В результате наблюдений при изучении красок предназначаемых для днищ судов, предлагается ряд гипотез для выяснения наблюдаемых явлений. Одной из этих гипотез является понятие о концентрации воды на поверхности раздела между сталью и слоем краски, на так называемом «водно-насыщенном» слое. Полагается что этот слой оказывает неблагоприятное влияние на адгезию покрытий и вызывает участок сравнительной проводимости для ионного тока между анодными и катодными областями. Это понятие также применяется в качестве объяснения коррозии покрытой стали подверженной действию атмосферы. Предлагаются гипотезы объясняющие ингибирующее влияние алюминия и некоторых других металлических пигментов на противоадгезионные реакции, которые оказывают влияние на некоторые покрытия для катодно-защищенной стали в морской воде.

Introduction

For some years studies have been carried out on marine coatings at the Defence Research Establishment Pacific* (DREP), which provides scientific advice to the Canadian Armed Forces. In this programme, ships' bottom coatings have been given the greatest priority.

An evaluation procedure has been developed[1] which is in continuous use at this laboratory. Since Canadian Naval vessels are protected cathodically, a test for coatings on cathodically protected steel is incorporated into the procedure. The equipment used for the evaluation procedure has made it possible to conduct experiments, with frequent observations, on a variety of coatings on cathodically protected and unprotected steel in natural sea water.

From these experiments, and the work of others, hypotheses have been suggested, some of which are presented below.

Loss of adhesion with cathodic protection

The tendency for some paint coatings to lose adhesion near a bare area on cathodically protected steel immersed in sea water has been described elsewhere[2]. A strongly alkaline condition develops at the steel-coating interface where adhesion has been lost.

The reaction taking place at a cathodic steel surface at a potential sufficiently negative for hydrogen evolution is:

$$2H_2O + 2e \longrightarrow H_2 + 2OH^- \quad \text{.....(1)}$$

The destruction of the adhesion of coatings near bare areas on steel cathodically protected at potentials negative enough for hydrogen evolution is considerably greater than that of similar coatings on steel at less negative potentials. Reaction (1) may be initially operative only at bare areas and at underfilm areas immediately adjacent to them. As the distance along the

*Formerly known as the Pacific Naval Laboratory.

substrate away from the bare areas increases, the voltage drop due to resistance will reduce the potential between coating and steel until it is no longer in the range required for hydrogen evolution.

If the potential is not sufficiently negative for hydrogen evolution, oxygen is required and the following reactions are applicable:

$$2H_2O \longrightarrow 2H^+ + 2OH^- \quad \text{.....(2)}$$

$$2H^+ + 2e \longrightarrow 2H \text{ (monatomic hydrogen)} \quad \text{.....(3)}$$

$$2H + \tfrac{1}{2}O_2 \longrightarrow H_2O \quad \text{.....(4)}$$

The overall reaction is:

$$H_2O + \tfrac{1}{2}O_2 + 2e \longrightarrow 2OH^- \quad \text{.....(5)}$$

If water, oxygen and electrons are supplied to an area of steel/coating interface at a potential in the range of reaction (5), hydroxyl ions will be produced there at the same rate as that of the reactant having the lowest rate of supply when all rates are expressed in equivalents per unit time. If the rate of alkali production is changed, it will be because the limiting rate of supply has been changed. The effect of a bare area must be to increase the rate of supply of one or more of the reactants, since it accelerates alkali production at the adjacent coated interfacial area. This implies the lateral transmission through the film to the area of one or more of the reactants. Paints generally have much lower diffusion rates for ions than they do for water or oxygen, and it is assumed that, at least initially, the ion diffusion rate is the controlling factor. To increase significantly the hydroxyl production at the steel/coating interface adjacent to a bare area, there would have to be a considerable increase in the exchange of ionic current between the area and the sea water environment over what would occur with an unflawed coating. The resistance of the film to the ionic current may be reduced with time as adhesion is lost until current supply is no longer the controlling factor. The lateral supply of oxygen and water may also increase with loss of adhesion.

This argument assumes that the alkali is generated at the steel/coating interface by reaction (5) only, and does not diffuse laterally from a site of production at the bare area. Experimental evidence for this is shown below.

Two mild steel panels, 3in $\times$ 4in were grit-blasted and a coat of wash primer applied. Small circular pieces of universal pH paper were fixed at scattered positions on the face of the panel, which was scored with a standard X-cut after four unpigmented vinyl topcoats had been applied.

One of these panels was immersed in a beaker of sea water made alkaline by the addition of sodium hydroxide (pH $>$ 14). In 29 days, there was no indication that alkali had penetrated from the scratch. A band of rust blisters had developed around the score, and a spot on a piece of pH paper near one of these indicated acid.

The other panel was protected cathodically at -0.9 volt (*vs* Ag/AgCl) in a sea water electrolyte maintained at a pH $<$ 1 with hydrochloric acid. The catholyte was separated by a cotton bridge from the anolyte, which was an aqueous solution about 1 N in sodium hydroxide.

After 3 days it was noted that a piece of pH paper close to the bare area indicated acid adjacent to the score, but strong alkali at points further removed. There was a similar situation with two pH indicators having paper fibres which penetrated the coating. Points on the indicators close to the fibre indicated strong acid; at a greater distance strong alkali was indicated.

The water rich layer

Ions do not usually readily migrate directly through paint coatings, whether they are immersed or not. Why should the resistance to lateral ion migration through the film be so low relatively, with these cathodically protected panels, that there is a considerably larger ionic current along this much longer path than the one directly through the film? If most of the ionic current went directly through the film, it would be expected that the effect would develop at all areas and gradually intensify, rather than starting adjacent to a bare area and spreading out from there as it does. Any modification in the resistance of the affected coating is likely to involve the distribution of water. Good, dry, paint coatings have a low dielectric constant, and ionic materials have little tendency to ionise in them.

It is suggested that water will tend to concentrate in the paint coating near a hydrophilic steel/coating interface in a "water-rich layer" (WRL). Ionic materials can ionise in this layer. If the ionic substances remain in solution the resistance of the WRL will be considerably reduced. Sea water cations, such as Na^+, migrating through the WRL to cathodic steel would tend to remain in solution in the WRL and lower its resistance. Such cations will be hydrated, and will carry more water into the layer. If the adhesion is destroyed, oxygen may also diffuse along the interface.

Mayne has proposed that water may not always be distributed homogeneously in a paint film, but tends to concentrate around ionogenic sites in the polymer[3]. He supported this view with the evidence of phase-contrast microscope photographs. The author suggests that the water would also concentrate in water-rich envelopes around hydrophilic pigments, as well as at the hydrophilic metal substrate.

Since first making this suggestion the author has noted from the literature that others have arrived at a similar conclusion. Gay[4] wrote that his experimental data indicated that water passes through paint films on steel by osmotic or electroendosmotic processes and builds up at the interface between primer and steel. Michaels[5] stated that "the hydrophilic nature of the particle surfaces renders them capable of adsorbing significant quantities of water: if the particles are very small, their water-adsorptive capacity may exceed by a wide margin the water-absorption of the matrix resin in which they are imbedded". Kumins[6] concluded that: "Ion transport across these films may involve the initial passage of water vapour and oxygen which concentrate at the metal-film interface". Funke, Zorll and Murthy[7] have also concluded that water may concentrate at both the pigment/coating and steel/coating interfaces.

It may be useful to review the other evidence that led to this conclusion.

Unprotected panels coated with a nitrocellulose lacquer and scored with an X-cut were also strongly alkaline under the film and had lost adhesion

near the score after a period of sea water immersion. In this case, it may be assumed that the underfilm area is cathodic to corroding bare steel at the scratch.

It is difficult to measure the current passing along the WRL as compared to that which goes directly to bare steel at the scratch on a scored, cathodically protected, panel. However, the cathodic current to such a panel often increases to double or more in 100 days, whereas the cathodic current to a bare steel panel decreases during this period. If the excess current passes along the WRL, this portion of the cathodic current will generally be in the order of 10 μamp in the case of the red lead or aluminium vinyl ships' bottom systems investigated.

Sometimes severe pitting is experienced at a scratch when an unprotected panel is immersed in sea water or ammonium chloride solution. The only cathodic area other than that on bare steel at the scratch is under the film, yet the extent of corrosion makes it seem unlikely that all the cathodic areas in such cases would be on the very small areas of exposed steel. Also, some types of coats will be accompanied by considerably more severe pitting than others under these conditions. Nitrocellulose coated panels are subject to this pitting, and these readily form an alkaline underfilm area near a scratch.

According to Bullett and Rudram[8], all the liquid in a blister, in many cases, could not have passed directly through the blister cap but must have migrated laterally under the film from some distance around. It has frequently been observed that blistering of vinyl coatings is much more prevalent near a bare area. It is suggested that some of the blister solution migrated along the WRL. Hydrated cations moving towards a cathodic blister site would contribute to the blister solution, which has invariably been strongly alkaline on the bottoms of the ships investigated.

When scored panels with an unpigmented alkyd coating were immersed in ammonium chloride solution with and without cathodic protection, two layers developed in the film. There was an adherent lower layer with a yellow colour, and an uncoloured upper layer with good cohesive strength. There was a loss of adhesion between the two layers, which were fairly easily separated. IR spectra of the two layers showed them to be similar with minor differences. It is known that ammonia will cause yellowing of alkyd films. If ammonia caused the yellowing it may have been present in the layer near the substrate after having migrated as NH_4^+ along the WRL.

A panel coated with wash primer and then with a scored, unpigmented vinyl coating was exposed for 129 days to a 100 per cent RH atmosphere which was contaminated with ammonia. At the end of this period, adhesion was reduced to a very low value. The colour of the wash primer became grey (similar to the colour observed on scored, cathodically protected panels immersed in sea water). Drops of a green solution were observed at the cut at the end of the first week of exposure. A blister filled with a bright green solution had developed.

In this case, the alkali may have aggravated the loss of adhesion and helped to cause the very low adhesion observed. The adhesion was considerably greater on similar panels exposed to 100 per cent RH without ammonia contamination.

The most likely cause of the green colour is Cr^{3+} which has been produced by reduction of the Cr^{6+} present in the zinc tetroxy-chromate pigment of the wash primer. The solution would have to leach out along a layer near the interface to get to the cut.

Funke[9], in a paper dealing mainly with the pigment/coating interface, made the remark: "Earlier investigations with unpigmented films showed that the amount of water absorbed by the supported film was in no case less than by the corresponding free film. Moreover, supported films frequently absorbed considerably more water than free ones and tended to blister formation after prolonged immersion. It could be stated that, generally, an increased water absorption of supported films indicated loss of adhesion to the substrate, and finally resulted in blister formation or even film detachment. In other words, a comparison between the water absorption of free and supported films enables one to judge whether the interaction between the film and substrate is strong enough to resist the penetration of water into the interface."

Walker[10] has shown that, on exposure of coatings on stainless steel to an atmosphere of high relative humidity, adhesion was reduced below the initial value. He measured initial adhesion values of various coatings on stainless steel and also the adhesion of these coatings after intervals of exposure under controlled humidity. With all types, there was a reduction of adhesion at relative humidities greater than 90 per cent. At 100 per cent RH the adhesion was, in almost all cases, reduced to less than half the initial value and in some cases to less than 20 per cent. The drop of adhesion, as a percentage, during exposure, varied considerably with various types of coatings. The initial adhesion values were not generally a good indicator of the adhesion after exposure to a humid atmosphere. The loss of adhesion seemed to have been caused by entry of water into the film, with the initial adhesion having no obvious relationship to the adhesion when exposed to a humid atmosphere. This loss of adhesion could be explained by a concentration of water adjacent to the substrate.

This evidence suggests a water concentration near the substrate with a consequent loss of adhesion which will be more severe if the water rich layer is alkaline. The effect of the alkali may be to increase the water concentration by osmotic effects.

As has been explained elsewhere[2], unpigmented vinyl coatings will tend to lose adhesion near a bare area when protected cathodically if the electrolyte is an aqueous solution of the chloride of sodium, potassium or ammonium. They will retain it under similar circumstances with the chloride of calcium or magnesium, or with hydrochloric acid. It is suggested that the alkali and ammonium cations tend to remain in solution in the WRL and to lower its electrical resistance. They promote cathodic reactions on coated steel adjacent to bare areas, with the consequent production of alkali and loss of adhesion. The hydroxides of calcium and magnesium are less soluble and tend to precipitate in the WRL. Moreover, dissolved carbon dioxide may convert them to the still less soluble carbonates. With the hydrochloric acid electrolyte, the resultant water would not have much effect on the resistance of the WRL.

The effects of metallic pigments in inhibiting loss of adhesion

The effect of aluminium pigment in inhibiting loss of adhesion on cathodically protected steel has been previously discussed[1,2]. The standard Canadian Naval bottom system has consisted of wash primer applied to grit-blasted steel, followed by a red lead pigmented vinyl primer and then a cuprous oxide pigmented vinyl antifouling paint. This system is subject to adhesion loss with cathodic protection. It is being replaced by one in which an aluminium pigmented vinyl primer replaces the red lead primer. The latter system has given very successful performance on our Naval vessels.

If the effect of the aluminium pigment is to increase the transmission of alkali through the film, a lower concentration of adhesion-destroying alkali will remain at the interface. The possibility of a water concentration around hydrophilic pigments has been mentioned. This may occur around the aluminium pigment particles.

Near a bare area on cathodically protected steel the aluminium pigment is converted to a hydrated aluminium oxide and the proposed reaction is:

$$2Al + 6H_2O \longrightarrow Al_2O_3.3H_2O + 3H_2 \quad \text{.....(6)}$$

There is no alkali consumption in this reaction. It is likely, though, that hydroxyl is temporarily combined as the aluminate. The following intermediate reactions are suggested:

$$2Al \longrightarrow 2Al^{+++} + 6e \quad \text{.....(7)}$$

$$6H_2O \longrightarrow 6H^+ + 6OH^- \quad \text{.....(8)}$$

$$6H^+ + 6e \longrightarrow 3H_2 \quad \text{.....(9)}$$

$$2Al^{+++} + 8OH^- \longrightarrow 2Al(OH)_4^- \quad \text{.....(10)}$$

$$2Al(OH)_4^- \longrightarrow Al_2O_3.3H_2O + 2OH^- \quad \text{.....(11)}$$

Reaction (6) is the resultant of these reactions.

The result of reaction (10) would be a strong affinity of hydroxyl for aluminium. The solution of aluminium may result in a high concentration of water around the pigment particles because of osmosis effects. The water rich envelopes around pigment particles may overlap so that there is a relatively low resistance path for hydroxyl ion through the film to the sea water environment. The hydroxyl ion does not remain concentrated at the substrate but is transmitted through the film. Since hydroxyl ion originates in water at the substrate there may also be a dehydrating effect.

There may be an additional factor involved if reaction (5) is in operation. When alkali dissolves the oxide coating from aluminium pigment particles, the exposed metallic aluminium is very reactive to diffusing oxygen. The oxygen which reacts with aluminium does not reach the substrate to generate hydroxyl ions by reaction (5). The rate of production of hydroxyl ion is lowered, and that which is produced is transmitted through the film. Some hydroxyl ions must be produced at the substrate to dissolve enough of the oxide coating for oxygen scavenging to take place.

It has been confirmed with steel panels protected cathodically at −1.2 volt (*vs* Ag/AgCl) and scored with a standard X-cut that alkali is transmitted through an aluminium vinyl film at a greater rate than through a similar red lead vinyl film. The vinyl system consisted of two coats of either aluminium vinyl or red lead vinyl over wash primer. Pieces of universal pH paper were laid down over these layers, followed by a vinyl topcoat which was the vinyl antifouling paint without pigment. A gradually increasing band of discolouration developed around the scratch in each case, but this was better defined with the aluminium vinyl. Shortly after the boundary of discolouration on the aluminium vinyl panels became tangential to a piece of pH paper, the whole piece indicated strong alkali (Fig. 1). The alkaline blue colour developed more slowly with the red lead vinyl, and only after the pH paper was surrounded by the area of discolouration was there any indication of a lower pH than with aluminium vinyl (Fig. 2).

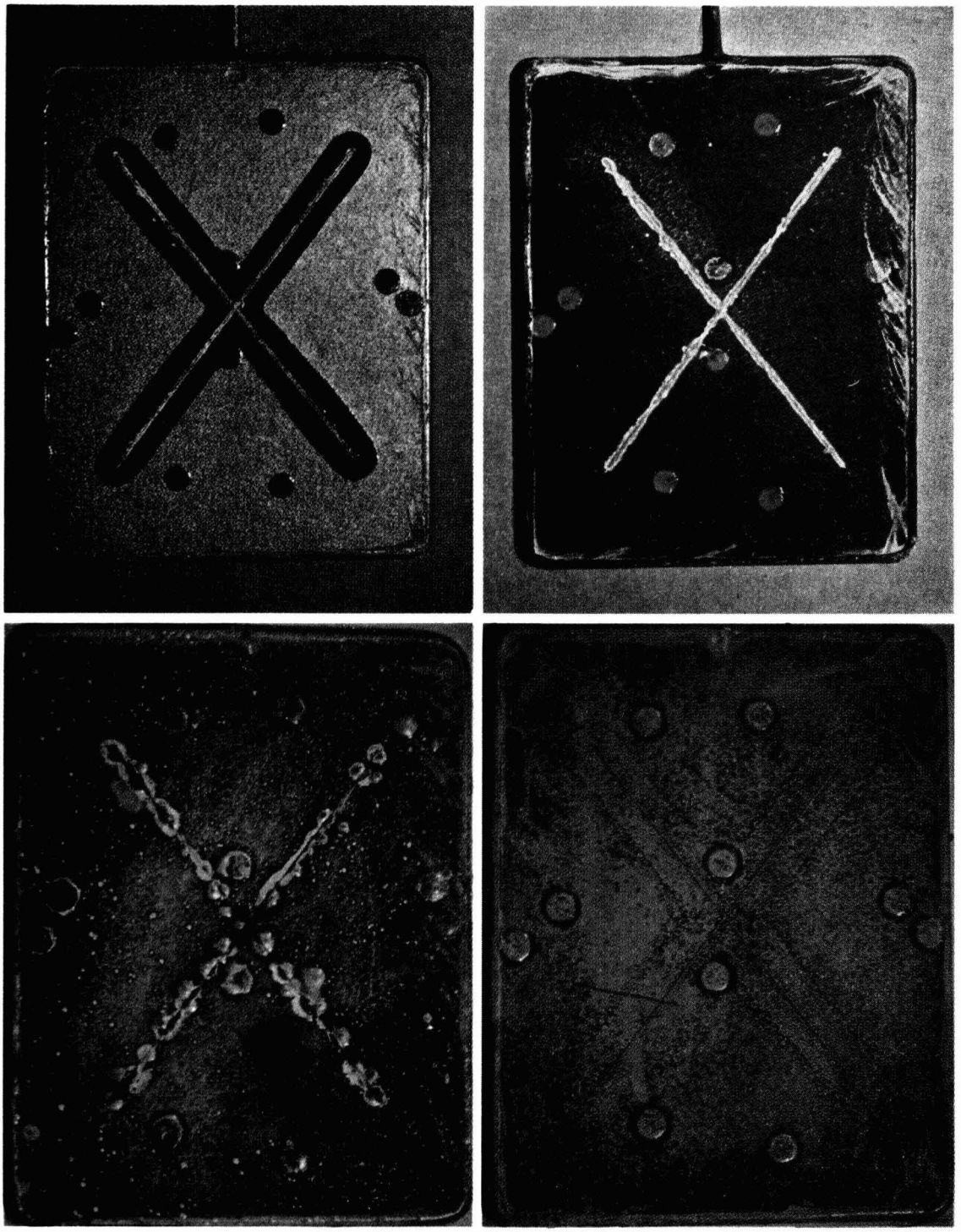
Similar panels were immersed at −1.0 volt. The alkaline colour was slow in developing with the red lead vinyl; no indication of alkali was observed on the aluminium vinyl panels. The lower alkalinity, in the case of aluminium vinyl, could be explained by a lower rate of production of hydroxyl ion due to oxygen scavenging by the aluminium pigment (Figs. 3 and 4).

