The 12th Reinforced Plastics Congress 1980

MARKETS FOR THE 80's

The British Plastics Federation
Reinforced Plastics Group

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The British Plastics Federation Reinforced Plastics Group

The **British Plastics Federation** is the representative body of the plastics industry in the United Kingdom . It coordinates the efforts of its members to expand trade, both at home and abroad, by protecting and pursuing their technical and commercial interests. It also represents the industry on legislative and government matters relating to plastics.

The activities of the British Plastics Federation (BPF) are undertaken by twelve groups, each dealing with a specific aspect of the plastics industry. A group for reinforced plastics was established in 1958.

Reinforced plastics (RP) have achieved prominence as strong lightweight materials with unique moulding characteristics and properties which clearly distinguish them from other plastics. The Federation, as early as 1952, set up a technical committee on glass fibre and asbestos reinforced plastics to cater for the problems of this new industry. As the industry expanded, the committee grew until it necessitated the formation of a group.

The aim of the **Reinforced Plastics Group** is to promote in every way the interests of the industry:
—by tackling technical and commercial problems associated with raw materials, fabrication and machinery
—by cooperating with outside agencies (eg government departments and other organisations) in the use of reinforced plastics
—by establishing and maintaining good relations with the Press
—by the active promotion of reinforced plastics as a material
—by the encouragement of research to widen the knowledge of the behaviour of reinforced plastics and to establish design criteria.

The RP Group exists as a 'collective body' of companies drawn from fabricators, suppliers of resins, reinforcements and ancillary materials, and machinery manufacturers. Through being representative of the reinforced plastics sector, the Group can monitor, protect and pursue the interests of the industry. In order to achieve this, the Group has been structured to facilitate the monitoring of developments within the industry, both commercial and technical, and to respond speedily to those problems and needs.

Integral to these activities is the central role of the Group Management Committee (GMC), the policy making and enacting body. It is the GMC that determines the Group's numerous work programmes that are delegated to its committees and working parties.

The technical work of the Group is undertaken by the Technical Committee to which all members of the Group are entitled to send representatives. Thus it is a committee fully representative of the various elements that make up the reinforced plastics industry. The Technical Committee appoints sub commitees to deal with specific matters and currently topics such as the monitoring and technical research of atmospheric styrene, the incidence of blistering and water degradation, customer safety and information, methods of testing and design data, are being studied. The Group gives considerable assistance to the British Standards Institution and to other official bodies in the preparation of standards or codes of practice relevant to reinforced plastics.

In dealing with its members' technical needs, the Group has become all to conscious of the particular difficulties and requirements of the specialist industrial sectors of the reinforced plastics industry, such as building, marine, land transport, etc. In response it has launched a scheme for establishing specialist sections for those manufacturing companies involved in a particular industrial sector. The first of these sections was the *Chemical Plant Manufacturers Section*, which comprised of those companies involved in the design and fabrication of RP chemical products, and represented approximately eighty per cent of that specific industrial market sector. The Chemical Plant Manufacturers Section has developed its own autonomous role within the Group, concentrating on those issues which it has determined crucial to its sector and has subsequently undertaken an ambitious programme of work. This programme currently includes discussion with specifying and inspection authorities to obtain a common approach in the supply of technical information and data and a survey of available information on GRP dust and fumes.

The promotion of reinforced plastics as a unique high performance engineering material is an integral part of all the Group's activities and it is specifically and actively engaged in professionally promoting reinforced plastics, principally through a series of group publications. These include a guide to High Performance Plastics Composites, Engineering Design Properties of GRP, Repairs to Blisters in Glass Fibre Hulls and the up dated Buyers' Guide. The Reinforced Plastics Group has actively participated in the Design Engineering Show both in 1979 and 1980 by supplying components and information for use on the Federation's stand.

Additional to these activities is the dissemination of information about member companies and their particular products from the Federation's comprehensive Information Bureau.

The Group also plays an active role in the affairs of the EEC where they are relevant to reinforced plastics, through the GPRMC. (The Organisations of Reinforced Plastics Associations of the Common Market) which is in turn affiliated to EUTRAPLAST (Committee of Plastics Converters Associations of Western Europe). The aim is to promote and to protect the common professional interests of its member bodies and to ensure regular liaison. The RP Group is active through the GPRMC in examining and producing input to the relevant EEC directives, particularly in boats, pipes and underground storage tanks.

Details of membership of the Reinforced Plastics Group may be obtained from the Membership Manager at the Federation offices.

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The competitiveness of reinforced plastics against metals: Trends in the 80's

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1. Introduction

The basic question which this paper sets out to examine is: can reinforced plastics still be as competitive against more traditional materials at the end of this decade as they are at the beginning? The question is worth examining in very broad terms at the start of a conference such as this, before we all become deeply involved in discussing the successes – and the problems – of particular materials, applications and industry sectors.