At potentials more negative than −1.1 volt (i.e. in the hydrogen evolution range, where alkali is produced which must diffuse through the aluminium vinyl coating), it might be expected that there would be an upper limit of thickness at which coatings would resist adhesion loss. The diffusion rate would decrease as thickness increased and, if sufficiently thick, an alkaline condition would again develop near the substrate. It was found that, with 25mil of aluminium vinyl on panels protected cathodically at −1.2 volt and −2.0 volt, adhesion was lost from $\frac{1}{4}$ to $\frac{3}{8}$in from the scratch in three months, and there was extensive blistering in this area. The blisters were dry, indicating that they may have been caused by hydrogen gas. When cut near the scratch, gas and liquid oozed from the film. The liquid was strongly alkaline.

Vinyl primers pigmented with stainless steel and zinc have also resisted adhesion loss with cathodic protection at −1.0 volt. It is suspected that the stainless steel pigment had become electrically connected to steel and that enough particles were in contact to give the layer appreciable electrical conductivity. This was confirmed by resistance measurements between points on the surface of the layer of stainless steel pigmented vinyl primer. If this had occurred, oxygen would be consumed by reaction (5) at the pigment particles. Although alkali would be produced there, less oxygen would be available at the substrate for production of adhesion-destroying alkali. A similar mechanism might explain the performance of the zinc pigmented primer.

Figs. 1 to 4. Transmission of alkali

1. (top left) Aluminium vinyl, cathodic protection −1.2v (*vs* Ag/AgCl)
2. (top right) Red lead vinyl, cathodic protection −1.2v (*vs* Ag/AgCl)
3. (bottom left) Red lead vinyl, cathodic protection −1.0v (*vs* Ag/AgCl)
4. (bottom right) Aluminium vinyl, cathodic protection −1.0v (*vs* Ag/AgCl) None detected



Figs. 1 to 4. (see opposite)

In this case, oxygen scavenging by a direct reaction of oxygen with the zinc may also occur.

Effect of the water rich layer during atmospheric exposure

Before underfilm corrosion occurs there must be a concentration of water in the film at the steel/coating interface. If the rate of the corrosion reactions is controlled by electrical resistance, the effect of dissolved substances in the WRL will be important. If there is little in solution, or if the dissolved substances are inhibitive, the corrosion rate will be low. But if corrosion accelerators, such as chlorides, sulphates, or sulphites, are in solution, the corrosion rate may be much greater.

Since the contaminants may have to diffuse through the paint film as ions, the permeability of the film to ion diffusion and hence the electrical resistance, will be a factor in the performance of the paint system. It may be, though, that some atmospheric contaminants, such as ammonia or sulphur dioxide, may penetrate the film in the molecular form and ionise in the WRL. The sulphur dioxide may be converted to the sulphate ion and in this form become locked in the WRL.

Harrison[11] has described an atmospheric exposure test using five-foot lengths of six-inch channel girder section, deliberately selected as being as near as possible to the completely millscaled state. These sections are rusted outdoors for six months and wire brushed using a rotary wire brush. Two coats of primer are applied to the rear and two coats of primer and one finishing coat to the front or weather-face. Experience has substantiated a statement made in 1962, to the effect that this girder test is the most reliable accelerated test extant when using the north facing primer coats as a means of prediction. He reports that, when carried out carefully, the onset of breakdown of the primer coat in months when applied in one coat is, by and large, the performance of the system (two coats primer, one coat finish) in years. He now uses two coats of primer rather than the original single coat to eliminate null tests due to over-brushing by applicators of one coat of primer.

To explain this phenomenon, it is suggested that a given primer influences the results not only by its thickness which determines its effectiveness as a barrier to contaminants of the WRL, but also by its inhibitive properties, which are independent of thickness. The barrier effect of the complete paint system delays the onset of corrosion, but the effectiveness of the system is also determined by inhibitors from the primer which become dissolved in the WRL. If corrosion begins when enough corrosion accelerators have become dissolved in the WRL to counteract the effect of the inhibitors, it will be delayed by a system having low permeability to atmospheric contaminants. A system of the same permeability but with less inhibitive properties would be subject to under-rusting at an earlier time.

In addition to diffusion through a paint film, there are two other ways in which impurities may get into the WRL. They may have been on the surface when coatings were applied, or they may have migrated from a flaw or bare area along the WRL.

If corrosion accelerators were present on the surface at the time of paint application, the life of the coating would probably be considerably reduced.

Rust in industrial atmospheres, for example, has been shown to become contaminated with ferrous sulphate and to affect paint coatings adversely.

Ionic contaminants which migrate underfilm from a bare area are likely to be alkali or ammonium cations, since the coated area tends to be cathodic to a bare area. The alkali cations are probable in a marine environment. Harrison and Tickle[12] have pointed out that "the ammonia content of the atmosphere is always positive and is the most consistent measure of atmosphere pollution in a given locality, not only on a national basis, but on a worldwide scale, irrespective of environment, be it industrial or rural." Ammonia, then, seems to be a probable contaminant at any location. If the interfacial area is cathodic it will inhibit the entry of anionic accelerators, such as chloride or sulphate.

[*Received 4 September 1969*

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J. Oil Col. Chem. Assoc. 1970, 53, 192-197

Curing of coal tar/epoxy paint in relation to adhesion of subsequently applied coal tar/epoxy paint

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Summary

An investigation into the intercoat adhesion of a coal tar/epoxy system, intended for application to outer bottoms of ships fitted with cathodic protection, is described.

The investigation confirms that one month's weathering between successive coats of coal tar/epoxy paint produces an intercoat adhesion failure between the weathered and subsequently applied film. This weakness is only partially restored by wiping the weathered film with methyl *iso*butyl ketone before applying the next coat of coal tar/epoxy.

Key words

Types and classes of coating
coal tar/epoxy coating

Properties, characteristics and conditions primarily associated with dried or cured films
intercoat adhesion

L'effet de l'état de durcissement d'une peinture à base de goudron de huile/époxyde sur l'adhérence de la couche suivante de peinture goudron de huile/époxyde

Résumé

On décrit une étude sur l'adhérence entre les couches d'un système goudron de huile/époxyde destiné à être appliqué aux carènes extérieures de navires munies de protection cathodique.

L'étude démontre qu'après une période de vieillissement d'un mois entre l'application des couches successives de peinture à base de goudron de huile/epoxyde, il y a un manque d'adhérence entre le feuil vieilli et le suivant. Ce défaut ne se redresse qu'en partie lorsqu'on nettoie le feuil vieilli à l'aide de méthylbutylcétone avant de l'application de la prochaine couche de peinture goudron de huile/époxyde.

Der Einfluss des Härtungsgrades von Kohlenteer/Epoxyfarbe auf Nachfolgenden Anstrich von Kohlenteer/Epoxyfarbe

Zusammenfassung

Beschreibung einer Prüfung der Haftung von Filn zu Film in einem Kohlenteer/Epoxysystem, das für den Aussenauftrag auf Schiffsböden, die kathodisch geschützt sind, bestimmt ist.

Die Untersuchung bestätigt, dass die einen Monat lange Bewitterung vor dem nächstfolgenden Anstrich mit Kohlenteer/Epoxyfarbe Haftungsstörungen an der Grenzfläche zwischen dem bewitterten und dem darüber aufgebrachten Film verursacht. Diese Schwächung wird nur teilweise durch Überwischen mit Methylisobutylketon vor dem Aufbringen des folgenden Kohlemteer/Epoxyfilms wiedergutgemacht.

*Chairman, Prediction of Performance Sub-Committee, Joint Services Research and Development Boards Standing Committee on Paints and Varnishes.

Сушка каменноугольно-смольных эпоксидных красок в связи с адгезией последующей прилагаемой каменноугольно-смольной эпоксидной краски

Резюме

Описывается исследование межслойной адгезии каменноугольно-смольной эпоксидной системы, предназначенной для применения на наружных днищах судов снабженных катодной защитой.

Исследование подтверждает что один месяц выветривания, между последующими слоями каменноугольно-смольной эпоксидной краски, вызывает межслойное разрушение адгезии между выветренной и последующей приложенной пленками. Этот недостаток только частично устраняется путем обтирания выветренного слоя метилизобутилкетоном, до применения последующего слоя каменноугольно-смольной эпоксиды.

Introduction

Coal tar/epoxy paint is specified by the Navy Department for the protection of outer bottoms of ships fitted with cathodic protection (impressed current).

The painting process comprises brush application of three coats of coal tar/epoxy paint (0.003-0.004in per coat) with an interval of 1-3 days between each coat. This process is normally followed after an interval of 7 days by two coats of anti-fouling composition 161P.

Conditions in shipyards may arise when it is not possible to adhere to the recommended painting schedule. During winter months, with temperatures below 10°C, the curing of coal tar/epoxy paint is retarded, and longer intervals between coats must be allowed. Situations may also arise when more prolonged periods of weathering elapse between the application of successive coatings.

A proprietary paint, amine adduct cured and based on a coal tar pitch, was used. The epoxy resin content was approximately 45 per cent on the cured medium.

A short programme of tests was carried out to investigate factors prevailing when such abnormal intervals of conditioning between coats applied. The investigation covered the following points.

Would premature intercoat adhesion failure result when the interval between coatings was grossly exceeded?

Would intercoat adhesion be improved by wiping weathered coal tar/epoxy films with methyl *iso*-butyl ketone before applying subsequent coats?

The work was carried out by the Central Dockyard Laboratory and the Paint Research Station, under the auspices of the Prediction of Performance Sub-Committee of the Joint Services Research and Development Boards Standing Committee on Paints and Varnishes, of which the author is chairman.

Experimental

Preparation of test panels

Twelve 6in × 4in mild steel 18 BG panels were prepared by each laboratory as follows, after grit-blasting.

Three panels coated with three coats of coal tar/epoxy paint with 24 hours' air-drying between coats.

Three panels coated as above with an interval of 7 days between coats.

Three panels coated with two coats of coal tar/epoxy paint with 24 hours between each coat, weathered for one month at the laboratory exposure site (Portsmouth or Teddington) and one further coat of coal tar/epoxy applied.

Three panels prepared and weathered as above but wiped with methyl *iso*-butyl ketone before applying the third coat of coal tar/epoxy paint.

Exposure

From each of the above four series:

panel A was retained as control

panel B was immersed in sea water for three months

panel C was maintained in sea water under cathodic protection (−0.85 volts relative to Ag/AgCl reference electrode) for three months. The method is described in the Appendix.

Adhesion testing

Four discs of 1.25in diameter were punched from each panel and tested by the sandwich modification of the direct pull-off technique[1] in the Hounsfield Tensometer. Central Dockyard Laboratory used Eastman Kodak 910 adhesive and carried out the adhesion test one hour after gluing. Paint Research Station used two-pack Araldite adhesive MY750/HY951 and carried out the test 48 hours after gluing at 25°C.

Table

Panel treatment	Control "A"						Thre		
	CDL			PRS			CDL		
	Bond strength psi	Mean psi	Site of failure	Bond strength psi	Mean psi	Site of failure	Bond strength psi	Mea psi	
24 hour interval between coats	1900 1800 1600 1720	1755	adhesion 2/3 coats	2128 2037 1451 1991	1905	mainly cohesion of paint or glue	910 860 890 810	867	
Seven day interval between coats	2810 2710 2580 2660	2690	cohesion 3rd coat	2260 1966 1571 2108	1976	mainly cohesion of paint or glue	910 810 1010 1160	974	
One month's weathering between second and third coat	1190 1320 1240 1370	1280	mainly adhesion 2/3 coats	1327 1206 1236 1074	1211	mainly adhesion 2/3 coats	380 450 340 360	377	
One month's weathering between second and third coat. MIBK. Wash before recoating	1160 1260 1270 1240	1232	mainly adhesion 2/3 coats	1743 1535 1687 1611	1647	mainly adhesion 2/3 coats	500 530 500 460	497	

Results

Results of tests are given in Table 1, "blank" tests correspond to specimens which collapsed before pulling in the Tensometer.

From these tests, the deductions shown below were made.

There was only a slight increase in bond strength of the film with a 7 day interval between coats over the system applied with 24 hours between coats.

The films weathered before the last coat of coal tar/epoxy was applied showed poor intercoat adhesion, even in the use of the control panels.

Wiping the weathered film with methyl *iso*-butyl ketone improved the intercoat adhesion, but did not restore it to the quality of that obtained in the unweathered systems.

Immersion in seawater for 3 months reduced the bond strength of the unweathered systems. Adhesion of the final coat to the weathered film was very seriously reduced.

The films immersed under cathodic protection showed slightly more deterioration than those immersed without cathodic protection.

The higher numerical values obtained by the Paint Research Station in comparison with Central Dockyard Laboratory values after immersion tests, represent the degree of recovery of the film with drying between 1 hour and 48 hours after removal of the panel from immersion in seawater.

Results

onths sea water immersion "B"				Three months seawater immersion under cathodic protection "C"					
	PRS			CDL			PRS		
Site of failure	Bond strength psi	Mean psi	Site of failure	Bond strength psi	Mean psi	Site of failure	Bond strength psi	Mean psi	Site of failure
mixed cohesion/ adhesion 2/3 coats	998 962 — 2118	1358	mainly cohesion of 3rd coat	760 1060 780 710	827	cohesion/ adhesion 2/3 coats	1206 1049 1160 1216	1160	glue line failure
mixed cohesion/ adhesion 2/3 coats	897 2204 1267 1702	1520	mainly cohesion of 3rd coat	1040 940 1040 1010	1007	cohesion/ adhesion 2/3 coats	1038 1246 1145 1099	1135	glue line failure
mainly adhesion 2/3 coats	268 658 — 587	506	mainly adhesion 2/3 coats	280 250 280 250	265	mainly adhesion 2/3 coats	253 207 — 162	207	mainly adhesion 2/3 coats
mainly adhesion 2/3 coats	968 260 537 1049	937	mainly adhesion 2/3 coats	360 500 560 560	492	mainly adhesion 2/3 coats	689 760 542 932	729	mainly adhesion 2/3 coats

Conclusion

The intercoat adhesion of coal tar/epoxy paint is severely affected by weathering between coats. Wiping the weathered film with methyl *iso*-butyl ketone improves the intercoat adhesion but does not restore it to the level of adhesion obtained with systems applied at intervals of 24 hours or 7 days between coatings.

[*Received 10 November 1969*

Reference

1. Paper submitted by the Joint Services R and D Committee *JOCCA*, 1963, **46**, 267.

Appendix

Method of test for immersion under cathodic protection conditions

Test panels

These consisted of 15cm × 10cm mild steel panels to the upper edge of which was attached a length of insulated copper wire. The connection was made by soft soldering, and care was taken to seal the joint area thoroughly with a coating of a solvent-free epoxy resin.

This work was completed before preparing and painting.

Apparatus

Glass tank, fitted with a suitable overflow device, to allow the provision of a continuous supply of seawater during the test.

Platinum anode.

Voltmeter, 1v DC fsd with a sensitivity of at least 20,000 ohms/volt.

Reference electrode—silver/silver chloride.

Potentiometer, about 5,000 ohms.

Voltage supply—A 12v car battery.

The electrical circuit was as shown.

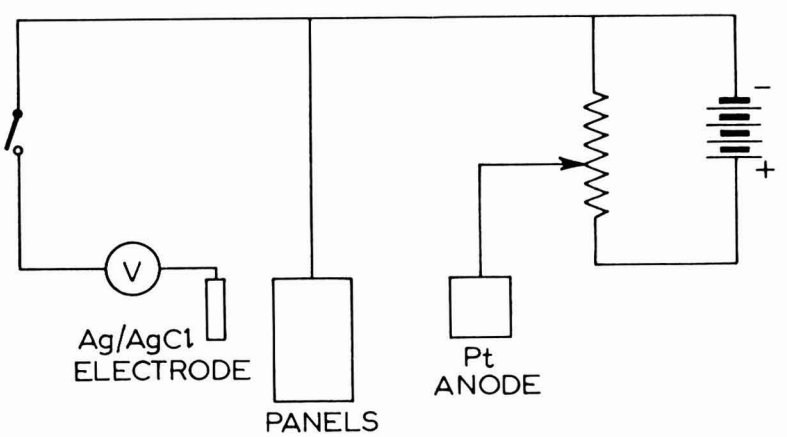

Fig. 1. Electrical circuit

Procedure

The test panels were connected in parallel, and arranged around the sides of the tank, so that the test surfaces faced toward the centrally situated anode. The reference electrode was situated close to one of the panels. The potentiometer was adjusted to maintain the panels at a potential, relative to the Ag/AgCl electrode, of —0.85v.

During the immersion period, daily checks of potential were carried out, the potentiometer being adjusted as necessary. To avoid drawing excessive current from the reference electrode, the measuring circuit switch was closed only while a reading was being taken.

A constant supply of seawater was maintained to the tank, at such a rate as to provide about one complete change of water in 24 hours.

The water in the tank was continuously aerated.

J. Oil Col. Chem. Assoc. 1970, **53**, 198-208

The application of advanced management techniques with particular reference to the surface coating industry*

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Summary

The paper deals, first, with management in general terms, explaining what is meant by principles, techniques, policies and objectives in firms. Reference is made to the measurements necessary for management control and the date required for decision-making in different circumstances.

Some aspects of management in different categories of firms and the manner in which problems may be tackled are then described. The application of various practical management techniques in small firms is demonstrated by case studies involving such problems as long-term financial planning, cash flow, management organisation and training, forecasting and wage structures. Examples are given of overcoming resistance to change and the use of the computer for management controls within a small unit.

The paper concludes by briefly alluding to future developments in management techniques and principles and with a final reference to the fact that unless industrial managers are trained more extensively in the advanced techniques of management, the application of such techniques, even by knowledgeable specialists, such as consultants, will continue to be severely handicapped.

Key words

Miscellaneous
management

L'application des techniques avancées d'administration à l'égard particulier de l'industrie de peintures

Résumé

Au début cet exposé se traite, en termes généraux, du sujet d'administration industrielle, et explique au point de vue des entreprises la signification des principes, techniques, plans et buts. On fait référence aux mesures nécessaires pour assurer le contrôle administratif et aussi aux données qu'exige la mise au jour des décisions en de divers circonstances.

Ensuite on décrit quelques aspects de l'administration en ce qui concerne de différentes catégories d'entreprise, et également, en quelle manière on peut attaquer leurs problèmes. On démontre l'application de diverses techniques pratiques d'administration à l'égard de petites entreprises au moyens des études sur certains problèmes tels que, le planning financier à long terme, le "cash flow" (la somme totale des bénéfices et de la dépréciation prévues pour l'année sociale), l'organisation et la formation des cadres administratifs, les prévoyances d'avance, et le tableau salaire. On donne des exemples pour démontrer les moyens de surmonter la résistance aux innovations, et l'emploi d'un ordinateur dans une petite entreprise pour le contrôle administratif.

Pour terminer on mentionne brièvement des développements éventuels dans le domaine des techniques et principes d'administration, et enfin on souligne le fait qu'à moins que la formation des administrateurs industriels ne deviennent plus extensive au point de vue des techniques avancées de l'administration, l'application de telles techniques, même par des spécialistes capables tels que consultants, restera-t-elle gravement embarrasser.

*Presented at the Midlands Section Symposium, 23 October 1969

Der Einsatz von Fortschrittlichen Geschäftsführungstechniken unter Besonderer Berücksichtigung der Anstrichmittelindustrie

Zusammenfassung

Der Vortrag behandelt in eerster Linie Management ganz allgemein und macht klar, was man unter Prinzipien, Techniken, der Politik und den Zielen einer Firma versteht. Auf die unter verschiedenen Umständen zwecks Kontrolle und Erzielung erforderlicher Daten, zu fassenden Entschlüsse wird Bezug genommen.

Alsdann werden einige Gesichtspunkte des Managements in verschiedene Kategorien von Firmen, sowie die Art, in welcher Probleme angefasst werden können, beschrieben. Die Anwendung verschiedener Management Techniken in kleinen Firmen wird an Hand prakischer Beispiele demonstriert. Dabei werden Probleme, wie finanzielles Planen auf lange Sicht, Flüssigkeit, Management Organisation und Training, Voraussagen und Lohnstrukturen behandelt. Es werden Beispiele dafür gegeben, wie Widerstände gegen Änderungen überwunden, und Managementkontrollen innerhalb einer kleinen Einheit unter Einsatz des Komputers ausgeübt werden können.

Gegen Ende des Vortrages wird kurz auf künftige Entwicklungen in Managementtechniken und -Prinzipien angespielt. Schliesslich wird betont, dass, wenn Leiter der Industrie nicht umfassender in den fortgeschrittenen Techniken des Managements trainiert würden, der Einsatz solcher Techniken selbst seitens kenntnisreicher, z.B. als Berater tätiger Spezialisten, auch weiterhin ernstlich gehandikappt sein würde.

Применение прогрессивных технических приемов управления в частности по отношению к производству поверхностных покрытий

Резюме

Статья рассматривает в первую очередь вопрос управления в общих чертах, объясняя что подразумевается под принципами, технологией, политикой и объектами в фирмах. Статья ссылается на измерения, необходимые для контроля управления и данные, необходимые для принятия решений в различных обстоятельствах и условиях.

Затем описываются некоторые аспекты управления в фирмах различных категорий и метод решения возникающих задач.

Иллюстрируются методы применения различных практических технологических приемов, в более мелких фирмах, путем изучения индивидуальных случаев, включающих такие задачи как долгосрочное финансовое планирование, денежный оборот, организация управления и тренировка, прогноз и структура заработной платы. Прилагаются примеры преодоления сопротивления против перемен и применение вычислительных машин для контрольного управления в пределах небольшой фирмы или учреждения.

Статья ссылается кратко на будущее развитие и тенденции в технических приемах и принципах управления и в заключение обращает внимание на тот факт, что если промышленные управляющие не будут получать более широкую тренировку и обучение в области прогрессивной техники управления, то применение этой техники, даже в руках хорошо осведомленных специалистов, как например консультантов, будет продолжать подвергаться серьезным недостаткам и оставаться в невыгодном положении.

Introduction

As this Symposium is the first major attempt by the Oil and Colour Chemists' Association to deal with management problems, it is probably inappropriate to deal in detail with advanced techniques of management. Instead, an attempt will be made to develop an interest in some of the current problems with which managements of firms may be faced.

In the paper, consideration is given to:

the nature and structure of the surface coatings industry;

some of the operational problems facing managements; objectives, policies, the execution of those policies and decision-making;

some of the principles which, if followed, will solve those problems and hence develop better management practice;

some of the management techniques which may be used in applying the principles enumerated;

examples of applications of management techniques in small firms.

The paper does not refer to technical matters or those concerned with the management of research and development.

Clarification of terms—what management is about

A principle: is a fundamental generalisation—it is not concerned either with details or with a particular case or application. It should be applied in all firms at all times and in all environments.

Management techniques: are used to apply a principle, and the choice of the techniques to be used is dependent upon the kinds of decision that the firm is going to make.

One should be wary and avoid following slavishly those techniques which are currently "fashionable" and appear to have been given much publicity. Such, well publicised, techniques are, however, often helpful, provided they are used appropriately.

Management decisions: are concerned with an evaluation of possible alternative courses of action. The kinds of decisions made in a firm are influenced by its policies regarding the risks involved in making those decisions, because there is uncertainty in its evaluation. The level of risk can be reduced by:

using more sophisticated techniques, this implying provision of an increased range of data or;

providing similar data more frequently.

In either case, the costs of obtaining information to be used in making decisions will be higher than otherwise, but the benefits obtainable through better decision-making are usually considerably greater than the costs involved in obtaining the additional data.

The significance of applying a given technique in a firm must be assessed by comparing the merits of that technique with the merits of others applied in that firm. This assessment can be made by comparing the differences between the probable costs of applying each technique and the probable benefits likely to accrue through using that technique in the firm.

Policies: are governed by the *Objectives* of the firm, both in the long and short term, hence clarity of these objectives is of paramount importance. A firm's objectives may, however, vary from time to time and, sometimes, the short-term objectives may not appear to complement those of the long-term. In such a situation, therefore, careful decision-making is required, after evaluation of the risks and potential benefits which could result from alternative actions taken.

Policies may refer to many different levels of the business, although sometimes they are stated in general terms only. This gives different levels of management flexibility in cushioning and overcoming short-term problems.

When formulating policies for a firm, one must take cognisance of many different parameters which contribute to a corporate plan. This involves identifying centres or sections within the business which one individual can control and for which he can account. The responsibility for the success of these different sections is delegated to individual managers. The act of delegation promotes the need for an organisation which identifies responsibilities and facilitates good communication. Provided the policies have been properly formulated in accordance with objectives, they will be useful guidelines within which the managers will be able to operate to attain their objectives and the objectives of the enterprise.

Some aspects of operational management in different categories of firms

Many successful firms were started by a man who was technically competent. Since then, personnel have been added gradually and, in firms whose products are dependent upon technical or scientific backing, the additional staff recruited have often been from those same technical fields. In time, such firms become top-heavy in technical expertise and often lack management expertise. The surface coatings industry is one which ranges from the production of raw materials to the sale of products formed from the blending of these materials. Many of the firms in the industry now owe allegiance to one or another of the larger groups, but the size of the individual, specialised unit within such groups is, often, still relatively small.

Management based on observation in the small firm generally gives way to management based on the use of recorded facts in the larger firm. Selection, generation and processing of the appropriate facts must be provided for as a firm expands, but it is considered that there is no difference in principle in managing businesses of different sizes or different industries.

Operationally, in the small business, one executive makes all the decisions normally delegated to several separate functional executives in the large business and he also makes the decisions involving co-ordination of the functions. He uses his knowledge of the business as a whole to evaluate the factors which he thinks have a bearing on the decisions he is required to make. He has the sole responsibility for formulating major policies, but will also have to resolve some of the day to day co-ordination problems at various levels in the organisation.

On the other hand, in a large company, the chief executive should be required to make only those decisions involving co-ordination of the delegated responsibilities. He will contribute to the formulation of policy but not solely be responsible for it as he would be in the small firm.

Within groups of firms, it appears that the co-ordination problems are similar, but of different scale. It is expected that co-ordination will be achieved using precise methods, based on the availability of factual information, in order that results may be compared with the original plan. Group boards would expect the individual executives to take the best action themselves in order to correct anything going wrong. The meetings with those executives would be used to pronounce the policy and to receive retrospective reports.

In relation to management controls, the operational difference between group organisations and single firms may be illustrated in terms of time span

of control. The reporting may be monthly or three-monthly to a group board whereas within a single firm, the managing director may be in daily contact with other members of the board, some of whom may also be executives who report to him.

Although the larger firms and groups often employ internal consultancy or management services units, frequently they engage external consultants, either because they require certain additional specialisms or some capacity additional to that currently available in their own team.

In operational management, decisions should never be delayed unduly. If a co-ordinator makes decisions within a reasonable period of time, he will achieve co-ordination with better co-operation and support. If no decision is made, this can lead to frustration because others are prevented from doing anything themselves which will contribute towards solution of a particular situation or problem.

In most industries, and the surface coating industry is not an exception to this, one firm is frequently dependent on another for the supply of its raw materials, parts in process or other bought-in items. In process industries, one can sometimes eliminate some of the problems of co-ordination by vertical integration of firms. Vertical integration can lead to better customer service and also reduce considerably the cost of inventories held at the various stages of work-in-progress because:

> a more comprehensive logistical plan can be developed and applied, and control against this plan may be effected throughout the chain of supply and manufacture.

When it becomes necessary to introduce another level of management to facilitate proper delegation and continuity, the sequence in which this is to be achieved must be decided carefully. It is usually more fruitful to delegate, first, the work which contains decision-making as far below the policy-forming level of the firm as possible, and to delegate those functions in which routine, monitoring procedures can be most easily set up, such as, for instance, in the routine accounts and production functions. The experience and training of the chief executive can influence the sequence, although if he is the "ideas" man, it may be difficult to delegate that task successfully. It is usually difficult to delegate the sales function at an early stage of growth, because most customers want to see the top man anyway.

The men appointed to the new levels of management must be suitably trained for the work and the existing managers should also be trained to delegate to these personnel. In practice, this training in man management must include giving to others the experience of making decisions requiring the use of judgement.

It is important, also, that the manager's training should cover fields wider than those in which he is expected to operate. Only by this means can he appreciate, fully, the responsibilities of others in the firm and ensure that his activities complement theirs.

Measurement

In order to maintain good management control, measurements must be made of achievements against targets. Such measurements must include comparison

of revenue and expenditure items, and continuous monitoring and analysis of this and other data is essential. Expression of data in the form of ratios, such as profit: capital employed or profit: turnover, can be useful.

Sometimes it is of critical importance to the firm to improve the cash flow, irrespective of the long-term effects this may cause. In contrast, the attainment of a particular share of the market in the short-term, even at a loss, can be significant to the future growth of the firm.

Many costing problems are not concerned with the actual techniques used. More frequently, they are concerned with the equitable allocation of the overhead charges to various cost centres or to product lines. The more diverse the range of equipment and levels of personnel, the greater are the difficulties of equitable overhead allocation. The significance of any cost data will depend upon whether the product selling price is determined by market forces or by production costs.

To the industrial user, paint on the product is part of its necessary specification and the costs are allowed for in the product selling price. Generally, contracts are awarded to paint suppliers and this permits them to plan and regulate capacity to assured demand and hence to ensure that all the paint making costs are recovered by the income from paint sales.

On the other hand, the household retail market for decorative paints may be more price sensitive because the prospective user can often elect to forgo using paint at any particular time. The paint-making firms must then bear the costs of excess idle capacity. The resulting higher cost of paint cannot be added to the domestic price under those conditions, because to do so would reduce demand still further. The low capital cost involved in setting up business encourages creation of this excess capacity in the industry.

The key to success lies in effective marketing, consistent with production capacity. Marketing personnel must be given specific information regarding the profitability of different lines and must be kept in touch, through production control, with the relative balance of demand and availability of resources to satisfy that demand. Sales staff may then sell the capacity which is profitable and available, and discourage potential orders which are less profitable or which require capacity already overloaded.

Many techniques are available to assist in forecasting and in target setting. Of these, market research data can be used as a basis for decisions concerned with expansion, new product introduction, product modification, entry into new markets and acquisitions in unrelated business fields. Similar data should be considered, also, when considering pricing policy, advertising, publicity and promotional campaigns. For an existing product, market research may be conducted on a smaller scale, and used in conjunction with the various methods of extrapolation of national demand, share of the market and corrections for seasonal variation. Generally, one hopes to reduce the risks inherent in decision making. For example, rationalisation of the product range can be arranged without prejudice to customer satisfaction.

Operational research techniques can sometimes be used on a firm-wide project or, currently more usually, in relation to a specific function or activity.

Applications of management techniques in small firms

In many textbooks, lectures, and papers, details, and sometimes worked examples, of particular techniques are given. Although the discussion technique is not frequently employed, it can be helpful in describing the circumstances in which those techniques have been useful to the firms concerned. It is in this manner and by means of particular case studies that a range of techniques will be discussed.

Long-term financial planning

The importance of long-term financial planning can be illustrated by a case in a small firm in the plastics industry employing about fifteen people. Arising from an initial assignment in the field of stock control, an elementary system of budgetary control was devised and implemented. The firm were successful and problems of factory space and layout began to emerge as expansion continued. Periodic consultation on policy matters was held with the owner of the business. On one occasion, producing an architects' drawing of a factory for the site, he said that he had bought a piece of land for a new factory. This was located about one hundred miles from his existing factory.

However, his architects' drawing related to a factory about twice as large as he would require. He was reluctant to accept this and a long-term financial plan, covering the next ten-year period, was created. This showed that, after a period of several years, it would be necessary to have an injection of outside capital, so that the business could continue expanding.

As one of his objectives was to retain control of the business he agreed to change his policy and erect a smaller factory in order that he could retain this full control. Three weeks later, a factory within a hundred yards of his existing factory went bankrupt, was put up for sale and was of almost the identical area newly proposed. He bought this factory after the consultant had inspected it with him and the business continued to thrive.

The moral of this is that long-term financial planning is vital, even to the smallest firm, and that the full impact of grandiose schemes for capital investment must be carefully considered before decisions are made.

Cash flow

The importance of cash flow in an organisation was demonstrated when considering a small firm manufacturing products having a high raw material cost. The business, which had been profitable as a small partnership for nearly twenty years, commenced making losses. No additional overdraft facilities were available. Materials were, by that time, on a cash sale basis. It was apparent that the firm would be in severe financial difficulties unless the business was turned into a profitable enterprise without delay; a considered risk was taken as to whether consultancy assistance should be offered. Within ten months of starting the assignment, the business was running at a profit.

In a seasonal trade, the firm originally manufactured for a stock of catalogued items, but production control in the factory was virtually non-existent. Because of the cash flow problem, stocks had been run down and manufacture was proceeding against firm orders only, although the product was ideally suited for mass production, for which the factory was equipped. Collation and gradual

batching of orders, using normal production control techniques and the setting up of several control points in the production system, was achieved on a "shoestring" basis. The overriding factor in determining the sequence in which goods would be produced was the assessed expectation of the period of payment for various customers. A full-scale production control system was introduced progressively as the cash flow position improved.

This is a classic instance in which the consultant's recommendations may need to be far from the long-term ideal in the first instance, but be changed progressively with the situation. Suffice to say that, after a period of about two years, the annual profitability of the firm was well in excess of the consultant's accumulated fees to that date.

Personnel and organisation

On one occasion the author visited a small family firm to discuss the desirability of developing some pension scheme for the chief chemist. Although the firm had been established for many years, no one had retired on pension—they had always died in the job. To obtain background information, it was necessary to discuss the general organisation of the firm, the salaries and the relative lengths of employee service. During this preliminary survey, it was discerned, and remarked upon at the time, that there were weaknesses in the organisation structure and possibly in the personnel filling some of the positions.

Before the report was completed, the author was telephoned by one of the joint managing directors, who indicated that the proposed assignment concerned with the establishment of a pension fund was now "off", because the chief chemist had died. "Nevertheless," he went on, "I should like you to give specific consideration to the matters of organisation and finance, about which you remarked on the day we talked about the pension scheme." This marked the beginning of a long association with that firm and involved development of a sound organisation structure, specifying the responsibilities of managers, and establishing financial control data.

Better management control and overall profitability resulted from the breadth of experience of the management consultants in an area of operations not previously considered by the directors.

Sales forecasting

In a medium sized firm, a preliminary survey of production control was conducted examining specifically the systems and techniques used for stock control. It was found that the production ordering was based on previous sales as shown on the stock record cards. This sales "forecast" was made without reference to the sales department. The sales director, previously unaware of these earlier findings, maintained that forecasting sales was impossible in his particular industry.

The assignment quoted for was not secured in this case, but a little while later it was noted that the sales director was no longer with the company. The moral here is to remember that forecasting, to a certain tolerance level, is always possible. A manager's job involves using the techniques which will improve the accuracy and reliability of the forecast.

Overcoming resistance to changes—a production and stock control example

In one firm, the implementation of changes which would improve production and stock control within the firm was resisted by one of the directors, a major shareholder. He wanted to continue keeping the stock control records personally, and considered that sophisticated systems were not needed because his clerk, or Mr X, was excellent and completely reliable. He did not agree that staff were sometimes sick, saying that his firm always recruited staff who were healthy and arranged that they had a good medical before they were engaged. In combating another ploy, he added that they employed people who were always particularly careful when they went about, and were unlikely to meet with road accidents. At this point, it was found necessary to retire gracefully, yet make arrangements for others to implement the changes.

About six months later, that director made a social call on the author, who asked him how the clerk, Mr X, was going on. He said that, unfortunately, he had been away for some weeks because he had met with an accident one day on his way home from work! He then agreed, reluctantly, that the system which had been implemented without his support had enabled the firm to overcome this handicap without undue difficulty.

Management development and training

The necessity for training staff in new management techniques cannot be over-emphasised. In some organisations, this training can be undertaken on an individual tutorial basis, which is particularly appropriate to small firms. When it is necessary to create a new function in a small firm, usually an existing member of staff has to "grow" in the new position, because a firm cannot afford to recruit an additional member to its management team.

One optical equipment firm was completely unaware of the throughput of the factory, and there was no check on the amount of scrap; lenses are easily broken and disposed of. The managing director ordered all the supplies of glass, but there was no control over its use. There was a need for a new look in production management, but the works director, an old servant of the company, did not agree to the introduction of many modern management techniques. It was necessary, therefore, to wait until he retired and then to implement without delay the residue of the recommendations which had been made. In the meantime, staff had been fully trained to operate the new procedures and in works management duties.

Incentive schemes

Incentive schemes can be introduced in order to secure all-round improvements in productivity. These may range from straight piecework schemes, through premium bonus schemes, to profit sharing, but there appears to be no general panacea.

In a small firm making clockwork motors, the introduction of an incentive scheme led to a 40 per cent increase in productivity within one and a half weeks, extricated the firm from its difficulties in meeting a very substantial order book, and established the reputation of the firm locally, which enabled it to recruit a better class of labour within a very short space of time. This provided a sound

and solid basis from which the firm was subsequently able to expand still further and be very successful.

Computer techniques for management control

The need to delegate responsibilities and the fact that measurement is a pre-requisite to control of this delegation have been discussed. One must know the areas in which delegation can most effectively be executed and, if a saving is to be made in management time through delegation, then it is essential to know how management spends this time. In the case of the author's division at PERA, all staff time on different tasks and assignments has been recorded since the consultancy practice was established, hence sufficient data exists for trends to be established, monitored and acted upon.

PERA now produces the management control information on a computer. For what is the equivalent of a small firm, employing some forty consultants, the backing up secretarial staff, and with a computer bureau staff numbering about fifteen, complete time utilisation figures are produced effortlessly from basic data. Cost control is facilitated within the profit centres for which different managers are responsible. Thus, PERA is able to practice delegation and the management by objectives that this implies.

Future developments

This paper has discussed management in general terms and illustrated some of the principles and techniques used by referring to specific cases of consultancy assignments in industry. More advanced techniques, such as those requiring a more extensive knowledge of mathematics, are available, but are not yet applied widely. In any event, these advanced techniques are less suitable for firms who tend to manage by observation rather than through using collected data. Furthermore, in order to increase the use of more advanced techniques, even with the aid of consultants, it is necessary to ensure that industrial managers are trained to become sufficiently familiar with the uses to which such techniques can be put.

Acknowledgment

The author wishes to thank Mrs E. M. Baxter for her considerable assistance in preparing this paper.

[*Received 20 November 1969*

Discussion at the Midlands Symposium

MR H. J. GRIFFITHS asked if Mr Digby could give more details on ability to obtain increased prices from industrial paint users as opposed to the retail decoration market.

MR P. K. DIGBY said that, in terms of economics, the ability to pass on costs to a buyer depended on the interaction of supply of, and demand for, the product. Fundamentally, this was the same whether the buyer and seller were both industrial firms or whether one of them, the buyer, was a retail consumer. Textbooks on economics went into full explanations but, in brief, two of the parameters to be considered were the elasticity of demand, and the nature of or absence of competition between suppliers.

One could pass on costs only to the extent that the purchaser was prepared to pay for them in the price of the goods, this being reflected by the demand price of the goods. There was, too, the price at which, for a given overall output, the seller was prepared

to sell his products. If this price was higher than the buyer was prepared to pay, then no business would be done, and ultimately the seller would have to reduce his prices to make less goods available on the market. Under some conditions, this would cause a correction to the situation, and the point of equilibrium between supply and demand would be attained.

DR J. B. LEY asked if Mr Digby would expand on the newer management techniques.

MR DIGBY replied that during the last 15 year period, newer techniques, such as those concerned with operational research, had come to the fore. They were not being applied very widely at the present time, particularly in smaller firms, and it was considered that, until management and senior staff become more aware of the potentialities offered by these and other new techniques, of which OR was but one example, greater practical use would not be made of them. One must, therefore, ensure that managers were given appreciation courses and detailed instruction courses in newer management techniques, appropriate to the level of their employment, and they would then be able to use their own technique specialists to a greater extent and, also, be able to make the best use of any consultants they might wish to employ.

MR B. A. TAYLOR inquired if market research techniques could be used by the smaller manufacturer, to determine the size of the market and the firm's position in relation to that of its competitors.