That reinforced plastics, particularly the various glass-reinforced materials, are competitive in 1980 is an assumption; if not quite self-evident it will certainly be demonstrated in later papers on the programme. The present paper is concerned with identifying basic factors which may shift the balance one way or the other. It will concentrate on medium and long term trends, and in doing so it may seem to pay scant attention to the month-by-month fluctuations which afflict the GRP business like any other; this is quite deliberate.

There is no doubt that one of the major factors which will determine the future competitive position of GRP against alternative materials will be the trend in costs of production. In the long run the level of total costs must be the key determinant of the trend in prices, at least in growing markets; there are other determinants, particularly in the shorter term, and we shall examine some of them, but costs are fundamentally important.

Fibreglass Limited would have encountered some difficulty in setting out into the field to obtain detailed intelligence on current and future production costs of the alternative materials in question, and literature research alone would at best have yielded a superficial picture. In order, therefore, to present reliable and independent information on this topic we have drawn upon the expertise of two London-based consultancy companies – Commodities Research Unit Ltd., and Chem Systems International Ltd. A recent analysis carried out by CRU, with the assistance of CSI, provided detailed estimates of the costs of production of a range of metals, plastics and other materials over the next fifteen years. The study was itself based on work carried out over several years by both companies in the field of comparative cost and market analysis; the results are believed to be as authoritative as any available, but being forecasts they are naturally not guaranteed.

The estimates and forecasts provided directly by CRU/CSI are for *semi-finished material* – sheet metal, die casting alloys, thermoplastics, polyester moulding compounds – and not for final products of any kind. The matter of processing costs and their future trends has been explored independently and is returned to later in this paper.

2. Principles of cost estimates

Forecasts of any kind are mere sets of figures which are unlikely to be very convincing unless their conceptual basis is explained. While it is not intended in this paper to reproduce any of the CRU/CSI cost forecasts in full, it is essential that the key terms be defined, that the methods of calculation be outlined, and most importantly, that the central techno-economic assumptions be stated (Section 3). Those with an interest in so doing can then evaluate the forecasts, construct equivalent ones for other materials, and so on.

It is also important that the meaning of the term "costs of production" as used in this paper is clearly understood. The definition provided by CRU is as follows:

> The amount which the consumer of the product would have to pay to acquire it, delivered to his works and ready for processing, if the full costs of production and delivery *and normal profits* of a supplier operating a new production facility are to be covered.*

*This quantity is frequently referred to as the long-run marginal cost of production, or the reinvestment price. In theory, unless this price is being achieved expansion of capacity cannot be justified; in practice, we often have to build on a less solid foundation, but it remains the ideal.

The procedure for analysing the production costs of a particular material involves:

- determining the present level of all inputs to the production process (materials, labour, energy, capital investment, etc.)
- forecasting future changes in the quantity of each input per unit of product, allowing for technical development, improved labour productivity, energy conservation, etc.
- forecasting changes in costs of the inputs over the period of interest.

The detailed working is carried out, and the results are presented, *in constant money or 'real' terms;* the effects of general inflation are taken out of the figures. Evidently the level of general inflation in a particular country influences its competitiveness internationally, but it does not in itself alter the relativities between competing materials within a country.

3. Basic elements of cost: key assumptions

There are some elements of production cost that can be influenced by the level of managerial skill and technical inventiveness we bring to our operations. Others lie beyond our span of control and the clear leader in this respect is energy. The forecasts that follow are based on careful analysis by CRU/CSI of the demand/supply and cost position for each of the main primary energy sources – oil, coal, gas and uranium – and they take into account similar studies by oil companies, government and international agencies, and other bodies.

The two central assumptions that stem from this analysis and underlie all the forecasts presented in this paper are given in the table below.

Table 1: European Energy Prices, 1980-1990

	Average annual change, %	
	1980-85	1985-90
Crude oil, c.i.f.	4.9	6.8
Electricity (heavy users' rate)	3.9	3.2

Clearly these figures represent a high rate of increase in the real cost of energy over the 1980's. The full implications of this trend will be explored in Section 6.

The other major assumptions were that *in real terms:*

(a) Labour cost *per man-hour* would increase by 1.5 per cent per annum. (Note: labour costs *per unit of output* will also be affected by labour productivity and may well fall rather than rise.)

(b) Capital costs for a given capacity of plant of fixed technology would increase by 3 per cent per annum, continuing the recent trend of rapidly rising construction and engineering costs.

The above assumptions cannot be regarded as optimistic. They are certainly somewhat more severe than the planning guidelines currently in use within the writer's organisation. Let us now see what results they yield when used as part of the forecasting process already outlined.

4. Production cost forecasts for selected materials

Table 2 over page displays cost forecasts for a range of materials of relevance to the GRP industry. Most of the figures have been provided by CRU/CSI but some have been calculated independently using the same procedures.

Table 2: Costs of production of selected metals, plastics and composites 1980/1990

	Costs in constant money terms (1980 = 100)	
	1985	**1990**
Steel sheet	111	124
Aluminium sheet/casting alloy	113	127
Zinc casting alloy	108	116
Unsaturated polyester resin	107	126
Nylon 6.6	110	137
Glass fibre reinforcement	110	122
Sheet moulding compound*	108	125
Glass-reinforced Nylon 6.6†	110	129

* 20% glass † 33% glass

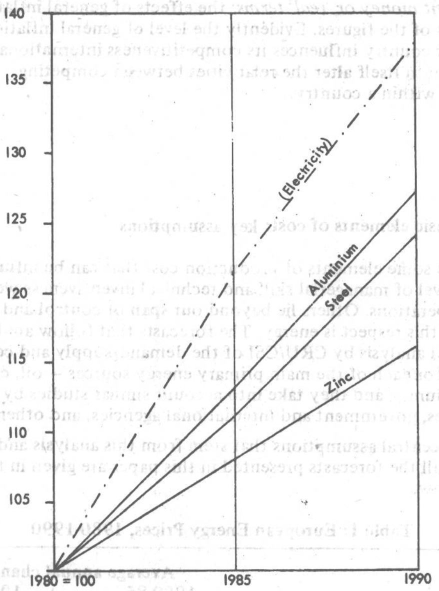

Fig. 1 Forecast movements in real costs of production of metals 1980-90.

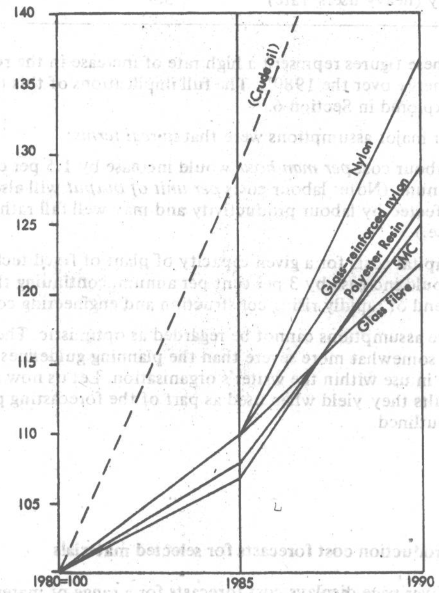

Fig. 2 Forecasts movements in real costs of production of GRP materials 1980-90

The forecasts are presented graphically in Figures 1 and 2. At this stage the following points should be noted:

1. Very broadly, those materials having the highest dependence on energy and/or petrochemicals inputs show the greatest increases in production cost (in real terms) over the whole period.

2. The rate of increase is higher in the second half of the decade than in the first, reflecting the underlying assumption of an acceleration in the rate of rise in crude oil price.

3. *The differences in the rates for various materials are not great.* With the exception of zinc and nylon 6.6, the materials considered have annual average rates of cost increase over the decade which span a very limited range, viz:

	%
Glass fibre reinforcement	2.00
Steel sheet	2.17
Sheet moulding compound	2.25
Unsaturated polyester resin	2.34
Aluminium	2.42
Glass reinforced nylon	2.58

5. The influence of processing costs

So far only the costs of semi-finished materials (and the input materials from which they are compounded) have been considered. The further processing operations of moulding, pressing, fabrication etc. whereby a final article or component is produced must now be touched upon. Evidently it is not possible to discuss the costs of these processing operations in a general way, and detailed design studies are beyond the scope of this paper. However, many design guides and case histories have been published (and more will be presented at this conference) from which broad indications can be derived of the relative contributions made to final product costs by the various inputs, viz.

Semi-finished material (including wastage)
Direct labour, supervision and maintenance
Tooling costs
Press operating cost (or equivalent)
Equipment depreciation and other period costs.

One example that readily comes to hand is from the die casting field. A recent publication[1] analyses the total production cost of a simple model component (a 250 mm x 125 mm plate) which can be made either by die casting in zinc or aluminium, or by injection moulding in glass-reinforced nylon or ABS. The breakdown in percentage terms of the final cost of an unplated component, derived from the data given in the publication, is shown at the left-hand side of the table below. The 1980 values are converted into the corresponding forecasts for 1990 on the right by applying the percentage increases shown. (For purposes of this illustrative calculation, manufacturing costs as a whole have been inflated at a weighted mean rate of 2.25% p.a. in real terms, giving a 25% increase over the decade.)

Table 3: Movements in costs of production of a die-cast or moulded plate

Cost element (%)	1980 Zn	1980 Al	1980 Nylon	Forecast change 1980-90 (%)	1990 Zn	1990 Al	1990 Nylon
Materials input	49	44	56	16 27 29	56.8	55.9	72.2
Casting/moulding costs	39	47	44	25	63.8	70.0	55.0
Trimming/polishing costs	12	9	–				
TOTAL	100	100	100	–	120.6	125.9	127.2

We see that by 1990, in terms of product manufacturing cost, zinc has improved its 1980 competitiveness. The point to note, however, is that *the original gap between the costs of the input materials has been reduced by a factor of two* (from 13% to 6.6%) in the final product