MR DIGBY said that for such firms, market research investigations could be undertaken on a smaller scale in the first instance. One could widen and deepen the scope if the decision-making data becoming available from it pointed to an ultimate conclusion that the firm should proceed. Progressive increase of sample size would increase the probability of making the correct decision. Some desk research could be undertaken by referring to statistical journals and reports relating to the industry. This could provide data about the whole of the market and hence the percentages of the market taken up by different suppliers. Market research should be geared to finding out the prices of competitors' products and to evaluating the specification and appearance of those products against the price that the market was prepared to pay for them and for one's own firm's products.

MR T. D. NATION asked Mr Digby to define the principle motivating factors necessary to obtain maximum effort and success from an average man in production and sales within the surface coating industry.

MR DIGBY said that the production man at operating level was motivated primarily by the method of payment for his services. His motivation when producing parts that were process or machine controlled was often linked with the technical excellence of the product. He might be required to respond to control data and his action or decision might affect the quality and output of the product. Then, he could be paid on an incentive scheme geared to that output.

Sales, as distinct from orders taken, were important as a reward to the salesman. One should assess, therefore, the extent to which business might be of an automatic repeat nature. One's incentive scheme should not be geared solely to either turnover or number of orders but, where possible, geared to the difficulty of obtaining those orders. One must set targets with this in mind. For example, the first order from a company that has never before purchased from the firm might lead to very valuable orders in the future and, perhaps, a higher commission should be paid in those instances. It was important, also, that salesmen sold the products that bring the greatest profit to the firm. Hence, some differentiation in commission rates, according to the profitability of the different lines, might be beneficial.

J. Oil Col. Chem. Assoc. 1970 53, 209-217

Managing the research and development function*

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Summary

The management of a research and development organisation is discussed. The setting up of an organisation structure, and the preparation of the R & D programme, are described. The methods of control of the programme, both with respect to finance and to time, are shown, and the technique of the technical audit of each project to assess its potential outlined. Finally, emphasis is laid on the importance of communication between all levels of personnel in a research establishment.

Keywords

Miscellaneous
management

La gestion d'un centre de recherches et de développements

Résumé

On discute la direction d'une organisation de recherches et de devéloppement. On décrit l'établissement de la structure de l'organisation et aussi la préparation d'un programme de projets convenables à être effectués par ce genre de structure. On démontre les méthodes de contrôle du programme à l'égard de sa durée et également des aspects financiers. On mentionne l'appréciation de la valeur potentielle de chaque projet par l'emploi d'une vérification technique. Enfin, on souligne l'importance de bons réseaux de communication entre tous les niveaux du personnel dans un centre de recherches.

Die Leitung von Forschungs-und Entwicklungsaufgaben

Zusammenfassung

Die bestmöglichste Leitung einer der Forschung und Entwicklung gewidmeten Organisation wird besprochen. Die Errichtung einer Organisationsstruktur und die Vorbereitung eines Programmes Forschungsund Ausarbeitungs werden beschrieben. Die Methoden zur Kontrolle des Programmes, sowohl in finanzieller Beziehung, als auch hinsichtlich Zeitaufwand, ausserdem die Methode jedes Projekt technisch zu prüfen und seine Möglichkeiten abzuschätzen, werden skizziert.

Schliesslich wird auch die Wichtigkeit des Ideenaustausches zwischen dem Personal aller Grade eines Forschungsinstitutes betont.

Управление функцией исследования и развития

Резюме

Обсуждается управление организацией по исследованию и развитию. Описываются учреждение структуры такой организации и подготовка программы для нее. Указываются методы контроля программы, как по отношению к финансовым соображениям так и с точки зрения времени и отмечаются приемы технологической ревизии каждого проекта, для оценки его потенциальной продуктивности.

В заключение подчеркивается важность надежных средств сообщения между всеми уровнями личного состава в научно-исследовательском учреждении.

*Text of a lecture delivered at the Midlands Section Symposium, 23 October 1969.

Introduction

When I was invited to take part in this symposium it was explained that contribution would be last in the morning session dealing with the principles and techniques of management, and before proceeding to consider training in the surface coatings industry in the afternoon. My first thought was that management and training were odd bed-fellows indeed. However, in accepting, I thought that it would be enjoyable to discuss some of management's problems in turning academically trained young people into useful members of a science-based money-making business concern, especially in R & D departments. I was therefore somewhat alarmed to find myself billed on the programme as a specialist, an honour I must decline for two reasons.

The sceptic might say that specialists in R & D management are partly made up of those managers who have been so successful that they have been allowed by their industrial employers to escape to the various august business schools to teach others how to manage R & D. The sceptic would also say that these are the only people who have time to investigate the application of new methods of manipulating men and money emerging from the schools of psychology and social science on the one hand, and of mathematics and economics on the other.

Secondly, we all know the definition of the specialist as someone who knows more and more about less and less. This is the very opposite of a good research manager or research director, who must know less and less about more and more. This must be so, for most of us must recruit, train, and lead scientific teams embracing many disciplines, and with sufficient business sense that our departmental profit and loss statement shows a healthy return upon our research investments. To achieve this, we must have sufficient sales ability to sell our scientists' and technologists' better ideas to hard-headed financial experts and sceptical managing directors and chairmen to ensure continuing confidence in our R & D programme, and to obtain early exploitation of successful projects.

Now in case the organisers of this symposium think they are not getting their money's worth, let me masquerade as a specialist for a moment in cataloguing the jargon.

Personality testing
Job description and appraisal
Motivation
Innovation
Value engineering
Defensive research
Cost value analysis
Technical auditing
Network analysis
—PERT technique
—CPA technique
Discounted cash flow
Entrepreneur
Profit centres
Technological forecasting
—Normative method
—Delphi method

The remainder of this paper will be a short account of how one moderately successful research and development organisation organises its affairs, including mention of one or two judiciously selected techniques which are found quite useful in dealing expeditiously with some of the problems which arise. My illustrations are mostly from the Paint Research Association's laboratories, and no apology is made for this since your companies are all members of the RA, or ought to be!

Organisation structure

An organisation structure is necessary to delegate responsibility and authority effectively and to give people promotion to work for (after age 30 salary increases are not enough). It does not greatly matter whether one structures the R & D department by scientific discipline or by product area, provided the manager takes steps to avoid the former becoming too academic or the latter becoming too narrow minded. At the PRA we have a simple organisation by disciplines.

Our organisation is divided into chemistry, physics and technical divisions and the service departments. Under the head of division each division is subdivided into a number of sections with its own section leader and staff in various status and salary grades as PRO, SRO, RO, ARO, and Assistant. The PRO grade is of equivalent status to section leader in the organisation chart. This means that the first rate scientist can aspire to a salary as high as or even higher than his section leader. Not all good scientists make good administrators and it would be foolish and wasteful to have to "promote" an able experimenter behind a desk when we simply wish to give him a salary increase. This scheme has come to be known in industry as the dual ladder for promotion.

Having got an organisation one is equipped to prepare the R & D programme. One is also in the training business or should be. I believe that the most effective form of training is internally and by example. This means managing in public as far as possible. On the old-fashioned view this is impractical, for reasons of security and the dignity of managers who were supposed to make all decisions in the privacy of their office or what have you. This is, of course, nonsense. On security one can instance the large proportion of the US space programme which, with its few blemishes and failures, is unremittingly conducted in public out of responsibility to the US taxpayer who pays for it. If this is possible, surely the company can trust its carefully selected staff with the forward plans which only they can bring to fruition, and with the management techniques of decision by which they were arrived at and purported to come about most expeditiously. Such work in public *is* training in its most persuasive and effective form. Moreover, by working in public you have the opportunity to engender confidence and enthusiasm. What is more, you show that certain procedures are possible and ensure that things get done your way next time.

Research and development programme

The research manager must first prepare a *skeleton research programme* listing the main targets of his department and the target percentage effort to be devoted to each. This will normally list product areas reflecting the extent of market penetration the sales departments have achieved with modifications according

to the company's forward policy of expansion or contraction in each product area.

This can be illustrated by the first page of the PRA's published research programme. As a research association, the PRA has a number of member service activities amounting to 28.4 per cent of its technical effort. (This could be compared with the technical service function of a company). The research programme is divided into projects of primary interest to the raw material manufacturer (17.8 per cent), projects for the paintmaker (3 headings, 19.6 per cent), projects for the paint user (31.2 per cent), items for the printing ink industry (3 per cent) and finally diversification and new science. The fact that the PRA has no effort under this heading this year is not very significant, as some adventurous work is being carried out under the main customer headings.

It is also necessary to plan the amount of effort to be expended in seeking new products or processes (25.3 per cent), product or process improvement (33.0 per cent) and background studies (13.3 per cent). The health of an advanced technological company is partly judged from the proportion of its income derived from new products (those marketed within the last three years). The research department must therefore maintain a proper balance between aggressive and defensive research. This skeleton is then presented and justified to a meeting of all R & D staff of graduate level.

Ideas

Each scientist or technologist is then required to produce a series of ideas for *definite* work towards a target set down in two or at most three sentences. For this it is not sufficient to have an item such as, "To study the interaction of latex, thickener and wetting agent in emulsion paint," for this has no definite objective and the project "to study" cannot fail—nor succeed. Neither is it sufficient to have an item purporting "To make better emulsion paints." This is a pious hope or at best a prayer. The two or three sentences should state the target and indicate what experimental methods will be used to achieve it and why. In editing these, pruning out the weaker items and strengthening others, the section leader should, in conjunction with the scientist, list the staff needed to carry out the project in the coming year with a "guesstimate" number of man months required of each and including service or co-operation needed from other divisions.

The heads of division and research manager will, if they are worth their salt, wish to add further items before finally selecting approved items for the research programme. At this stage, criteria for final selection in the case of PRA are, (1) technical merit, (2) possibility of obtaining sponsorship, (3) capital equipment needs, (4) need for a balanced programme in accordance with the original skeleton, (5) full utilisation of existing staff. It is necessary to make out a personnel/project chart and cook the books somewhat to ensure that no one is going to do more than a conventional number of months' work in the year. Then a final check is made of effort per main market objective compared with target skeleton and any necessary adjustments made.

In this manner one ends up with the research programme for the year. At this point it is worth-while once again to discuss it with the staff to disarm a few of those alarmed to find that it has been necessary to cut down from 12 months

to 6 on certain items; you don't mean them to work nights but merely anticipate that the project may overrun the time allotted. In any case this research programme is a forecast *estimate*—this is what is going to happen if things work out only averagely well. Should things work out really well, one will wish to shut down or omit less important items to support those that are working out really excitingly.

Capital equipment list

I remarked earlier that capital equipment was normally one of the criteria for selecting R & D items, so there should be no unpleasant surprises in formalising a capital equipment list at this time. It is not necessary to say more about this except that it is not a signal for immediate purchase of all items, but simply a list of equipment which may be purchased as needed for the work as it progresses.

Having at this stage a sound research programme and the necessary authorisation for staff numbers and capital equipment (or the cash equivalent) the research department cannot overspend, except by gross negligence of this budget; it can, however, fail to produce the goods (i.e. research results) in sufficient quantity. Thus, whether or not part of the research programme is sponsored, e.g. by separate divisions of the company, it is desirable to do a little simple bookkeeping or budgetary control, both by money and by time, for each research project in hand, and this is done by the section leaders and checked by the head of division.

Budgetary control or R & D bookkeeping (Fig. 1.)

It is a simple matter to plot the likely course of a research project in a bar chart. Thus, a research project to synthesise and evaluate new water repellent preservatives for use in pretreatments for joinery timber may involve the project leader full-time in a month's literature survey followed by part-time supervision of this project with, say, three other projects. Synthetic work may commence while the literature search is being done, say, in the hands of one graduate and one laboratory assistant, and it will finish leaving time for evaluation of the last-made compounds within the total time planned (say, one year). Formulation of the new water repellents and their evaluation cannot start until the first compounds have been synthesised, but will normally continue until the end of the programme of work (not necessarily as a full time job for, say, one graduate and one assistant). These simple facts can be represented in the bar chart. The monthly totals of section leader, graduate and assistant effort converted to expenditure units can readily be plotted as a target budgetary control chart. A weekly or monthly timesheet then allows the project leader to follow expenditure of effort on this project and to see immediately when the rate of expenditure exceeds that planned. This example is, of course, a simple one, and this type of control is even more necessary for a development project which can involve more people, more expensive experimentation and the occupation of plant which could otherwise be on production.

Control by time

I do not propose to deal with network analysis in this paper. The subject is covered well by Battersby[1] in 414 pages.

PROJECT NUMBER

	COST UNITS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
SECTION LEADER	4	4	1	1	1	1	1	1	1	1	1	1	1
ORG. CHEMIST	2	1	2	2	2	2	2	2	2				
ORG. ASSISTANT	1	$\frac{1}{2}$	1	1	1	1	1	1	1				
TECHNOLOGIST	2				1	1	1	1	1	1	1	1	1
T. ASSISTANT	1				$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
COST PER MONTH		$5\frac{1}{2}$	4	4	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$
TOTAL COST		$5\frac{1}{2}$	$9\frac{1}{2}$	$13\frac{1}{2}$	19	$24\frac{1}{2}$	30	$35\frac{1}{2}$	41	$43\frac{1}{2}$	46	$48\frac{1}{2}$	51

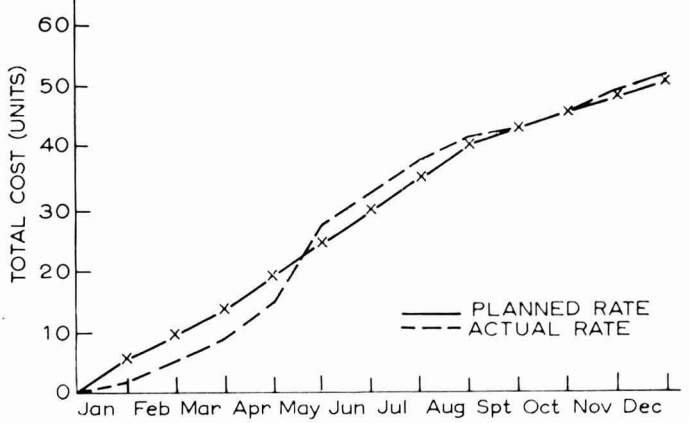

Fig. 1. Bar chart and budgetary control

No matter how simple a programme appears, if it involves a marketing date, or more than one group of experimenters, it is worth while drawing out a simple network of steps involved and noting the critical dates on the route to completing the job. In R & D the law of inanimate malice applies—if things can go wrong, they will. And as in other forms of do-it-yourself it is always the unexpected which causes the trouble, so minimise the unexpected with a timetable drawn up in consultation with the various working groups involved.

For instance, in your first schedule you may find that:

(1) the pilot plant at Bolton works is shut down for Wakes Week on 1 July just when you wanted to commence pilot plant manufacture,

(2) delivery time for the new high speed dissolver is twice as long as hopefully estimated,

(3) unless you can clear the first full production run by mid-November it will come in the middle of a production campaign of another product, and

(4) key marketing personnel have booked a winter sporting holiday twelve months ago.

All of this means that you have got to complete the research to product selection at a much earlier date than everyone thought, if the new product is to be marketed by your target date.

As the research year proceeds, management, in the person of the research manager with his colleagues in corporate management, will wish to review progress of the projects making up the company's R & D programme. Such an exercise is usually called the technical audit.

The technical audit

In its most effective form this is precisely what it says, namely an investment expenditure set against an estimated return with a risk factor which may be assessed with greater precision as the work proceeds. For each research project one can estimate:—

Technical audit

Size of market Profitability Patent cover?	*Return*
Capital investment required Value of stock needed Size of R & D team Time for R & D Past performance of the team Likelihood of success Needs for more rapid progress	*Investment*
How certain are above estimates	*Risk*

I must emphasise that *all* those taking part in the TA committee must, after examining the progress of the work, *immediately* fill out their estimate of all the factors listed. If the item under review cannot be justified from the common business knowledge of the assembled senior managers, it should not have figured in the research programme anyway and the time to count the profit accurately has not yet arrived.

The section leader should be one of the auditors, first because of his specialised knowledge and secondly for educational reasons. The educational value of a well-conducted TA is very high, and is likely to become part of the useful ethos of the research department. It is frequently said that one of the most difficult of the research manager's decisions is when to shut down a research project, and that this is doubly disappointing for the scientist carrying out the work. It is therefore good to develop that critical appraisal which can lead your staff to tell you when a project should be considered for shut-down—and your staff will always have the facts before you do!

Scientists are people

Most of this paper has been about the mechanics of research management. In the long term, however, the department's or company's only worth-while asset is its people and I would like to say a word or two about them. I cannot stop the expert calling this communications and motivation if he insists, nor stop the expert pointing out that the newly recruited graduate represents a capital investment of £80,000-£100,000 to his company, for this of course is true.

Each of you will have your own methods for ensuring that your company obtains its fair share of the bright young people emerging from the universities and colleges. Some of them will have a 1st or upper 2nd degree, or other qualifications to prove that they have a retentive memory and, on one occasion, the ability to work hard when interested. It is now up to their new employer to interest them in his problems. This means introducing the new man to one of the technologies comprising the business and finding him a useful job of work which will extend his scientific abilities to the full. Most companies are reasonably good at this. Now the new man has been a bright youngster at school and an able science student at his university or college. Nowhere along the line has he been exposed to the concept of making science or technology pay. Although "communications" has been an "in" phrase for years now, and although communications between management, the trade unions and workers have notably improved, communication between management and newly acquired scientists and technologists is, on average, deplorable. In many cases, it is limited to the one or two days per annum when consultants appear and the research director may sit in (frequently in silence) while the younger staff present their problems for discussion. This is indeed one-way communication. There are remarkably few instances where the research director or, better, the managing director, walks across to the laboratories to describe the business as seen from the boardroom today and to explain hopes for the next three, five and ten years to those who can fulfil these hopes. This represents a failure to profit from the basic human desire to do something useful and to have one's work appreciated. A good research department will have:

A good director,

Clearly defined objectives,

Good selection of staff,

Pleasant, efficient working conditions,

An adequate information service,

A stimulating atmosphere,

An efficient but minimal organisation,

Adequate arrangements for staff development or staff transfer.

Finally, the research director is in the privileged position of being able to share the excitement of a number of projects; the proper place to share that excitement is in the laboratories, and, of course, enthusiasm is infectious.

[*Received 13 November 1969*

Soon.

(In volume. And first in Europe.)

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Discussion at the Midlands Symposium

DR. K. SELLARS said that incentive schemes had been mentioned in relation to specific sections of production of sales. How could an incentive scheme, as opposed to a bonus or profit sharing scheme, be operated on a more general basis relating, for example, to R & D, accounts, and other service departments? Would such a scheme be reliable? DR G. de W. ANDERSON replied that he did not think incentive schemes desirable for R & D departments. It was most important that the scientist or technologist who had done a very good piece of work which had been a near-miss commercially should be rewarded as well as those who had been completely successful, for this was the man who could well be more lucky next time.

In research, especially, there were two sorts of projects; first simple, perhaps imitative investigations which had a high probability of success, and secondly, more adventurous projects which, although less certain to succeed, would give much higher benefits.

There was a very real danger that incentive schemes might encourage staff to concentrate on somewhat pedestrian items having the highest chance of success.