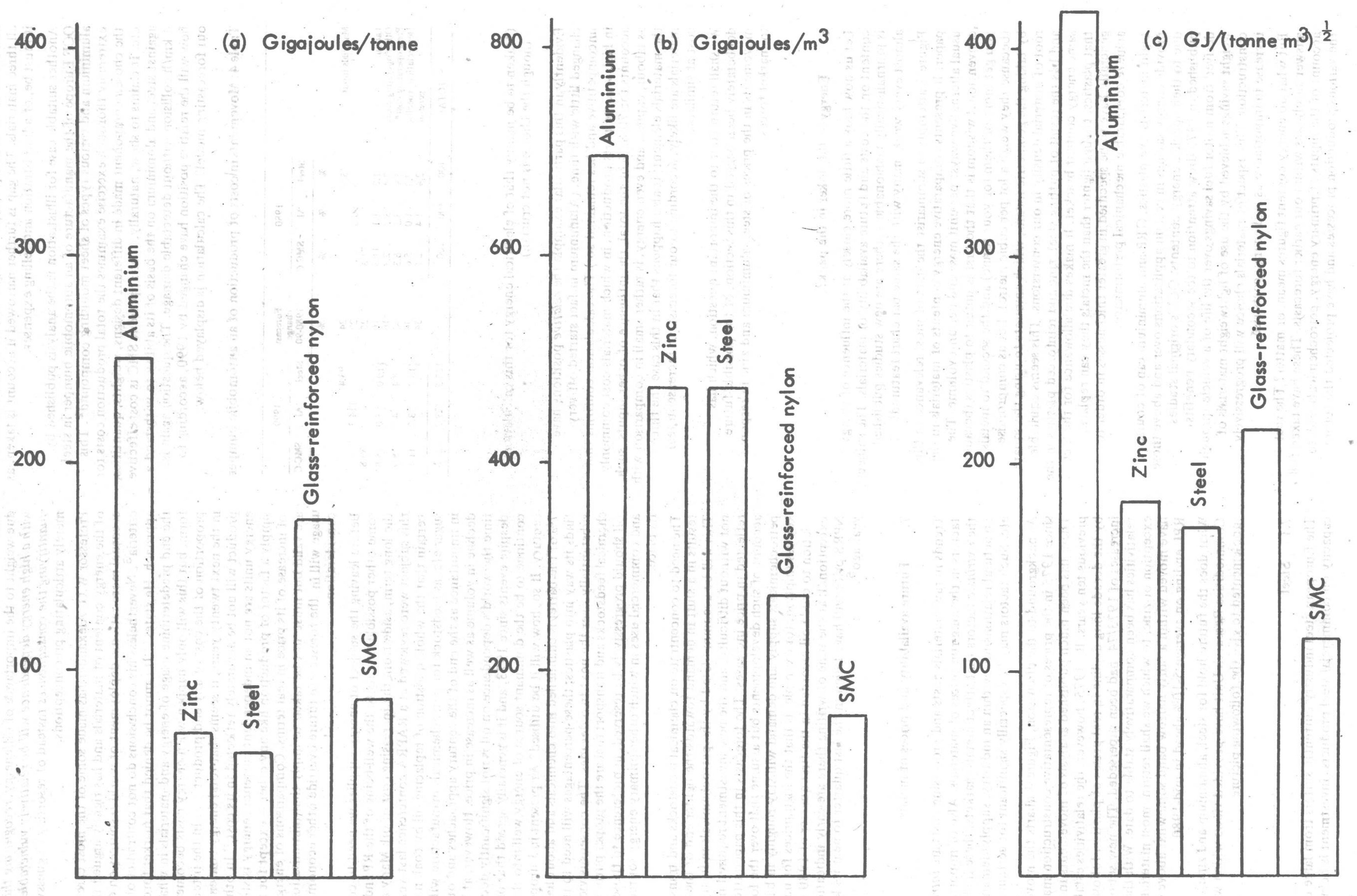

Fig. 3 Comparative energy contents of fabricated materials.

as a result of considering the processing costs, which are similar for all three materials. The gap is further narrowed if account is taken, as it must be, of administration and selling expenses.

Another suitable case for illustration is the analysis published by OCF Europe of the manufacture of an automobile bumper in steel, aluminium and various types of sheet moulding compound[2]. This extremely thorough exercise examines the total production costs for the chosen component made in different designs, weights, quantities, etc. It claims to show, naturally, that at present SMC is cost-effective against steel and aluminium on the basis of its ability to withstand a 4 km/h collision without detectable damage. The question again is: how will the relative position have changed by 1990, according to our forecasting model? The calculation is displayed below.

Table 4: Movements in costs of production of an automobile bumper

	1980			Forecast change 1980-90	1990		
	Steel	Al	SMC-C		Steel	Al	SMC-C
	%	%	%	%			
Materials input	75.3			24	93.4		
		90.0		27		114.3	
			71.8	25			89.8
Labour	1.2	1.1	11.3	16	} 10.0	5.0	15.8
Other operating costs	7.4	3.2	2.3	16			
Press operating cost*	5.9	3.3	6.3	42	8.4	4.7	8.9
Depreciation: specific	7.8	1.0	5.6	34	} 13.7	3.2	11.1
general	2.4	1.4	2.7	34			
TOTAL	100	100	100		125.5	127.2	125.6

(*taken to be mainly that of electrical energy for this calculation, though the choice is not crucial.)

Evidently in this particular example the *relative* positions have changed little with time. (Aluminium in fact started off very uncompetitive and has remained so.) The calculation confirms that in high volume parts production, in which materials cost commonly accounts for 70-85% of the total, the influence of other inputs, such as labour, capital, and even energy, is rather small in comparison with the materials element; it also happens that in this case the three materials are likely, according to our forecast, to increase in real cost at similar rates.

We shall return later to the important question, which has deliberately been begged in this section, of the possible future movements in the prices of steel, aluminium and zinc in response to market forces.

6. Energy – the Joker in the pack?

Let us now look a little more closely at the influence of energy content on the costs and future availability of materials. The subject is journalistically fashionable – there are new studies published almost every week, many with the same bar chart featured!

Figure 3 attempts to summarise the data of most relevance to this paper. It presents comparative energy contents of materials in the usual alternative ways: per unit mass and per unit volume. The conventional wisdom is that the first is unfair to plastics (because you get more of them for your tonne) and the second to metals (because they weigh a lot per cubic metre). Let us compromise by taking the geometric means, which amounts to using the square root of material density in our conversions. This seems equitable and has the result of putting steel, zinc and reinforced plastics in the same energy content bracket. It makes due allowance for the fact that plastics, though lighter than the metals they can replace, generally have to be specified in greater thicknesses in order to achieve comparable mechanical performance.

Light materials like plastics, GRP and aluminium can of course provide energy savings in certain applications over and above those due to their specific energy contents. OCF's original studies published in 1975 drew attention to the secondary benefits derived from motor fuel savings over the life of a vehicle through weight savings achieved by the use of lightweight materials of construction. This aspect of materials choice will progressively increase in importance as real energy costs rise.

But what do energy content figures mean, or matter? The real answer surely lies within our earlier forecasts. These have taken full account of the inputs of primary energy, petrochemicals, etc. to the various production processes and have projected the future effects of all foreseen increases in real costs. Hence they have given due weight to the importance of oil/energy, *recognising that materials with a high energy dependence will be relatively vulnerable but quantifying the consequences* instead of resorting to guesswork or merely articulating preconceptions.

Professor W.O. Alexander has made some of the most careful studies of the energy content of materials and has rightly argued the case for eventual more rational deployment of world resources on energy criteria[3]. Nevertheless his conclusions do not contradict our approach. He states: "It cannot be denied that market forces will in the end predetermine usage of energy and materials in whatever form, but this will only happen when energy costs become a major proportion of the cost of any end product . . . In the interim, i.e. in the next twenty years, it seems that total energy content in a product will not be accurately reflected in its cost." In other words, energy units are not an independent currency; energy is still simply a factor of production like any other – except for the rate of increase of its price in real terms. Comparisons of energy content are valid but must not be taken to imply that minimisation of energy usage will in the foreseeable future override other economic considerations.

Before leaving the subject of energy supplies we need to consider some other possible threats to the well-being of the RP industry in the long term, aside from the increasing *cost* of oil. Many aspects of this subject were reviewed at a RAPRA conference last year[4]. It is certain that the whole question of replacing oil by coal, natural gas, sugar etc. as feedstock for petrochemicals manufacture will increase in importance as the end of the century approaches and oil supplies decline in volume as well as increase in price. However, at the present time the world's dependence on oil is not significantly decreasing, despite events since 1973, and it is generally agreed that oil will continue to be the dominant source of energy well into the next century. If so, how will it be utilised? At present in Europe around 7% of the barrel is channelled into chemicals and about half of this finds its way into plastics; these percentages will need to rise substantially over the next two decades. The consensus view is that chemical feedstocks and transport fuel are the proper purposes for which oil should progressively be reserved, in preference to those industrial and commercial uses in which other primary energy sources can take its place.

The need to concentrate on chemical feedstocks and transport fuel results in a shift in demand towards the lighter end of the oil barrel. This will be accommodated by the petrochemicals industry, though not without difficulty, and the new investment required must be reflected in price increases. The forecasts in this paper attempt to take account of such developments but assume that over the longer term petrochemicals supply and demand will stay roughly in balance. One key assumption, for example, is that the high prices for naphtha in relation to crude oil recorded in the first quarter of 1980 were exceptional; at the time of writing there are early indications that the NPRS price will have fallen in the last quarter to near its level of a year ago[5].

7. Future availability and prices of metals

Trends in raw materials costs and processing costs are *intrinsic* factors in the long-run prices of materials. Also of importance are the *extrinsic* factors that affect metals markets; these include structural relationships within an industry, supply/demand balance etc. Such factors may be especially significant for certain metals.

As background to the discussion, Figure 4 charts the movements since 1975 in the prices of representative construction materials[6]. There has been much published analysis of movements in the previous ten years. By 1975, however, the relativities established by the decade-long decline in real prices of plastics, followed by the increases of 1973/74, had been superseded. The new set of relativities has been comparatively stable to date. With the notable exception of zinc, to which we shall return, most materials prices have moved within a fairly narrow band somewhat above of the RPI, ending on average 5-10% ahead in mid-1980.