Next month's issue

The Honorary Editor has accepted the following papers for publication and these are expected to appear in the April issue:

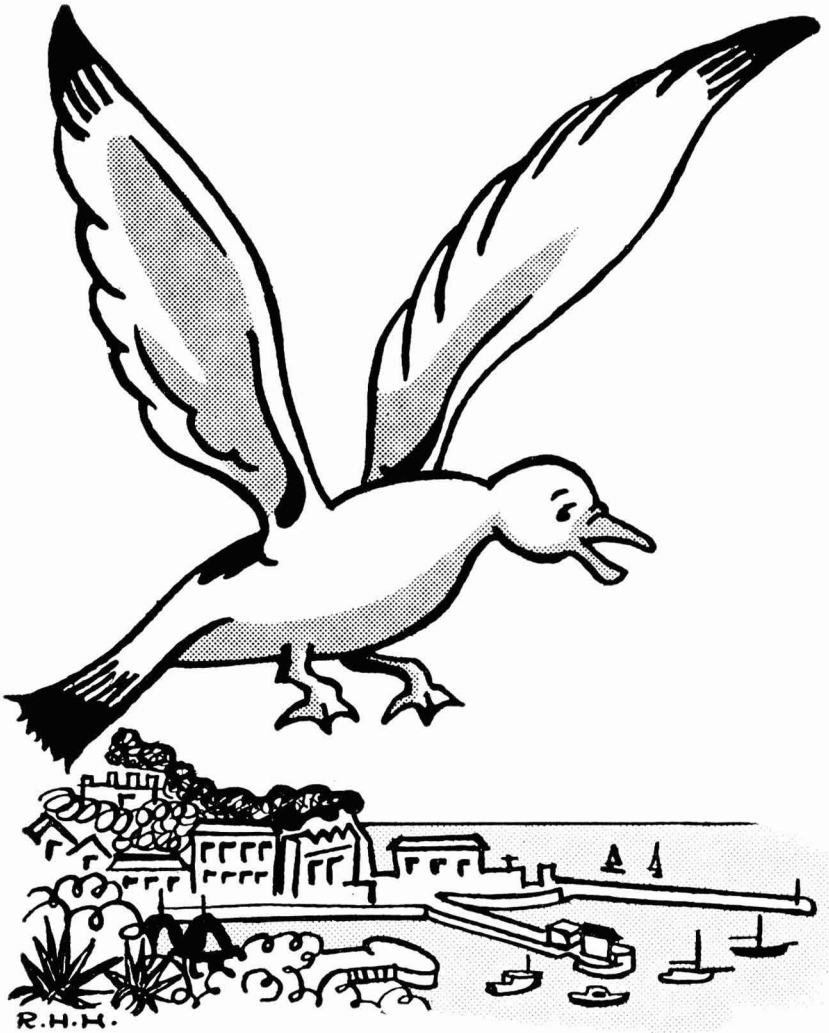
"The application of the industrial training act," *by C. G. Lebeter.*

"The development of training in the chemical industry," *by D. G. Worthy.*

"Problems of management in the smaller business," *by E. A. B. Perrigo.*

"Preferential deposition of pigment during electrodeposition," *by F. D. Robinson and B. J. Tear.*

"An electron microscope study of the 'clear layer' at the surface of paint films," *by R. D. Murley and H. Smith.*



O.C.C.A.

CONFERENCE

Palace Hotel

TORQUAY

4 - 8 May 1971

Surface properties and appearance

J. Oil Col. Chem. Assoc. 1970, 53, 218-219

Short Communication

A note of the chalking of zinc oxide latex paints

By C. J. Lancucki and E. Hoffmann

Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia

A curious phenomenon was observed during an investigation of chalking of latex paints pigmented with zinc oxide and mixtures of zinc oxide with rutile titanium dioxide and stainless steel[1]. The experiments were carried out on stainless steel panels coated with the paint being investigated and exposed under various conditions including those in the humid tropical climate at Lae, New Guinea. The amount of chalk formed was measured by determining the loss of weight of the panels after the chalk had been wiped off with a soft cloth.

In all cases in which the paint contained other pigments in addition to zinc oxide, the chalk came off on slight rubbing, but much harder rubbing was required when zinc oxide was the only pigment.

If a piece of adhesive tape was applied to the surface and then slowly withdrawn, a layer of material which had practically no adhesion to the paint film underneath flaked off. This phenomenon of coherence of the uppermost layer of the paint film was observed not only on the panels exposed at Lae but also on those exposed to xenon arc irradiation at humidity near 100 per cent[2].

The material adhering to the tape was analysed by X-ray diffraction methods. In addition to zinc oxide, which was the main constituent, a line was observed at 6.8 Å as well as some weak lines at higher angles. As the paint originally contained only zinc oxide pigment, it was postulated that another zinc compound was being formed as a result of exposure to the atmosphere. If this were so, the greatest concentration of the new compound should have been on the outer surface of the paint. An undisturbed part of the paint film was X-rayed *in situ* on the metal panel, and a stronger pattern of the newly-formed compound was obtained; this was identified as basic zinc carbonate ($4ZnO.CO_2 .4H_2O$)[3]. The part of the paint film from which the top layer was removed by adhesive tape was also X-rayed *in situ* on the steel panel, and was found to contain only zincite (ZnO).

Thus it would appear that, as the binder deteriorates, the loose zinc oxide powder produced on the surface can react with the carbon dioxide and water vapour of the atmosphere to produce basic zinc carbonate. On crystallising out, the latter binds together zincite particles in its immediate neighbourhood, giving rise to a weakly adhering but slightly cohering layer of zinc oxide.

It is important to point out that the paint films that were weathered in the weatherometer and at Lae did not look chalky, but appeared as glossy as in

their original state. If the decomposition of the binder had been followed by measurement of gloss, as is the usual custom, instead of by loss of weight, it would have been wrongly concluded that zinc oxide pigment does not cause chalking.

It may be mentioned that, in 1837, von Bonsdorff (quoted in ref 4) made $ZnCO_3.3ZnO.4H_2O$ by the action of a stream of carbon dioxide on zinc oxide suspended in water. The panels have evidently undergone an essentially similar reaction under much milder carbonating conditions prevailing in the atmosphere.

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Correspondence

SIR,—I am interested in obtaining literature references on "etch primers," particularly those references which use the terms "etch" or "etching" primer as opposed to "wash" or "pretreatment" primer. I would, in fact, like to determine when the name first came into use. Any reference in which the excellent adhesion, and good general properties of this type of coating are attributed to an etching effect on the substrate, would be particularly welcome. Would you please, through the medium of your journal, enquire of your readers, if they can help me in my search.

Yours faithfully,

P. Walker.

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Review

STRUCTURE AND MECHANISM IN VINYL POLYMERISATION

EDITED BY T. TSURUTA AND K. F. O'DRISCOLL. New York: Marcel Dekker Inc., 1969. pp. xii + 540. Price £14.

This book comprises a collection of critical surveys dealing with the interrelation between the reactivity of vinyl type monomers, initiation mechanisms and structural aspects.

In a concise introductory chapter, M. Imoto gives a useful account of the historical development of the theory of the reactivity of monomers. This is followed by eleven more chapters, which are equally well done, covering a range of topics under the following titles: "Structure and reactivity of vinyl monomers"—T. Tsuruta discusses resonance, polar, steric and energy factors governing radical and ionic polymerisation; "Initiation in free radical polymerisation"—K. F. O'Driscoll and P. Ghosh consider the kinetics of free radical polymerisation with particular reference to initiation and factors affecting efficiency, and include the chemistry of some simple and complex free radical initiators, particularly those based on metal compounds; "The termination mechanism in radical polymerisation"—A. M. North and D. Postlethwaite discuss all those processes by which a growing chain radical is converted to inert polymer; "Organometallic compounds as radical type initiators for vinyl polymerisation"—S. Inoue; "Heterogeneous metal peroxides"—T. Otsu describes some features of these radical initiators, especially nickel peroxide for stereospecific polymerisation; "Polymerisation of α-β disubstituted olefins"—Y. Minoura reviews in terms of resonance, polarity and steric factors the reactivity of this type of monomer, which is in general difficult to polymerise,

and also lists the polymerisation and copolymerisation behaviour of a number of compounds; "Polymerisation of $\alpha\beta$ unsaturated carbonyl compounds" —D. M. Wiles considers the free radical and ionic polymerisation of acrylic esters, acids and amides, and vinyl ketones and aldehydes by organometallic catalysts in particular, with reference to stereospecificity; "Cationic polymerisation of vinyl monomers by metal alkyl catalysts"—T. Saegusa; "Rate constants of elementary reactions in cationic polymerisation"—T. Higashimura describes attempts which have been made to measure absolute rate constants; "Elementary steps in anionic vinyl polymerisation"—J. Smid details studies on the properties of the propagating species and kinetics and mechanism of propagation; "Molecular rearrangements in the polymerisation of vinyl monomers" —A. D. Ketley and L. P. Fisher deal with cases in which the repeat unit in the polymer is different from that expected from a simple addition polymerisation.

It is apparent that the topics have been carefully chosen to avoid substantial overlap with other recently published monographs dealing with specific areas of vinyl polymerisation. A few cases of overlapping of contents between individual chapters were noted as, for example, in the discussions on the use of nickel peroxide and metal carbonyls as radical initiators and on the participation of maleic anhydride and of sulphur dioxide in free radical polymerisation. All in all, however, the editors have succeeded within their objectives in producing a useful, up to date book surveying much of the literature on the reactivity of vinyl compounds.

Primarily, it is a specialist book; the high price will not recommend it to would be buyers with a limited budget and a more general interest in polymers.

R. N. FAULKNER

Information Received

(In case of difficulty regarding addresses, members and subscribers to the JOURNAL should apply for details to the Director & Secretary of the Association at the address shown on the front cover.)

Vinyl Products Limited formally opened its new research and technical service laboratories on 19 December 1969. In opening the laboratories, Dr E. G. Woodroofe, a vice-chairman of **Unilever Limited,** of which Vinyl Products is now a subsidiary, named them "The Mayne Laboratories," in recognition of the technical guidance and leadership the company has had in its 30 years of existence from Dr J. E. O. Mayne, the chairman and technical director.

The new laboratories are contained in a three-storey building, with specialised installations for basic research and development work in each of the fields of use of the company's products, as well as office and library facilities.

At a recent press conference, **ICI Limited, Dyestuffs Division,** announced the production of its new "Colour atlas."

The atlas is said to represent a major advance for the dyeing and colour-using industries, particularly where ready means of accurately indicating a specific shade is required. Printed by **McCorquodale Colour Display Ltd.** to match a master copy produced by a complex dye-transfer process, the atlas contains 1,379 colour samples, but, by use of the 19 graded neutral grey filters supplied, a possible 27,580 shades can be matched. The use of the filters, which are produced by **Ilford Limited,** was the breakthrough which has made possible the provision of the large number of shades. Previous similar collections of shades have been much narrower in scope, the best known, the "Munsell Book of Colour," containing only 1,450 shades.

Each colour has a simple code number, and by knowing the code and the number of the filter used to match a sample, the supplier can make an accurate match in a few seconds without the necessity of having the sample transferred from the customer. The "Colour Atlas" is being issued to ICI customers, and is complementary to the company's Instrumental Match Prediction service, in that the customer can phone through the details of the shade in the atlas, and this can be identified immediately and information fed to the computer so that a dye to produce this shade on a particular substrate can be formulated.

Geigy (UK) Limited has recently introduced a new high performance yellow pigment, *Irgazin Yellow 2RLT.* The new product, which is an isoindolinone yellow, is chemically identical to *Irgazin Yellow 3RLT*, but is greener and stronger.

Having good transparency, *Irgazin Yellow 2RLT* is said to be particularly suitable for selected metallic shades for automotive finishes. It has the same all-round properties as *Irgazin Yellow 3RLT* in most media, and, in view of its good colour strength, is expected to prove very useful as a tinting colour for pale shades in high quality paints.

A new brochure has recently been published by **R. J. P. Nicklin and Company Ltd.,** giving details of the company's services in corrosion engineering. Copies are available from Nicklin.

It has recently been announced that agreement in principle has been made for the acquisition by **Cabot Corporation** of all the assets of the *Stellite* operations of **Union Carbide Corporation.** As from 31 December 1969, the *Stellite* facility, at Kokomo, Indiana, USA, will be known as the Stellite Division of Cabot Corporation. *Stellite*

products are, in the main, high performance alloys and castings for the aerospace, chemical processing, and power generation industries.

G. J. Erlich Limited is now UK, British Commonwealth and Eire Agent for **Pressindustria SpA** of Milan, it was recently announced. In particular they will be handling Pressindustria's plant for use in ethylene oxide condensation reactions. The absorption process used in the plant is said to offer reduced production costs and increased capacity and speed, as well as optimum operator safety. In the paint field, the plant is said to be of particular interest to those manufacturing modified fatty acids for alkyd paints.

It has recently been announced that **Farbenfabriken Bayer AG** has acquired a majority interest (80 per cent) in the Swedish firm of **AB Nordstrom and Sjorgren (Nordsjo),** one of Sweden's most important paint producers, who market surface coating materials of all types.

The two firms are said to have been co-operating closely for some years, with Nordsjo recently becoming one of Bayer's most important customers. Nordsjo will continue to produce its products as before, as well as some special colours in various Bayer products, and will also commence to produce polyurethane systems, aided by know-how from Bayer.

The partnership, it is said, will enable a closer watch to be kept on the coatings market, as there will be a continuous flow of information and experience from the paint manufacturer to the producer of raw materials.

Bayer has also recently established, in conjunction with **Shell,** a joint company in Antwerp, Belgium, to produce isocyanates.

Techne (Cambridge) Limited has recently added a new, deeper, fluidised bath, model *SBL/2D*, to its range of fluidisation equipment. The *SBL/2D* can be used as a constant temperature bath up to 600°C, and eliminates many of the disadvantages associated with conventional equipment such as oil and salt baths, being completely safe at high temperatures and free from unpleasant vapours and flammability problems. Sand or Alundum (fused alumina) is used as the medium.

"Super *Synolacs* for the Seventies" is a new range of *Synolac* alkyd resins recently announced by **Cray Valley Products Limited.** The new resins are the first results of a long range programme of research and development, and the first group consists of four basic resins which have been designed to meet the market demands for improvements in drying time, colour retention and improved durability. Field trials have been carried out, and the resins are now under full scale manufacture.

CVP has also issued its "Resin Finder" for 1970, and copies are available from the company.

Following the announcement made in 1969 that **Monsanto Company** was to apply for a quotation of its Common Shares on the London Stock Exchange, it has now been announced that the company has been granted permission to deal in the 33,088,362 issued common shares at $2 each.

A new colour matching service for printers, *Telematch*, has been set up by three printing ink manufacturers, **A. B. Fleming and Company Limited, A. Gilby and Sons Limited,** and **Winstones Limited.**

Under the system, the printer will buy from one of the manufacturers eight basic colours, three grey inks and a transparent tinting medium. When a match is required the printer will send a colour sample to his manufacturer together with a paper sample and details of the machine to be used. The manufacturer's laboratories will immediately match the sample, based on the twelve standard ingredients, and the formulae will be phoned to the printer, followed by written information.

The properties of the formulation can then be understood by use of the 28-page *Telematch System* guide.

It is claimed that, by use of this system, a printer can be running the ink within 24 hours of the request for a match.

Furniture coated with the paint developed for use in the testing environment found on Concorde supersonic aircraft is now available, announce **Jarman and Platt Limited.** The company's managing director, Mr A. D. Smith, was struck by the advantages that such a durable coating system would offer for furniture, and approached **ICI Limited,** the makers of paints for the Concorde, to investigate the possibilities. Some modifications were made to suit the furniture industry, and the coating has now been used on Jarman & Platt's *Venus Concorde* range.

Following the acquisition of the **L. A. Mitchell Group** by **A.P.V. Holdings Ltd. Group,** some rationalisation has taken place. **L. A. Mitchell (Holdings) Ltd.** has been renamed **A.P.V.-Mitchell Holdings Ltd.,** and will control the following operating companies: **A.P.V.-Mitchell Ltd.** in Croydon; **A.P.V.-Mitchell (Dryers) Ltd.** (previously Pratchitt Bros. Ltd.) in Carlisle, and **A.P.V.-Mitchell Craig Ltd.** (previously Mitchell Craig Pumps Ltd.) in East Kilbride. **A.P.V.-Mitchell Ltd.** will comprise the Process Contracting Division, carrying out work previously performed by L. A. Mitchell Ltd., and the Kestner Metal Propellers Division, which will manufacture and market the combined range of unit process plant and services offered previously by Metal Propellers Ltd., L. A. M. Pipework Ltd., and the Contracts Division of A.P.V.-Kestner Ltd. Plastics and Pump Divisions of **A.P.V.-Kestner Ltd.** will continue to operate from Greenhithe.

Bristol

Management by objectives in research and development

The subject of the Bristol Section meeting held at the Royal Hotel, Bristol on 28 November 1969 was "Management by objectives in research and development." The paper was given by Messrs. R. N. Felstead and R. J. Woodbridge of John Hall & Sons (Bristol & London) Limited.

Mr Felstead commenced by describing management by objectives as a means of integrating various management techniques for maximum utilisation of a company's resources. It was also important to increase a person's job satisfaction by involvement as much as possible in planning and execution of operations. It was essential to have well defined objectives, both long term and short term, that were attainable. Starting and finishing dates should be agreed for maximum efficiency. On a company scale, this involved the development of an overall masterplan and a proper delegation of responsibility. Manager development was essential and encouraged by involving managers in writing their own job descriptions, which described the scope and limitations of their responsibilities. Specialised training courses should be made available when required. Ultimately, the expected improvement in the company's performance would be reflected in the salaries and job satisfaction of those involved. Finally, Mr Felstead stressed that management by objectives should be regarded as a continuous process needing to be dynamic and flexible to maintain results.

Mr Woodbridge then went on to describe in detail the application of this technique to a development department, with examples of possible long and short term projects in hand. The scope of the job was defined, together with lines of communication with other departments. The manager's function also included staff development and the need to remain up to date with changing raw materials, changing user requirements and competitive activity. Projects were reviewed at intervals to assess progress and to determine how much more effort should be allocated to projects under development.

A lively discussion followed the paper, during which the speakers stated that management by objectives avoided overpromotion of a person to a level where he could not function efficiently. It also ensured that following promotion, a person was involved fully in the new post and left the old position to the successor. A vote of thanks was finally proposed by Mr L. J. Brooke and warmly supported by the members and guests present.

T.I.P.

Hull

Dispersion

At the third meeting of the 1969-70 session, held at the Hull College of Technology on 1 December, Professor G. D. Parfitt gave an enjoyable and stimulating lecture entitled "Dispersion."

The lecturer considered that the dispersion of powders by liquids involved three stages, (i) wetting, (ii) the break-down of aggregates or agglomerates, (iii), the stabilisation of the dispersion once formed. The principles of the first stage were well understood, and the significance of surface tension and the contact angle between solid and liquid in the wetting process was briefly discussed. The basic principles of the second stage were not at present well understood but those controlling stage (iii) were well documented theoretically.

In the main body of his lecture, Professor Parfitt discussed the results of work which was a continuation of that reported at the Association's 1967 Scarborough Conference and which was later published in the *Journal*. (Parfitt, G. D. *JOCCA* 1967, **50**, 822). The lecturer had worked at that time with pure carbon black—Graphon—and had studied the wetting and dispersibility of this material in aqueous solutions of sodium dodecyl sulphate and dodecyl trimethyl ammonium bromide (DTAB). The wettability and effectiveness of dispersion had been judged visually and by measurements of optical density. An important feature of these dispersions was that a stage was reached where the quality of the dispersion was excellent and substantially unchanged by further additions of surface active agent and this was achieved before reaching the plateau region of the adsorption isotherm.

In the extension of this investigation to dispersions of pure rutile titanium dioxide in aqueous solutions of the same surfactants, a stability problem had been demonstrated. As before, very little mechanical energy had been employed in the dispersion process which was achieved by simple end-over-end tumbling in glass tubes. The adsorption of very small quantities of DTAB rendered the pigment surface hydrophobic and difficult to wet, but at higher levels the contact angle was reduced to less then 90° and wetting and effective dispersion took place. Beyond this stage, the optical density of the dispersion fell dramatically owing to flocculation and the reduced stability of the dispersion was further confirmed by a significant lowering of the zeta potential. Similar results had been obtained with sodium dodecyl sulphate as the dispersing agent, though the flocculation tendency was less strong. The overall dispersion process was obviously more complex with titanium dioxide.

For all the systems, the flocculation process had been studied in a fundamental way using particle counting methods and Professor Parfitt concluded his lecture by demonstrating the applicability of the DLVO (Deryaguin, Landau, Verwey and Overbeek) theory to the stability of the Graphon and titanium dioxide dispersions.

During the discussion which followed, Professor Parfitt answered questions from Messrs. B. Tear, S. J. Read, N. F. Lythgoe, J. Milne, E. A. Brown and J. E. Gilroy.

The vote of thanks was proposed by Mr N. F. Lythgoe, and carried warmly by the members present. The meeting was attended by 21 members and seven visitors.

J.A.H.