What does the future hold for steel, aluminium and zinc? Commodities Research Unit have provided views which we have supplemented to give the following picture.

7.1 Steel

The European steel industry currently suffers from large over-capacity on commercial steel products. Investment is being undertaken

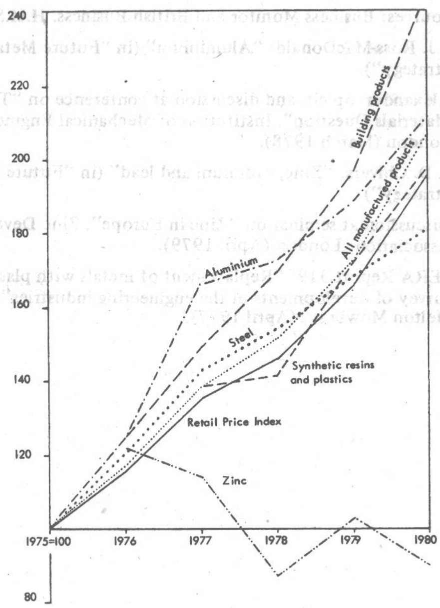

Fig. 4 Movements in materials prices 1975-80

at present, but its purpose is to modernise equipment. The net effect of the policies of the European producers, encouraged by the EEC Commission, will be to reduce commercial steel capacity during the first half of the 1980's. The pace of this capacity reduction will probably in practice be sufficiently slow that there will remain a substantial surplus of steel capacity throughout the period to 1985. In this situation prices of steel products will, on average, continue to be on the downward side of reinvestment levels.

Many commentators on the world steel industry identify a shortage of crude steel capacity worldwide by 1985 and indicate that steel prices will have to rise sharply by that time to ensure adequate supplies. CRU's view is that there will be no need in Europe for further investment in additional steel capacity until at least 1985 and relatively little need beyond that. They do not envisage a shortage of commercial-grade steel products in Europe, but expect prices to recover in the second half of the 1980's towards the levels at which investment in new capacity would be commercially viable.

7.2 Aluminium

Commentators are generally agreed that aluminium smelting capacity in the western world will be insufficient from 1982 onwards to prevent demand significantly exceeding supply. Prices of aluminium will therefore have to equate to reinvestment levels; further, the temporary shortages that could develop might force prices above the levels corresponding to the costs of production alone. These considerations apply equally to casting alloy and to sheet material.

It must also be noted that although there is inherent stability in the costs of power to existing smelters (owing to contract duration, self-generation, etc.) the position is different when additions to capacity are contemplated. On average, energy costs at present represent only about 30% of the market price of aluminium, but at least two thirds of this energy is electrical, and it has been pointed out[7] that the estimated cost for new firm electrical power supplies is many times the weighted average price being paid by existing smelters in the western world. Thus the need to cover the full costs of production of new smelters could exert upward pressure on aluminium prices since these reflect the present low average cost of electrical power.

7.3 Zinc

Zinc is the only one of the three metals considered for which the ore reserves situation needs to be examined. Zinc is generally included in the short list of metals which are expected to decline in availability and consequently to increase substantially in price over the next twenty years or so[8]. People within the industry claim that there is no sign of a general shortage, while admitting that the indicated reserves in the western world equate to only some fifteen years consumption at present rates[9]. There is apparent confidence that new reserves will be discovered over the next decade, with the benefit of the more refined techniques of mineral exploration now becoming available.

The fortunes of the industry have been at a low ebb for some years. Consumption is stagnant, prices are very low (Fig. 4) and there is a structural imbalance, with smelter capacity too great for both metal demand and available mine supplies of concentrates. Mine supplies and demand are, however, roughly in balance. Consequently any increase in consumption could cause a marked price rise, since the ability of the industry to produce more is restricted. However, the underlying downward pressure of excess capacity on prices is likely to persist because of lack of demand growth.

The situation appears to be that with no prospect of supply and demand reaching balance until the mid-80's at the earliest it will not be possible for producers to raise prices to economic levels. Not surprisingly, there is real concern within the industry over the long-term viability of the zinc business[10].

8 Conclusions

It is now time to draw from the foregoing discussion a view of the threats and opportunities that will confront the RP industry in the 1980's. Once again it must be remembered that we are primarily identifying trends, assuming that the present situation is neutral, as it were.

If the forecasts presented are accepted, it is clear that continuing increases in the real cost of energy will place greater pressure on the production costs of resins and plastics than on those of metals and inorganic materials in general (including glass fibres). The gap that may appear is unlikely to be large: the difference between the annual rates of cost increase of zinc and nylon, the extremes of the range of materials considered, is less than 2%. When we turn to composites the differences shrink further, and further still when the impact of moulding and forming process costs is quantified. **The net differences seem unlikely to alter significantly the competitive balance between reinforced plastics and alternative materials.** Price changes in response to market conditions will in any case probably be at least as important as those caused by trends in the costs of production.