Paint production today

A meeting was held at the Hull College of Technology on 5 January 1970, with Mr E. A. Brown in the chair, to hear Mr R. Ward of Torrance & Sons speak on "Paint production today."

The lecturer surveyed four important classes of machinery currently available to the paint manufacturer: high speed dispersion equipment, the sand mill (open and closed or pressurised forms), the ball and pebble mill, and finally the Szegvari attritor.

In the course of his review Mr Ward dealt very fully with such matters as milling action, design geometry, mill velocities, production rate, choice of pigment and, where appropriate, discoloration of the product. Consideration was also given to the selection of millbase parameters, i.e. composition and rheology, which favoured efficient milling, and to the influence of composition on millbase stability in the let-down stage. In each case, the Daniel flow point technique provided a useful starting point towards the formulation of the optimum millbase.

During the discussion period, questions were asked by Messrs E. A. Brown, F. D. Robinson, P. Mell, J. Gibson, J. W. Wenham, S. J. Reed, and L. Tasker. The meeting concluded with a vote of thanks proposed by Mr S. J. Reed. Eighteen members and five visitors were present.

J.A.H.

London

Particle size reduction in ball milling and sand grinding

A meeting of London Section was held on 10 December 1969, at Imperial College London, SW7, with Mr J. E. Pooley in the chair. Dr W. Carr, of Geigy (UK) Pigments Division, gave a lecture with the above title.

Dr Carr said that there were particular difficulties in the dispersion of organic pigments, owing to their small primary particle size (0.1 μ) and high surface area. This made considerable demands on the dispersion process, and the results obtained depended to some extent upon the type of mill used. With the new technique which had been developed, it was now possible to determine the particle size distribution of the pigment in the millbase, as a measure of the degree of dispersion. Dr Carr then described the operation of the ICI/Joyce Loebl disc centrifuge. This was now used with non-aqueous solvent systems, with a mixture of carbon tetrachloride and white spirit as the spin fluid, which was compatible with the alkyd solution used in the millbases.

The pigments used were phthalocyanine blue, pigment green B, and dioxazine violet, all of which were non-bleeding in the carbon tetrachloride/white spirit mixture. These were dispersed in a long oil soya/penta alkyd, at 8 per cent concentration. Varying periods of milling in a ball mill and in a sand mill were used, all other factors being kept constant. The pigment dispersions at various times of milling were diluted with white spirit to 0.04 per cent solids content and 1ml of the diluted millbase was injected into the disc centrifuge on top of the spin fluid. After a specified time the sample was withdrawn from the centrifuge and analysed for pigment content. The pigment green B was merely dissolved in dimethyl formamide, while the phthalocyanine blue and dioxazine violet were dissolved in concentrated sulphuric acid and precipitated in a solution of a surface agent. All the pigments were then analysed colorimetrically. This would give one point on the size distribution curve.

The conditions investigated were ball milling from one hour to 72 hours, and sand milling from 15 minutes to eight hours. As it was inconvenient to compare the complete size distributions of each sample, the median diameter (50 per cent above and below) was used. This gave a good indication of the progress of milling and one could compare the times of ball milling and sand grinding to produce the same effect. Sand grinding generally produced a much finer product. It was possible to relate the surface area calculated from the size analyses to the BET nitrogen adsorption surface area to give a measure of the efficiency of dispersion. However, even after eight hours sand milling dispersion was not complete. Thus, with the phthalocyanine blue, the ultimate size was 0.08 μ, but the minimum mean diameter reached was 0.13 μ.

It was important to consider each pigment separately, in terms of the time necessary to achieve maximum dispersion, and the rate at which colour strength increased with increased dispersion. It might be found that there was an optimum particle size. Thus the phthalocyanine blue and dioxazine violet pigments increased in colour strength rapidly with increasing milling, whereas the pigment green B reached its optimum colour strength after 12 hours' ball milling. Storage tests had shown that there was no problem of major flocculation of the pigment dispersions after six months' storage.

In the discussion after the paper, the question was raised of the extensive dilution which was necessary. Dr Carr said that with care dilution shock could be avoided. This had been checked by dilution to different levels. After an extensive discussion a vote of thanks was proposed by Mr I. Bews.

V.T.C.

Colour control

A joint meeting with the Colour Group (Great Britain) and the London Region of the Society of Dyers and Colourists was held on 7 January 1970 at Imperial College, London SW7, with Dr R. A. Weale of the Colour Group in the Chair. Two papers were given, by Dr K. McLaren of ICI Dyestuffs Division on "Instrumental shade passing" and by Mr R. Best and Miss S. R. Williams of BIP Chemicals Ltd., on "Visual and instrumental colour tolerances in plastics."

Mr Best described some of the difficulties experienced in operating a colour control system based on visual matching, particularly when shift working necessitated essentially three or four persons to control the product. Instrumental methods based on simple tristimulus colorimeters could be used together with ellipses in the CIE system produced by visually uniform colour differences. It had been shown that ellipses of acceptability could be lopsided. It was well known that the sizes of the ellipses varied over the CIE diagram. A method had been developed involving "just noticeable differences" as a means of applying tolerances, which method could considerably reduce the time taken to reach a decision. These "just noticeable differences" varied in different regions of the colour space, and it was not valid to assume that one could multiply them by a single factor to obtain "commercial tolerances." However, it was found from experience that the errors occurring with instrumental control were less than those with visual judgments alone.

Dr K. McLaren, in his paper on "Instrumental shade passing" referred to the textile industry, which did not, in many cases, have a set of standard shades. Consequently, one was concerned with colour difference formulae. It was essential that visual judgments should be made by a large number of experienced observers and the mean taken. In practice in the textile industry it was generally found that the decision to accept or reject was made by one person. The use of a formula and instrumental methods had to be assessed against a panel of human observers, and it must allow for the fact that about 20 per cent of the individual judgments would be incorrect. Dr McLaren referred to various published comparisons on which there was sufficient data available, and showed that as a result of instrumental measurement the consequences of error were mainly in wrong rejections of samples, rather than in wrong acceptance.

The papers were followed by a lively discussion.

V.T.C.

Southern Branch

Emulsions for paint and paper

The second meeting of the 1969-70 session was held on 11 November 1969 at the Pendragon Hotel, Southsea, when Mr E. Swales and Mr Nicholson, of Vinyl Products Limited, gave a lecture on emulsions for paper and paint.

Mr Swales opened his talk by outlining the history of synthetic polymer emulsions. They were used initially by the Germans when they experienced difficulties in obtaining drying oils during the war, and by the Americans who found an outlet for synthetic rubber latex in clay coatings. In the early fifties, emulsion paints were becoming established and emulsions were used for overcoating paper. By the late fifties there was a switch to co-polymers owing to the extensive advertising, and acrylics became the most popular monomers.

At the present time, newer comonomers, namely VeoVa and ethylene, had become available. The former gave increased alkali resistance and the latter gave acrylics with good low temperature film formation. There was also styrene, which was cheap, hydrophobic, and alkali resistant. These various monomers could be selected for particular properties and used to prepare emulsions that were most suitable as distempers, primers, and undercoats.

Of the older monomers, acrylonitrile had good solvent resistance but high toxicity. Butyl methacrylate was expensive, whilst methyl methacrylate was a brittle monomer requiring high plasticisation. In comparison, styrene was cheap and hard, and possessed excellent alkali resistance, which made it useful in paper coatings. Vinyl acetate was well established in emulsion paints but vinyl chloride was of little interest because it was excessively corrosive. On the Continent vinyl proprionate was used, but it was expensive and rather too soft for paint formulations.

When selecting monomers for emulsions for use in paint or on paper, it was necessary to consider the end use requirements. In the case of paint, long-term storage was essential, with both high and low temperature stability necessary, but for paper coating, only high temperature stability was required because the coating was applied by air knife on a machine in a warm factory, whereas paint was applied by brush or spray. The rate of cover also differed, being about 200 square yards per gallon in paper coating but only 80 square yards per gallon with paints.

In paint emulsions, there was a continuing trend towards cheaper interior paints and more durable thick coatings loaded with sand for exterior use. In working towards these cheaper, but good quality, paints it had been found that polymers fell into distinct classes with respect to wet scrub resistance, and this pattern was closely followed by opacity. It had thus been found that styrene acrylate gave the cheapest paint followed by vinyl acetate/ethylene copolymers. These were followed by methyl methacrylate/acrylate copolymers which were in turn cheaper than vinylacetate/acrylate copolymers. The old externally plasticised vinyl acetate homopolymer was most expensive.

For board coating, only a short storage life was required, with good mechanical stability. A temperature of 28°C had to be tolerated and there must be no blocking. Styrene/acrylate had proved to be most economic in satisfying these requirements.

Mr Nicholson then described paper coating in greater detail. Emulsions were applied by machine, with high temperature drying conditions between 40° and 120°C and with calendering. Emulsions were used in ground coats as the adhesive for china clay, metallic or mica pigments, or for overcoating to produce washable papers. In pigmented coatings, the emulsions were used for coated paper and board as well as for ground coats for wallpaper, printing and copying paper. Emulsions were also used as clear unpigmented coatings for heat sealing, protective over-coating varnishes and copying papers. In some cases emulsions were also used as paper saturants and beater coatings.

One function of the emulsions in paper coating was to improve appearance and printability. The usual methods of printing, such as offset litho, letterpress, and gravure, required different properties. The required strength decreased from offset litho through letterpress to gravure, but offset litho was a wet process so that the paper must have good water resistance. Paper for letterpress must have good resilience, whilst solvent resistance was essential in gravure. Smoothness was important in gravure printing but less essential in litho, whilst with letterpress it was simply a matter of appearance.

When considering binders for paper coatings, certain properties were required of the wet mix. It must be stable in the presence of the pigments and the pH must remain constant. It must maintain the correct viscosity and mechanical stability during application and the rheology must be good with no foaming or settling. The coated paper must have high IGT printability rating and gloss, and it must be water resistant but yet sufficiently absorbent for the ink. The paper must be smooth white and uniform without yellowing, and for packaging it must be non-toxic and have no residual odour.

The IGT tester was demonstrated with the aid of a slide. This machine was used to check pick resistance, failure resulting from poor cohesion, low bodystock strength

and blistering. At the present time starch/latex and all synthetics were tending to replace casein. Styrene/acrylate was low in odour and non toxic and was particularly popular, although styrene/butadiene was sometimes preferred as it gave a softer finish.

B.A.R.

Manchester

The impact of British Rail modernisation on painting problems

The first Liverpool meeting of the Session was held at the Liverpool Building and Design Centre on 12 December 1969, when the chairman, Mr W. F. McDonnell, introduced Mr F. D. Timmins, Superintendent of the Surface Coatings Laboratory, British Rail, Derby. Mr Timmins' lecture—"The impact of British Rail modernisation on painting problems"—was delivered to an audience of 65 members and guests.

The content of Mr Timmins' lecture was basically similar to that given to the Trent Valley Branch, a report of which appears in this issue of the *Journal*.

Management in R & D

At a meeting under the chairmanship of Mr W. F. McDonnell, at the Manchester Literary and Philosophical Society on 9 January, Mr A. W. Pearson, Manager of the R & D unit of the Manchester Business School, read a paper "Management in R & D."

Mr Pearson introduced his subject by explaining that the R & D unit was sponsored by MinTech and that originally they thought their task was to discover the correlation between the R & D cost and profitability of a project, but had concluded that a direct link could not be found. An inter-related system from basic research to marketing operated in many projects and it was important to attribute financial success properly to each part. It was, however, feasible to compare R & D costs with other means of gaining the same end results, i.e. buying in or licensing processes, or with other means of deploying R & D effort in other fields, i.e. applied research, development, production or marketing.

Well known management techniques could be used to evaluate R & D projects and were capable of selecting very good, or very unrewarding ideas, but gave difficulties in discrimination between borderline cases.

Check lists were first described by Mr Pearson; here attributes of the project, e.g. capital feasibility, harmony with company policy and with capability of R & D staff, likely success of project, etc., were graded on a 1-6 scale and a project profile was obtained. The problem was still the decision between competing projects, and although assistance was given by weighting the various attributes, a numerical summary was obtained in which the weak and strong points were lost in the average.

The curve of discounted cash flow versus time displayed the combined success/financial attributes, but if divergence from the predicted times occurred, financial success would inevitably be less likely. What was needed was the probability of achieving a DCF/time curve.

The use of network analysis put a time scale in a project, giving dates for the various parts and for completion. If this final date produced a DCF/time curve with an unsatisfactory result, the network could be re-examined and the result on DCF of shortening some network sections, for example by increasing effort, could be found.

A series of inter-related projects could be compared by using a linear programming model; here a selection could be made to obtain an optimum result without exceeding the specified resources. If time scales were included, then the optimisation included the effects of delay in any project, and the effect of variation in available resources

could also be included. This process was similar to the mental approach used by management and used the same information, but the input and optimisation was better quantified. It had been found that most organisations did not have adequate data for feeding to linear programme models and, incidentally, little information on how projects originated.

The lecturer concluded that models would help management to make better decisions but that the fields must still be chosen with care—they must basically be capable of yielding profit.

The 58 members and guests present then took part in a wide ranging and instructive discussion; at the close the vote of thanks was proposed by Mr I. S. Moll.

D.A.P.

Midlands

Trent Valley Branch

Determination of particle size and its significance to the paint industry

The above title was the subject of a lecture given by Dr R. J. Akers of the Department of Chemical Engineering, Loughborough University, at the first technical meeting of the Trent Valley Branch this session, held at Loughborough University, on Thursday 25 September 1969.

Dr Akers began by saying that, for the purpose of measurement, the particle size of an irregularly shaped object would be defined as the size of an equivalent sphere but then showed what a considerable difference there could be between a sphere of equivalent volume and one of equivalent surface area. It was convenient but often misleading to talk of average particle size, and some comparisons by Heywood were illustrated with slides. Further works by Heywood, explained mathematically, were qualitative descriptions applied to particle shape instead of using terms such as acicular, angular, nodular, spherical, etc. and techniques for converting results of different particle count methods. On the question of representation, a statement like "not more than 3 per cent passes 60 mesh" was rather vague, and proper grading efficiency curves were required. Cumulative distribution curves were most frequently used for particle size measurement.

Various methods of measurement were described with comments. The field scanning technique, using a microscope, tended to overestimate sizes and might be tedious. Automatic scanning systems were quicker but might need correction. A good example of the stream scanning technique was the well known Coulter counter. Dr Akers used a large scale version in his department, comprising a 100 gallon tank and a six inch orifice. He was able to observe the behaviour of the "particles" (lumps of Plasticine) when the model was working.

Sieving was widely used for particle grading, but Dr Akers warned that electroformed sieves (down to 5μ size) would disintegrate with ultrasonic cleaners. Wet sieving was much more rapid than dry. Sedimentation techniques, leading to the ICI/Joyce Loebl centrifuge, were also mentioned.

An interesting discussion followed when Dr Akers replied to questions from Messrs H. F. Clay, G. Franklyn-Smith, E. Hare and P. D. Hare.

The vote of thanks was proposed by Mr D. Guest and carried with acclamation by the ten Members and four guests present.

J.R.T.

The influence of British Rail modernisation on paints and painting

An illustrated talk was given by Mr F. D. Timmins, Dr D. P. Earp and colleagues from the Surface Coatings Laboratory of the Chemical Research Division, British

Rail Technical Centre, Derby, at the second technical meeting of the Trent Valley Branch, held at the British Rail School of Transport on Thursday 30 October 1969.

Mr Timmins first requested the audience to choose provocative questions to enliven the discussion following the talk. He went on to explain that 60 per cent of their commitments dealt with modernisation and application techniques for civil engineering departments, and a further 20 per cent on quality control of supplies. The main aim was to reduce costs, and airless spray had been a tremendous success towards this end, from the application point of view. Structured coatings for this form of application necessitated the abolition of the BS Cup for all viscosity measurement, this being replaced by the cone and plate type viscometer (Shirley Ferranti). Suppliers of paint for airless spray were given specification limits of ± 0.1poise.

Electrification was a major modernisation programme, and some galvanised steel gantries expected to last ten years were breaking down in as little as two years. This was shown to be due to sulphur dioxide in the atmosphere, the concentration of which was directly proportional to the density of population. Charting this information enabled early painting programmes to be directed to those areas where pollution was most severe.

Painting had to be completed in three hours, and, as a one-coat system was not acceptable, a primer was required to be recoatable after two hours. A medium based on chlorinated rubber was chosen for this purpose. Further experiments with a range of anti-corrosive pigments showed that zinc phosphate, in chlorinated rubber medium, gave good protection over wire-brushed, rusty steelwork, enabling expensive preparation (derusting, sandblasting, etc.) to be eliminated. This led to a breakthrough in primers and a three-coat system was adopted for exceptionally high corrosion areas. Demonstration panels showed a lime green primer completely obliterated with a black undercoat, which in turn was completely obliterated with a silver metallic finish, this technique being used so that it was easy for the operator to see when adequate film thickness had been obtained, even in the hours of darkness, when most application was carried out. Etch primers were condemned as completely unsatisfactory.

Adhesion and durability of paint films were predictable using a micro-indentation technique which was explained by Mr D. Bishop, who guaranteed prediction of accelerated weathering performance using this method.

Preparation of old paint surfaces with soap and pumice rather than sanding gave sufficient adhesion of a new paint film. Too much adhesion between top coats caused the primer to come away from the substrate.

Emulsion paints were being tested throughout the country and demonstration panels were available for examination. Many commercial brands were just not good enough and paints to pass the specification were being developed.

A lively discussion followed, with Mr Burns leading the questioning on emulsion paints, Mr Franklyn-Smith on zinc phosphate primers and Mr Clay on the comparison of zinc phosphate and zinc chromate pigments. Mr Bishop explained the construction of his strain gauge paint brush and Mr Timmins ended with harsh words aimed at some commercial manufacturers of "polyurethane enamels" (urethane oil based) whose finishes were too hard to give satisfactory adhesion when subsequent repainting became necessary.

Mr Clay proposed the vote of thanks which was carried with acclamation. There were 20 members, and seven visitors present.

J.R.T.

Selected aspects of recent developments in coated titanium dioxide pigments

The third technical meeting of the Trent Valley Branch, held at the British Rail School of Transport, Derby, on Thursday 27 November 1969, incorporated a lecture given by Mr Willison of British Titan Products.

Mr Willison outlined the five main types of titanium dioxide pigments which were available a few years ago, based on the sulphate process of manufacture. This range had since been increased by implementation of the chloride process, and there were probably more than 20 grades now available.

Three grades were explained in detail, a plastic type, a latex type and a high durability type.

The plastics industry was a traditional user of anatase grades, which had a blue undertone, but, recently, the development of a fine crystal rutile form had changed the picture. Pigments were normally organic treated for the hydrophobic system of plastics, where the pigment volume concentration was of the order 2-10 per cent, compared with 20 per cent in paint. Several panels illustrated the improvements.

In latex paints, the polymer particles formed a network and the pigment occupied the spaces between. The titanium dioxide used for this purpose was heavily coated to keep the pigment particles apart. Slides illustrated that the efficiency of the heavily coated rutile grade was higher than for the standard product at all PVC levels.

In high durability systems such as thermosetting acrylics, conventional types of titanium dioxide pigments were not suitable and, as modern media absorbed smaller amounts of UV, pigments must be modified to reduce or remove the remainder of the energy. A new sulphate process rutile grade gave improved gloss retention. As this was the beginning of the era in which guarantees of 15 to 20 years would be commonplace for many finishes, the pigment manufacturer must be prepared.

In the discussion, Mr Burns requested the naming of a few simple types of pigment where simple addition gave optimum properties. A much wider discussion ranging from additives to repainting of badly chalked surfaces followed.

The vote of thanks was proposed by Mr Burns and appreciation was shown in the usual way.

J.R.T.

Thames Valley

Factories Acts and the paint industry

A most successful and crowded meeting was held at the Manor Hotel, Datchet, on Thursday 27 November. The audience heard Mr Ward, Chief Fire Officer for Buckinghamshire, and Mr R. L. Such, H. M. District Inspector for Factories, answer a wide range of questions on the working of the Factories Acts in which they managed to dispense much wit and wisdom. As an introduction, each of them sketched in the background to his particular job.