We have nevertheless identified a slight head wind – not the gale that our competitors tend to conjure up, (nor indeed the following wind that the BPF and some large chemical companies claim to feel!) but enough to call for some special effort. The rest of this conference will deal with the question of how that effort should be deployed; but let me suggest a few pointers.

Thin wall casting is a technique that has helped the zinc die casting industry to defend its markets in recent years by offsetting the weight disadvantage of zinc. A useful definition from within the industry[10] is: "calculating a wall thickness to make a casting thick enough to do the job but thin enough to get the job for the zinc die caster". We need to be just as intelligent, adaptable and inventive as our competitors – they are not standing still and neither must we. We must campaign vigorously to draw users' attention to the unique advantages reinforced plastics have to offer. In approximate order of significance those identified by a wide-ranging independent survey[11] in 1976 were:

- Low weight and high strength-to-weight ratio
- Corrosion resistance
- Low manufacturing costs as a result of design flexibility, parts consolidation, minimal finishing and painting, etc.
- Wear resistance
- Electrical and thermal insulation, noise absorption, etc.

Increased use of selective reinforcement, fillers, foaming and so on will amplify these benefits; I look forward to hearing in the next and later papers how we are going to exploit them in the future.

St. Helens
October 1980

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Production costs of GRP and alternative materials: trends in the 1980's

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Synopsis

The state of health of markets for reinforced plastics in the 1980's will be determined by the competitiveness of these materials, as regards both technical performance and cost-in-use, relative to the alternatives.

This paper will be concerned primarily with the trend of production costs over the next decade, concentrating on GRP and selected materials against which it competes directly. Estimates are made of the total costs incurred in processing raw materials up to the 'semi-finished' stage. The final manufacturing operations that yield the desired end-product (moulding, casting, etc.) are dependent on the precise form and design of the product, and the costs involved are outside the direct scope of the paper. The principles of the analysis can nevertheless be applied to such operations, given the necessary data on resource demands and the costs applicable.

The specific materials considered in the case of GRP are:—

1. Glass fibre reinforcements
2. Unsaturated polyester resins
3. Polyester moulding compounds (SMC, DMC)
4. Thermoplastics moulding compounds.

Competitive materials chosen for comparison include:—

1. Sheet steel (cold-reduced and galvanised)
2. Aluminium sheet
3. Die-casting alloys (zinc and secondary aluminium)
4. Engineering thermoplastics
5. Timber.

The basis of comparison used is the full cost of production of each material at a new manufacturing facility; this cost comprises all operating expenses plus the recovery of fixed capital investment and a normal rate of return on the capital over the life of the facility. In the medium to long term prices in the market must cover these full costs if new investment is to be viable and existing business truly sustainable.

Analysis of costs for a particular material begins with a breakdown of all the inputs to the production process. Embodied in this breakdown are techno-economic factors such as quantities of raw materials and energy consumed, labour required per unit of output, investment cost per tonne of annual production capacity, etc. Technological forecasts are then made for each input on the basis of past trends and expected process developments (yielding improved throughput, efficiency or productivity).

The next step is to forecast the costs of each input, in constant money terms, over the period of interest — in our case the next decade. Combination of the two elements of the forecast then provides an estimate of the cost of production of the subject material at a future date. The predicted costs for GRP and alternative materials enable an assessment to be made of GRP's likely competitive status in the 1980's.

Underlying the detailed forecasts are broader considerations of economic activity (international, national and sectoral), availability of basic materials and energy, labour rates, etc. A central factor is the future cost and supply of crude oil, vital to the RP industry as a source of both chemical feedstocks and processing energy. Both in this area and that of production costs for metals and plastics the paper is based closely upon forecasts compiled by two consulting firms — Commodities Research Unit and Chem Systems International Ltd.

Programme and Index

Conference Chairman:
B. J. Hawthorne,
Chairman of the *Reinforced Plastics Group*

Monday 24 November

Delegates assemble

8.30–19.30	Civic Reception given for delegates by His Worship The Mayor and Corporation of Brighton in the Banqueting Room of the Royal Pavilion Tickets for those who wish to attend must be collected from the Congress Conference Office at the Metropole Hotel during the afternoon of Monday, 24th November. Tickets are limited in number and will be issued on a first come first served basis.	