Mr Such described the factory inspectorate, which, country wide, was responsible for about 250,000 factories of very diverse activities and size and with considerable variance in the regulations which applied to each industry. There were 300,000 reportable accidents each year, of which about 600 were fatal, and they required exhaustive investigations. To cover this vast spread there were only some 350 appointed factory inspectors, with two inspectors attached to each district. Mr Such was responsible for 2,600 factories in the Bracknell, Henley, Bicester, Slough area. About 2,000 reportable accidents which demanded an investigation occurred each year in the area and some four to six were fatal. His job was, in essence, to enforce the Factories Acts, the Offices, Shops and Railways Premises Act, and subsidiary regulations in factories, offices, shops, railway premises, and Crown offices, with added new regulations being imposed every year. His main purpose was, however, to visit factories and other premises without warning and to study at first hand the hazards to personnel that might exist.

Mr Ward said that the Fire Services Act, 1947, was the cornerstone of basic policy. Under this Act, County Councils and County Boroughs were responsible for the establishment and policy of fire brigades. Since there were no County Boroughs in Buckinghamshire, the County Council was responsible for the whole area of 750 square miles, containing 570,000 population and a rateable value at risk of some £34,000,000. He was answerable to the County Council for the management and day to day operations of the fire brigade.

There were 25 fire stations but only five were continuously manned by professionals on a shift system. The remaining 20 were manned by "retained" men who followed a normal vocation in their areas and responded to the alarm when required.

All fire and emergency calls would soon be dealt with centrally at the new brigade control at Aylesbury. The County brigade now dealt with about 5,000 emergency calls a year—a three-fold increase since 1947.

The enforcement of the law on many aspects of fire prevention and fire protection was a rapidly increasing function of fire authorities. In the Buckinghamshire brigade he had a specialised and highly trained section of 12 inspectors who carried out this work. This, of course, was only one aspect of his work, unlike Mr Such who was almost wholly concerned with legal requirements.

All responsible bodies were becoming increasingly concerned at the rapidly mounting annual fire losses. Mr Ward estimated that "direct" losses alone might reach £120,000,000 in 1969.

Whilst the fire brigade felt it knew what was needed, its powers of statutory enforcement were mainly limited to the safety of life and limb. On many other important matters his service was restricted to an advisory role.

Some highly pertinent questions were put by Thames Valley members.

Mr Such was asked to what extent factory legislation was open to interpretation by factory inspectors, e.g. petroleum regulations.

He replied that the Petroleum Consolidated Act 1928 was enforced by the Petroleum Officer. He licensed all premises, all stores of petrol and was concerned with the storage of quantities over three gallons. It should be appreciated that the Factory Inspector was also involved since the petroleum mixtures are *used* in the factory as well as stored. Because the parent Act was very far reaching, there must be anomalies, but there were also regulations which could be more specific, though not sufficiently to render the factory inspector's job an easy one. However, since there was no highly detailed set of regulations, a more negotiable position could be maintained with the user or industrialist, for example terms such as "adequate," "suitable," "effective" were deliberately employed in the regulations to avoid a vast code of detailed practice and tight rules.

Mr Ward was asked what the relevance of flash point was to flammability, and replied that one had to remember the precise definition of flash point, but he was sure the audience was aware of this. Generally, the more hazardous liquids were those which evolved ignitable vapours at, or below, the prevailing atmospheric temperature, hence the concern for liquids with flash points below 73°F. But this only indicated the likely presence of ignitable vapour and not always the degree of flammability.

Certain solids could often be more hazardous—depending on their specific surface—than some of the liquids having a low flash point. Wood, for instance, could be in the form of large planks (bulk fuel), small slats (kindling) or shavings (tinder). This was fire service terminology to note the increasing degree of ease of ignition. Reduce wood to fine sawdust in suspension in atmosphere, and it was capable of explosion—a very hazardous situation from a relatively safe material in normal form.

With reference to paint spraying, which had been mentioned, the prime requirements were the exclusion of possible sources of ignition, the use of flameproof and sparkproof equipment and the constant extraction to a safe place of flammable vapour/air mixtures.

Mr Such's attention was drawn to the new draft regulations requiring a minimum flash point of 90°F instead of 73°F. What was the point of this?

The lecturer replied that this new measure was now referred to as the Highly Flammable Liquids Regulations (Draft), and it was intended to replace the existing Cellulose Regulations. Thus many more liquids, perhaps up to 80 to 90 per cent of the total, would come into the scope of the new regulations, and the issue would be flash point only, the cellulose regulations becoming irrelevant. The onus of proof would rest with the user, whoever he was, and he would in turn expect certification from his suppliers that the products, intermediates or raw materials in question had a flash point over 90°F. In this respect, continuing supplies of the product, or whatever it may be, would also need certification.

Mr Ward, in answer to a question on the relative merits of pre-warning and extinguishing systems in current use, said that a variety of warning and extinguishing systems were available to industry. A recent survey had shown that, of all the larger fires, something like 57 per cent occurred when the premises were unoccupied and (not surprisingly) at least 50 per cent were not discovered until the fire involved, or broke through, the fabric of the building. He considered that sprinklers were usually the most effective protection in industrial premises because they detected an outbreak, gave warning both externally and to the fire brigade, and attacked the fire at source. Smoke and heat detectors would also detect and warn but, of course, did not attack the fire. A fire in a non-sprinklered building was six times more likely to develop into a large fire than in a sprinklered building.

The next questioner felt that experience indicated a lack of agreement in attitudes between the factory inspector, the fire officer and the insurance companies. Would the panel please comment?

Mr Such's primary purpose was the protection of life and limb. The protection of property was of secondary importance. Insurance companies had no statutory obligations and were, of course, business concerns that must necessarily be motivated by profit. Nevertheless, as a body they were becoming more selective in the business they were prepared to accept and, furthermore, the sanction element was stronger than hitherto. At the same time, there was no clear duty on the part of the County Fire Officer that he must demand certain minimal protection—he could only advise.

As a conclusion, the two speakers looked into the future.

Mr Ward cited a multiplicity of legislation which existed with no single authority entirely responsible; this was obviously unsatisfactory for everyone concerned. He hoped for some fundamental change within the near future. For instance, means of escape in case of fire from a variety of buildings was still vested in district councils under the Public Health Act of 1936. The factory inspector was still the legal enforcing officer for fire fighting equipment, fire alarms and fire drills in factories. All these matters should be vested in fire authorities.

He also felt that insurance companies were going to be compelled to adopt increasingly tougher attitudes than previously before underwriting some of the risks offered to them. In fact, he would not be surprised to see insurance companies using their ultimate sanction of "refusal to insure" some inherently bad risks.

Mr Such concluded by referring once again to the newly developing aspects of factory law. He felt a consolidated act would finally emerge, although the groundwork and preparation would take some time. His optimistic prediction was for 1971, but he

could not be sure. If it did come about, then the fire officers, local authorities and factory inspectors would all benefit, since each of them would have a clearer remit in relation to each other. The new act would also cover *all* persons at work. A consultative document was already in being.

Thames Valley Chairman, Mr K. Chitty, proposed the vote of thanks which was most warmly supported by the audience.

R.E.G.

Scottish

Eastern Branch

Colour measurement and specification

The first ordinary meeting of the current session was held in the Carlton Hotel, Edinburgh, with Mr P. Gower in the chair, on Wednesday 22 October, when Dr R. Lakowski of Edinburgh University spoke on "Colour measurement and specification."

Because of the difficulty in describing a specific colour in a manner which would make that colour identifiable to others, a system of colour description in terms of the physical attributes of the stimulus was formulated. This system was adopted in 1931 by the International Commission on Illumination (or the CIE). This system was not subjective but took account of the precise nature of the stimulus and used a standard observer as a reference point in colour perception.

In the CIE system three imaginary primaries, X Y Z, embodying the characteristics of the red, blue, and green primaries, completely specify the various mathematical functions in the systems.

Specific viewing conditions were layed down. The CIE viewing geometry placed the illuminant at 45° to the sample of colour being examined and the sample was viewed at 90°. These viewing conditions were interchangeable. Various illuminants were specified:

Illuminant A (modified tungsten lamps run at 2,850°F).

Illuminant C (equivalent colour temperature of 6,700°K).

Illuminant D (equivalent colour temperature of 6,500°K).

Dr Lakowski concluded by explaining the chromaticity diagram for the X Y Z tristimulus and showed how these tristimulus values of X Y Z for any colour were the product of the spectrophotometric quantities of the stimulus and the colour matching quantities of the standard observer.

J.H.S.

Why do urethanes work?

The second ordinary meeting of the session was held in the Carlton Hotel, Edinburgh, with Mr P. Gower in the chair, on Wednesday 17 December, when Mr H. G. Cook, of Imperial Chemical Industries Ltd., spoke on "Why do urethanes work?"

Mr Cook introduced his lecture by describing the properties that a polymer must have to be an effective coating, namely a minimum molecular weight and a suitable geometry, for instance, a long chain polymer imparted flexibility to the coating, a rigid polymer imparted hardness and brittleness to the coating, and hydrogen bonding markedly improved strength without causing brittleness.

With the use of slides, Mr Cook then described the various types of isocyanates from the simple toluene di-isocyanate through the various aromatic and aliphatic

isocyanates available to the complex isocyanurate prepolymers. The reactivities of these isocyanates were discussed.

Isocyanates could be reacted with a large range of materials e.g. polyesters, polyethers, castor oil, pitch, epoxides, thermosetting acrylics, methacrylated alkyds, and water. All these materials did not react at the same rate and a list of the reactivities of various groups with isocyanates was given in descending order of reactivity.

Primary amines
primary alcohols
water
ureas
secondary and tertiary alcohols
urethanes
carboxylic acids
carboxylic acid amides

The reactivities of various catalysts were discussed, in particular di-*n*-butyl tin acetate and tertiary amines.

Finally Mr Cook described the ways of overcoming the problem of making coatings with these materials, in particular the removal of all traces of water. It was important to start with as dry materials as possible and any traces of water would be got rid of by:

use of molecular sieves to remove the water physically,

use of tin-ethyl-*o*-formate, or

pigment plus solvent could be reacted with a small quantity of isocyanate and allowed to stand overnight.

All these methods had some drawbacks and these were indicated.

After a lively discussion period Mr C. Cochrane proposed the vote of thanks.

J.H.S.

An Appreciation

Mr A. Z. Molteni

Dr H. Houlston Morgan, Past President and Founder Member, writes—"I was sorry to hear of the death of my old friend A. Z. Molteni, thus reducing the number of Founder Members still living to three, R. P. L. Britton, H. R. Wood and myself. Although now tinged with inevitable sadness I have pleasurable memories of his cheerful personality, lively sense of humour and his keen enthusiasm in the formation of the Oil and Colour Chemists' Association and his strong support in furthering its aims and objects during its very early years.

He was a regular attender at meetings and usually made useful and constructive contributions to the discussions following the reading of papers. At this period he was chemist at the factory of Jensen and Nicholson Ltd., where he had gone after obtaining the Associateship of the Royal College of Science, in Chemistry, in 1915.

In April 1919 he read a comprehensive and well-balanced paper entitled "The problem of corrosion of iron and its relation to the paint and varnish industry" in which the subject and the author's views were clearly and forcibly expressed. Towards the end of the paper he made what was probably the first openly expressed suggestion that a "Research Association be formed, supported by the trade and working for the benefit of the whole industry, similar to those being organised by other industries." The Chairman, Dr M. B. Blackler, in opening the discussion, said that such a suggestion was "too Utopian from our present standpoint," which indeed proved all too true. A period of seven years had to elapse before such an Association was formed and even then with small capital and limited faith. Incidentally, I have given a fully documented account of how this came about in my "Recollections" published in the December 1960 Issue of *Paint Technology*.

At the Annual General Meeting in 1920 Mr Molteni was elected a Member of Council but unfortunately he forsook the paint and varnish industry soon afterwards to join the staff of chemists of Lever Brothers Ltd., at Port Sunlight, where he stayed until his retirement some ten or more years ago.

I believe he never again attended any meeting of the Association but he retained clear and pleasant memories of the few years he spent in the paint and varnish industry. Thus, about ten years ago he took the trouble of writing an account of his recollections and impressions of those years for the benefit of those engaged in writing the History of the Association and he also presented to the Association a batch of documents relating to them which he had treasured so carefully for some 35 to 40 years, to replace those lost during the 1939-45 war.

Making special journeys to London from his home in Cheshire for the purpose, he regularly attended the reunions held annually during the last 12 to 14 years when the Council entertained to dinner Founder Members, Past Presidents and Past Honorary Officers. Having great respect and high regard for the initiative and hard work of the First Honorary Secretary of the Association he came specially to London for the Carwood Memorial Lecture and Dinner held in the Painter-Stainers Hall in 1963. Molteni was a loyal friend with whom I always enjoyed an interesting chat when we met at the reunions mentioned above."

Technical Exhibition

The Committee is pleased to report that arrangements for the Twenty-second Technical Exhibition, to be held from 27-30 April 1970 in the Empire Hall, Olympia, are well advanced. Copies of the *Official Guide* have been dispatched to Members of the Association and to chemists and technologists in Europe. Many copies have been sent on request and anyone wishing to have a copy should apply to the Association's offices.

Posters and information leaflets in six languages have been sent to technical colleges, Embassies and paint and printing ink manufacturing companies in many countries.

A large number of applications have already been received for the Exhibition Luncheon, to be held at the Savoy Hotel, London WC2, at 12.15 p.m. on Monday 27 April, and anyone wishing to attend should apply for a ticket (price £3 0s 0d each) on the form enclosed in each copy of the *Official Guide*. If any person wishes to have further copies of the application form, these may be obtained from the Association's office at the address given on the front cover of this *Journal*.

Lord Sherfield, GCB, GCMG, President of the Parliamentary and Scientific Committee, has kindly consented to be Guest of Honour at the Luncheon and to perform the opening ceremony at 3 p.m. at the Empire Hall.

Bristol Section

Student Symposium 3-5 April

The programme for the Bristol Section's weekend symposium, intended for students and newer entrants to the paint, printing ink and allied industries, has now been arranged, and is shown below.

Friday 3 April

18.30	Dinner
20.00-21.00	"Organic pigments"

Saturday 4 April

09.15-10.15	"Inorganic pigments"
10.15-11.15	"Industrial paint media"
11.15-11.30	Coffee
11.30-12.30	"Printing ink media"
12.30-13.45	Lunch
13.45-14.45	"Colour"
14.45-15.45	"Solvents"
15.45-16.00	Tea
16.00-17.00	"Decorative paint media" (a) Solvent-borne paints (b) Emulsion paints
17.00-18.00	Discussion period
18.30	Dinner

Sunday 5 April

09.30-10.30 "Quality control"
10.30-10.45 Coffee
10.45-12.30 Films
12.30 Lunch

The symposium will be held at Hiatt Baker Hall, University of Bristol, where meals will be available, and, if required, overnight accommodation can be arranged.

The charge to delegates will be £2 10s, which will include all meals from dinner on the Friday to lunch on the Sunday, as well as pre-prints of the lectures. The charge for those requiring overnight accommodation will be £6, which will include all meals and pre-prints, as above.

Both Members and non-members of the Association are welcome to attend, and should contact the Section Chairman, Mr J. R. Taylor, 51a Porth y Castell, Barry, Glamorgan.

Scottish Symposium and Association AGM

Dispersion in theory and practice

The programme for the Symposium "Dispersion in theory and practice," to be organised by the Scottish Section at East Kilbride, near Glasgow, in conjunction with the Association's Annual General Meeting, has now been arranged.

Careful selection of lecturers and subjects has been made, so that the Symposium committee's stated object, that of bringing together research workers carrying out fundamental studies and technologists and managers concerned with dispersion as an industrial operation in a commercial context, can best be achieved.

A panel of speakers of recognised authority has been assembled to cover the various aspects of the subject. After each lecture, about thirty minutes has been allocated for discussion, and at the close of the Symposium, an overall summary will be made, and a longer and more general discussion will take place.

The detailed programme is given below.

Thursday 21 May

10.30 Opening address.
11.00 "Some aspects of pigment dispersion, with particular emphasis on carbon black," by Mr W. M. Hess and Mr M. D. Garret, of Columbian Carbon Co. Ltd.
12.30 Lunch.
14.00 "Dispersion in aqueous media" by Dr W. Carr, of Geigy (UK) Ltd.
15.30 "The influence of non-aqueous media on dispersions," by Mr K. Pond, of Lorilleux & Bolton Ltd.
17.30 Annual General Meeting of the Association.

Friday 22 May

09.30 "Some aspects of dispersion in relation to titanium dioxide," by Dr R. Amberg, of Kronos Titanium Pigments Ltd.
11.00 "The influence of interfacial activity in paint films on their properties," by Dr W. Funke, of the Forschungsinstitut fur Pigmente und Lacke EV.
12.30 Lunch.
14.15 "Dispersion machinery" by Dr J. B. Slinger of ICI Ltd.
15.45 Summing up by Dr S. H. Bell, of the Paint Research Association, followed by a general discussion.

All lectures will be held in the Ballerup Hall, in the Civic Centre, East Kilbride. Lunch will be served to all registrants in the Bruce Hotel, East Kilbride. Morning and afternoon coffee will also be supplied.

Association AGM and Dinner

The Association's Annual General Meeting will be held in the Ballerup Hall at 17.30 on Thursday 21 May, and will be followed (19.30 for 20.00) by a dinner at the Bruce Hotel. All registrants, whether members of the Association or not, will be welcome at the dinner, the charge for which will be £2 10s inclusive of wines. Dress will be informal.

Accommodation

All bedrooms at the Bruce Hotel have been reserved for the Symposium for the nights of Wednesday 20 and Thursday 21 May, and the charge has been agreed at 55s per night for bed and breakfast. Participants wishing to extend their stay over the weekend may do so at the same rate, if the reservation is made on the Symposium reservation form.

Arrangements have also been made to provide additional accommodation in other hotels of comparable standard within easy reach of the Ballerup Hall, should bookings exceed the capacity of the Bruce Hotel. Payment in all cases will be direct to the hotel in question.

Transport

East Kilbride is within easy reach of Glasgow, local trains departing at regular intervals from Glasgow Central Station, which is close to the terminus for airport coaches in St. Enoch Square, and thus convenient for both air and rail travellers. If there is sufficient demand, the Bruce Hotel will provide transport direct from Glasgow Abbotsinch Airport.

Exhibition

A small exhibition of the latest developments in industrial dispersion equipment will be held in the foyer of the Ballerup Hall during the Symposium.

Social Programme

A programme of outside activities has also been arranged, primarily for the benefit of the families of delegates. All-day tours, to the Loch Lomond area on the Thursday, and to Edinburgh on the Friday, will take place, and a conducted tour of the East Kilbride fashion goods factory of Lerose is to be organised. Numbers on some excursions may have to be limited, and applications should be made as early as possible to ensure a place.

All delegates and their guests will have the use of the excellent local golf course, and it will be possible for those interested to visit the National Engineering Laboratory at East Kilbride.

Fees

Fees for the Symposium, which will include a set of short summaries of all the papers to be presented, will be as follows:

Members	£5
Student Members	£1 10s
Non-members	£7 10s

Application forms have been dispatched to all UK, Irish and General Overseas Members, and any other interested person should contact the Symposium Secretary, Mr I. R. McCallum, P. W. Hall Ltd., Woodilee Industrial Estate, Kirkintilloch, Glasgow, **no later than 31 March.**

Association Dinner Dance 1970

As reported in the January Journal, Council has approved the arrangements for the Association's Biennial Dinner Dance, to be held at the Savoy Hotel, London WC2. This will be held on Friday 29 May with the reception at 7.00 p.m. prior to dinner at 7.30.

After dinner there will, on this occasion, be three short speeches, so that dancing to the Jerome Orchestra may begin as soon as possible, and this will continue until 1 a.m. There will be an interval at 11.30 p.m. for refreshments, and a cabaret has been arranged to take place at this time also.

Applications for tickets (at £4 4s 0d each) were circulated to Members early in January, and non-members wishing to attend should apply to the Director and Secretary, at the Association's offices.

Association Conference, 4-8 May 1971

Surface properties and appearance

Council has decided that the theme of the 1971 Association Conference shall be "Surface Properties and Appearance." It is intended to hold four technical sessions, each of three papers, on the three mornings of the Conference and one afternoon. The other two afternoons will be devoted to workshop sessions and the Annual General Meeting of the Association. It is also intended, on this occasion, to hold a session on "The Management of Innovation," to run parellel with the afternoon technical session.

Submission of papers for the technical sessions

An invitation is now extended to any person, whether or not a member of the Association, who feels that a report of his work in this field may be suitable to be one of the 12 technical papers, to submit a synopsis (of approximately 250-500 words) to the Honorary Research and Development Officer of the Association (Mr A. R. H. Tawn, 34 Crest View Drive, Petts Wood, Kent) **not later than Friday 3 April 1970.** A few authors have already been invited to submit papers, but the remainder will be chosen from those synopses received. Papers selected for presentation at the Conference will be required in final draft by 1 September 1970. It will be appreciated that, on this occasion, the Association's Conference is being held earlier than usual, i.e. 4-8 May 1971, and it is necessary to prepare full pre-prints to be sent to all those who have registered at least one month before the conference.

It will be recalled that it is the custom at the Association's Conferences for the authors merely to outline their papers, highlighting points of interest, and for a general discussion of the paper to follow. The author will not be expected to deliver the paper *in toto*, since the object of sending out the pre-prints in advance is that delegates may read these thoroughly before the Conference.

Venue

The venue for the Conference will be the Palace Hotel, Torquay, which has been the venue for three previous Association Conferences, in 1957, 1961, and 1965.

Full details concerning the registration fees, and a form of application, will be sent to all Members of the Association before the end of this year; non-members wishing to receive these details, when available, should apply in writing to the Director & Secretary at the Association's offices.

News of Members

Mr K. B. Gilkes, an Ordinary Member attached to the Newcastle Section, has been appointed Technical Service Manager of Resinous Chemicals Limited.

The post has been newly created, with the object of ensuring that new and existing customers have available any technical help and advice which may be required.

Mr A. E. Slade, an Ordinary Member attached to the Thames Valley Section, has been appointed Technical Service Manager, Applied Research and Technical Service Department, Millwall, for S.C.C. Colours Limited. Mr Slade's duties will be to increase and improve technical service to customers, and he will continue to be responsible to the Assistant Director of Research and Development (South).

Dr D. M. Stead, an Ordinary Member attached to the Scottish Section, has retired from his position as Technical Director of the Geigy (UK) Limited manufacturing plant at Paisley, as from 31 December 1969. Dr Stead joined the

Geigy group in 1939, when he was a research chemist with James Anderson and Company (Colours) Limited, and remained with the company until it became part of Geigy's Pigments Division in 1965, during the group reorganisation, at which time he became Manufacturing Director.

He joined the association in 1951, and was Chairman of the Scottish Section from 1958-60.

Tenth FATIPEC Congress

Preparations for the tenth FATIPEC Congress, to be held in Montreux, Switzerland, from 7 to 13 June, are well under way, and the final details should soon be available. Response to the call for papers has been such that a full programme of lectures is expected under the twin themes "Resistance and deterioration of modern paint films, related to paint formulation, manufacturing process, application methods and surface treatment" and "The behaviour of printing inks in dependence of formulation, manufacturing, substrate and printing processes."

Those interested should contact the Congress Secretariat, 42 Grand-Rue, Case postale 97, CH-1820 Montreux.

SDC Discussion Meetings

The Society of Dyers and Colourists, on behalf of the Perkin Centenary Trust, is to organise a series of discussion meetings, designated "Perkin Discussions." The first of these will be held at Ashridge Management College, Berkhamsted, Herts, from 1-4 September 1970, under the title "Advances in dyeing theory."

Full details are available from the General Secretary and Editor, Society of Dyers and Colourists, PO Box 244, 19 Piccadilly, Bradford 1, and applications close on 31 March 1970.

Erratum

Please note that the address of Mr G. F. Jones, the Irish Section Hon. Training Officer, is not given correctly on page 7 of the January 1970 issue. This should read as follows:

G. F. Jones, Esq.,
Irish Printing Ink Co. Ltd.,
Eclipse Works, Dublin Road,
Swords, Co. Dublin,
Ireland.

Register of Members

The following elections to membership have been approved by Council. The Sections to which the new members are attached are given in italics.

Ordinary Members

BANKS, JAMES ALAN, BSc, 33 Fairfields, Dunscar, Nr. Bolton. (*Manchester*)

BRIDGE, CHRISTOPHER JAMES, BSc, 97 Methuen Road, Renfrew, Scotland. (*Scottish*)

CROW, WILLIAM, Armstrong Cork Co. Ltd., Kingsway South, Team Valley, Gateshead, Co. Durham. (*Newcastle*)

DEAN, WILLIAM HERBERT, 12 High Park, Hallatrow Road, Paulton, Bristol. (*Bristol*)

DOYLE, JOHN MARTIN, BSc, LRIC, 44 Carrowmore Road, Chester-le-Street, Co. Durham. (*Newcastle*)

FRAZEE, JERRY D., PhD, MA, BS, Texas Highway Dept., Section D-9, Paint Lab., 38th & Jackson Sts., Austin, Texas 78703, USA. (*Overseas*)

HALL, LEONARD, 18 Argo Street, Bolton, Lancs. (*Manchester*)

HAMDULAY, SIRAJUDDIN ABDUL REHMAN, BSc, 49 Glenparke Road, Forest Gate, London E7. (*London*)

INMAN, ERIC RICHARD, BSc, PhD, FRIC, 23 St. Andrews Drive, Bridge of Weir, Renfrewshire. (*Scottish*)

KERNOHAN, ALLAN GRANT, BSc, 34 Springhill Gardens, Glasgow S1, Scotland. (*Scottish*)

LADD, MEURIG EVANS, BSc, Dolrannog, Newport, Pembrokeshire. (*Bristol*)

LEVER, BRIAN GEORGE, ARIC, MInstMC, Armstrong Cork Co. Ltd., Team Valley Trading Est., Gateshead, Co. Durham. (*Newcastle*)

LLOYD, PETER CHARLES, Shepherds Grove, 114 Nursery Road, Taplow, Maidenhead, Berks. (*Thames Valley*)

LUNA DE PRADA, JULIAN, Licence en Sciences, Laboratoire Central Voine-Kuhlmann, 95 Rue Danton, 92 Levallois Perret, France. (*Overseas*)

MOFFAT, WILLIAM EASDON GLEN, 10 Norfolk Crescent, Sidcup, Kent. (*London*)

MORRISON, ANTHONY BARRY, BSc, 17 Drumbeg Luan, Killcarn, Glasgow, Scotland. (*Scottish*)

ONLEY, MALCOLM HOWARD, MA, 1 Bloomfield Road, Harpenden, Herts. (*London*)

PARODI, GIANCARLO, Via Voltri 5/23s, Voltri, Genova, Italy. (*Overseas*)

WAYGOOD, JOHN BRIAN, No. 7 Goetre Bellaf Road, Dunvant, Swansea, Glam. (*Bristol*)

WINDER, KEVIN RICHARD PATRICK, BSc, 16 Clayton Drive, Thurnscoe, Rotherham, Yorkshire. (*West Riding*)

Associate Members

BROWN, FRED GLYN, 15 Heathfield Close, Maidstone, Kent. (*London*)

DUNFORD, STUART, 36 Nevill Road, Uckfield, Sussex. (*London*)

STORER, DAVID LEONARD, 3 Blenheim Gardens, Denvilles, Havant, Hants. PO9 2PN. (*London*)

Student Members

NEAL, PETER CHARLES, 32 Davies Lane, Leytonstone, London E11. (*London*)

THOMPSON, HARRY DAVID, 289 Bolton Road, Radcliffe, Lancashire. (*Manchester*)

TRUEMAN, CHRISTOPHER MICHAEL, 52 Warwick Avenue, Slough, Bucks. (*Thames Valley*)

Forthcoming Events

Details are given of meetings in the United Kingdom up to the end of the month following publication, and in South Africa and the Commonwealth up to the end of the second month.

Monday 2 March

Hull Section. Ladies Evening. Talk and demonstration by a member of the Reckitt & Colman Toiletries Research and Development Laboratory at the Queens Hotel, George Street, Hull, at 7.00 p.m.

Thursday 5 March

Newcastle Section. "Modern paint factory layout," by Mr C. Moore, of Dufay Paints Ltd., to be held at the Royal Turks Head Hotel, Grey Street, Newcastle, at 6.30 p.m.

Tuesday 10 March

West Riding Section. "Colour measurement"—Film by Dr D. Patterson, of Leeds University, to be held at the Griffin Hotel, Boar Lane, Leeds 1, at 7.30 p.m.

Wednesday 11 March

Bristol Section. Annual Dinner Dance at the Mayfair Suite, Bristol Entertainments Centre.

London Section. Half-day Conversazione: "Paint user test methods," to be held at the Borough Polytechnic, Borough Road, SE1.

Newcastle Section—Student Group. Film show to be held in Lecture Theatre A406 of Rutherford College of Technology, Newcastle upon Tyne, at 3.00 p.m.

Thursday 12 March

Scottish Section. "Wood finishes," by Mr E. R. Stray, of the Furniture Industries Research Association, to be held at the St. Enoch Hotel, Glasgow, at 6.00 p.m.

Midlands Section—Trent Valley Branch. Workshop session consisting of an introductory talk by Mr R. D. Brace, to be followed by an open forum. To be held at the Business Administration Dept. of the Nottingham Regional College of Technology, at 6.30 p.m.

Friday 13 March

Manchester Section. "Thermoset acrylics—what next and where?" by Mr P. V. Robinson, of Styrene Co-Polymers Ltd., to be held at the Liverpool Building and Design Centre Ltd., at 6.30 p.m.

Saturday 14 March

Scottish Section—Student Group. "Pigments and extenders," to be held at the St. Enoch Hotel, Glasgow, at 10.00 a.m.

Tuesday 17 March

London—Southern Branch. "Artists paints—oils and water," speaker to be arranged. To be held at the Pendragon Hotel, Clarence Parade, Southsea, at 7.00 p.m.

Friday 20 March

Irish Section. "Industrial management" by Mr I. Kenny, of the Irish Management Institute, to be held at the Clarence Hotel, Wellington Quay, Dublin, at 8.00 p.m.

Bristol Section. "Modern trends in building and building paints," by Mr P. Whiteley, of the Building Research Station, to be held at the Angel Hotel, Cardiff.

Midlands Section. The Newton Friend Lecture, "Cosmetics—odour and colour" by J. P. Slater, Avon Cosmetics Ltd., to be held at the Chamber of Commerce House, 75 Harbourne Road, Birmingham 15, at 7.30 p.m.

Wednesday 25 March

Scottish Section—Eastern Branch. "Reflections on the career of a professional footballer," by Mr A. Glenn of Isaac Spencer Ltd., to be held at the Carlton Hotel, Edinburgh, at 7.30 p.m.

Thursday 26 March

Thames Valley Section. "Adhesives and adhesion" by Mr N. C. MacDonald, of Evode Ltd., to be held at the Manor Hotel, Datchet, Bucks., at 7.00 p.m.

Thursday 2 April

Newcastle Section: Annual General Meeting to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne at 6.30 p.m.

Tuesday 7 April

West Riding Section: Annual General Meeting to be held at the Griffin Hotel, Boar Lane, Leeds 1, at 7.30 p.m.

Wednesday 8 April

Manchester Section—Student Group. "Laboratory environmental tests—correlation with practice," by Mr A. Hipwood, of the Chemical Inspectorate, Woolwich Arsenal, to be held in the Pavilion Suite, Lancashire County Cricket Club, Old Trafford, Manchester 16, at 4.30 p.m.

Thursday 9 April

Midlands Section—Trent Valley Branch. Annual General Meeting. "Paint, art, colour and heraldry," by Dr S. H. Bell, of the Paint Research Station, to be held at the British Rail School of Transport, London Road, Derby, at 7.00 p.m.

Friday 10 April

Scottish Section. Annual General Meeting followed by the Smoker. To be held in the St. Enoch Hotel, Glasgow, at 6.00 p.m.

Tuesday 14 April

London Section—Southern Branch. Annual General Meeting, to be held at the Pendragon Hotel, Clarence Parade, Southsea, at 7.00 p.m.

Wednesday 15 April

Thames Valley Section. Annual General Meeting followed by a talk and films: "China clays in pottery," by Mr M. A. Hurst of English China Clays Sales Co. Limited, to be held at The Manor Hotel, Datchet, Bucks at 7.00 p.m.

Thursday 16 April

Irish Section. Annual General Meeting, preceded by a buffet and followed by a Social, to be held at the Clarence Hotel, Wellington Quay, Dublin, at 8.00 p.m.

Friday 17 April

Manchester Section. Annual General Meeting to be held in the Pavilion Suite, Lancashire County Cricket Club, Old Trafford, Manchester 16, at 6.30 p.m.

Wednesday 22 April

Scottish Section—Eastern Branch. "Science and the rule of thumb approach," by Mr G. H. Hutchinson, of A. B. Fleming & Co. Limited, to be held in the Carlton Hotel, North Bridge, Edinburgh 1, at 7.30 p.m.

Thursday 23 April

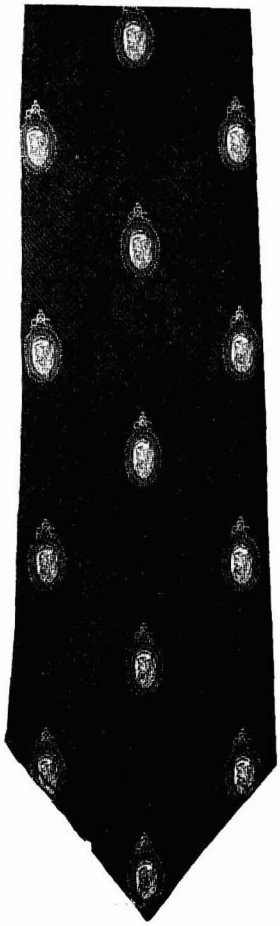
London Section. Annual General Meeting, to be held at the Criterion-in-Piccadilly, London W1, at 6.30 p.m.

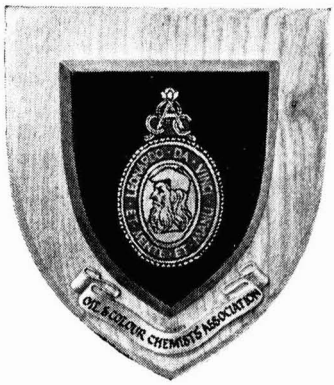
Midlands Section—Trent Valley Branch. "The operating & design principles of high speed dispersers" by F. K. Daniels, of Daniel Products Co., New Jersey, USA. To be held in the T1 Main Lecture Theatre in the Applied Science Building, Nottingham University, at 6.30 p.m.

Friday 24 April

Bristol Section. Annual General Meeting, to be held at the Royal Hotel, Bristol, at 7.15 p.m.

Midlands Section. Annual General Meeting, to be held at the Winston Restaurant, Birmingham, at 6.30 p.m.





The tie is blue terylene, with the Association's insignia woven in red and gold silk.

The blazer badge has the insignia embroidered in silver and gold wire on a red and blue ground.

The plaque has the insignia hand-painted in red and gold on a blue ground.

The car badge has the insignia embossed in red and gold on a blue ground, the whole being covered in transparent polypropylene, with a thick chrome surround. Bar and grille fittings are available.

In order to commemorate the Fiftieth Anniversary of OCCA, Council has authorised the production of a tie, blazer badge, wall plaque and car badge bearing the Association's insignia. These Items are available only from :—

THRESHER & GLENNY

Lancaster Place, Strand, London, W.C.2.

To : Thresher & Glenny Ltd., Lancaster Place, Strand, London, W.C.2.
As a member of the Association, please accept my order for the following:

.....OCCA tie @ 20/–	.....
.....OCCA blazer badge @ 63/–	.....
.....OCCA wall plaque @ 33/6	.....
.....OCCA car badge @ 36/6 (state bar or grille)	.....
(All prices include postage and packing)	_____
If tie is required airmail add 6s. 6d.	_____
Total Remitted	_____

Name .....

Section/No. .....

Address .....

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.....

.....

The ties will be supplied from stock; all other items are made to order. Only the tie can be supplied by airmail at an extra cost of 6s. 6d.

CLASSIFIED ADVERTISEMENTS

Classified Advertisements are charged at the rate of 9s. per line. Advertisements for Situations Wanted are charged at 2s. 6d. per line. A box number is charged at 1s. 0d. They should be sent to the Director & Secretary, Oil & Colour Chemists' Association, Wax Chandlers' Hall, Gresham Street, London, E.C.2. Telephone: Monarch 1439

SITUATIONS VACANT

FREELANCE TECHNICAL TRANSLATORS

from English into own tongue required. Overseas technologists with experience in the paint, plastic and ancillary industries wanting such work are requested to write briefly, in English, about their experience, preferred subjects and fees, to
H. D. Jefferies, 4 Tintern Avenue, Billingham, Teesside, England.

SITUATIONS WANTED

QUALIFIED CHEMIST, 27, with 10 years, experience in Paint Industry including Development, Production Management, Technical Service and Sales, recently returned from far east, seeks further overseas post. Box No. 316.

COURSE AVAILABLE

UNIVERSITY OF LEEDS

DEPARTMENT OF COLOUR CHEMISTRY AND DYEING

M.Sc. COURSE IN COLOUR CHEMISTRY

Applications are invited for entry to a twelve month postgraduate course commencing October 1970. The course, which will lead to the degree of M.Sc. by examination, will provide instruction in the branches of chemistry of particular concern to those whose interests lie in the field of colour. The course will consist partly of lectures on the chemistry of colour matters, the physical chemistry of absorption, photochemistry, colour physics and the chemistry of natural and synthetic polymers. The remainder of the course will be concerned with practical instruction and a research project. Applicants should normally possess a good Honours degree (or its equivalent) in chemistry or related subject.

The course is accepted as suitable for the tenure of S.R.C. Advanced Course Studentships. Firms wishing to second members of their staff may reserve places for candidates to be named at a later date.

Applications and enquiries should be addressed to Professor I. D. Rattee, Department of Colour Chemistry and Dyeing, The University, Leeds LS2 9JT.

COURSES AVAILABLE

THE CITY UNIVERSITY

DEPARTMENT OF OPHTHALMIC OPTICS

COURSE ON INDUSTRIAL COLORIMETRY

This Course is intended for scientists and technologists concerned with Colour Measurement in Industry and deals with the fundamentals of the subject. The Course includes both lectures and practical work.

It will be held all day on Wednesdays, for SEVEN weeks, beginning on 8th April and ending on 20th May 1970. Fee: £25.

Details and application forms from: The Secretary, Department of Ophthalmic Optics, The City University, Cranwood Annexe, Cranwood Street, London E.C.1.

Technical Exhibition

22 OCCA

27-30 April 1970

EMPIRE HALL, OLYMPIA,

LONDON

introduction to paint technology

second edition with additional chapter

The sales of this Association publication now exceed 13,000, and because of continuing high sales of the second edition, and the need for a work of reference to be constantly abreast of the latest developments in its field, the Council of the Oil and Colour Chemists' Association has authorised the addition of an eleventh chapter to the 'Introduction to Paint Technology.' Entitled 'Recent Developments,' the Chapter incorporates up-to-date information on the latest advances in the technology of the paint and allied industries.

This addition will help the 'Introduction to Paint Technology' to maintain its position as an invaluable aid to young entrants into the industries and to marketing and other personnel requiring a basic knowledge of the principles and techniques of surface coating production and application.

new chapter

The new chapter is subdivided to three sections

resins and media

Including polyester, epoxy, polyurethane resins and developments in water based paints vinylics, etc.

application techniques

Including electrodeposition, powder coatings, strip-coating, aerosol spraying.

instrumental testing and control methods

Including colour measurement, viscometers, brushability, hardness, film thickness, weatherometers, and use of computers.

The book contains 204 pages including 11 line diagrams, 8 photographs of common paint defects, and comprehensive index. Copies can be obtained from the Oil and Colour Chemists' Association, Wax Chandlers' Hall, Gresham Street, London E.C.2, price 20s. (post free).

Printed in England by Metchim & Son Ltd., 8 Storey's Gate, Westminster, London, S.W.1