Tuesday 25 November

0.900	Opening of the Congress	B J Hawthorne, Hepworth Plastics Ltd: RP Group Chairman
09.15	Opening address	Dr. Keith Humphreys, Managing Director, Ciba-Geigy (UK) Ltd.
09.45	**Session 1 : Marketing**	*Chairman of Session: K. Mullins, Fibreglass Ltd.*
	Paper 1 *page* 1 Production costs of GRP and alternative materials: trends in the 1980s	H J Gair, Fibreglass Ltd, UK
	Paper 2 *page* 3 The criteria for choosing GRP in different applications	M S Monkhouse and P G Scales, TBA Industrial Products Ltd, UK
10.35	Discussion	
10.55	Coffee	
11.10	**Session 2 : Building**	*Chairman of Session: S Moore, Moore Plastics Co Ltd*
	Paper 3 *page* 5 A glance back — a look forward	M Hinde, Anmac Ltd UK
	Paper 4 *page* 9 Improvement of long term properties of GRP laminates exposed to urban heating water (100–140°C) by using impermeable liners in suitable thicknesses	A M Otto, W H Piret, C Renaud Applications Development Technical Support, Owens–Corning Fiberglas Europe S.A. Belgium
	Paper 5 *page* 17 Performance tests on GRP building panels	DBS Berry & P H Nice, Yarsley Technical Centre, UK
12.15	Discussion	
12.30	Lunch	
14.00	**Session 3 : Processing**	*Chairman of Session: B A Pickett, Laminated Profiles Ltd*
	Paper 6 *page* 23 Manufacture of large GRP components using numerical control	Scott Bader Co Ltd., UK
	Paper 7 *page* 25 Developments & potential of vacuum impregnation techniques for GRP manufacture	T M Gotch, British Railways Board, UK

	Paper 8 *page* 35 Reinforcement choice & cost analysis for the resin injection process	S Bernardini, Vetrotex, Italy D Guillon, Vetrotex, France
	Paper 9 *page* 39 Improving Export Marketing Performance — a practical approach	A F N Worth, Rubber & Plastics Processing Industry Training Board, UK
15.30	Tea	
15.45	**Session 4 : Processing**	*Chairman on Session: P Oldham, Plastics Design & Engineering Ltd*
	Paper 10 *page* 41 Pultrusion: Market profile for the 1980s	R A P Spencer, GRP Components Ltd, UK
	Paper 11 *page* 47 Reinforced RIM Polyurethane using chopped glass fibres	J M W Forster, Fibreglass Limited UK J F Chapman, Imperial Chemical Industries (Organic Division), UK
	Paper 12 *page* 53 GRP/GRTP compression & injection mouldings prospects in 80s in India	L R Kishore, U P Twiga Fiberglass Limited, India
	Paper 13 *page* 59 Better rigidised high impact acrylic parts by design	J W Truelove, Rohm & Haas (UK) Ltd. UK
17.05	Discussion	
17.30	Session ends	
	Concurrent Session	
14.00	**Concurrent session held in County Suite** **Concurrent session 5 : Structures and Related Parameters**	*Chairman of Session: R Andrews, Polystructures Ltd*
	Paper 14 *page* 61 The Surface Effect Ship — the fast multi-purpose GRP marine platform for the 80s	Anthony J English AMR Ac S, Vosper Hovermarine Ltd, UK
	Paper 15 *page* 71 A short fibre material for fabricating components of complex shape	H Edwards, N P Evans, K D Potter MOD (PE), PERME (WA), UK
	Paper 16 *page* 79 Impact considerations & performance for FRP on British Rail	J Batchelor & P J Garrington, British Railways Board, UK
	Paper 17 *page* 85 The buckling behaviour of reinforced plastic box sections	Dr W M Banks & J Rhodes, University of Strathclyde, UK
15.20	Discussion	
15.30	Tea	
15.45	**Concurrent Session 6 : Materials**	*Chairman of Session: D O G Graham, TBA Industrial Products Ltd*
	Paper 18 *page* 89 Development of Low Styrene Emission polyester resins for the 80s	R F Russell, Scott Bader Company Ltd, UK
	Paper 19 *page* 97 Hybrid Isophthalic Polyester Urethanes	Roy S Rapp, Amoco Chemicals Corporation, U.S.A.
	Paper 20 *page* 103 Norsophen phenolic resins for improved fire resistance in GRP	D A Ritchie, KWR Chemicals Ltd, UK

	Paper 21 *page* 105 Solvent recovery	C C Appleton, Newgate Simms Ltd
17.05	**Discussion**	
17.30	**Session ends**	
	Wednesday 26 November	
09.00	**Session 7: Electrical**	*Chairman of Session: J Golding, Ciba-Geigy (UK) Ltd*
	Paper 22 *page* 109 Advances in the use of GRP for the power industry	M H Bryan-Brown, D M Walker & R C Wyatt, Central Electricity Generating Board, South Western Region, UK
	Paper 23 *page* 117 Laminates for printed circuitry	Dr M J Aggleton, Permali Gloucester Ltd, UK
	Paper 24 *page* 121 Production of composites from glass fibre & epoxide resins by novel processing techniques	E W Garnish & D E Gaulton, Ciba-Geigy Plastics & Additives Co, UK
	Paper 25 *page* 125 Market for the 80s: Domestic appliance applications for polyester moulding compounds	Gerald F Whitworth, BIP Chemicals Division, UK
10.15	Discussion	
10.30	Coffee	
10.45	**Session 8 : Compounds**	*Chairman of Session: J Mountifield, Groupement*
	Paper 26 *page* 129 Dry granulated thermosetting polyester moulding compound. A material for the 80s	E G Bowyer, Freeman Chemicals Ltd, UK
	Paper 27 *page* 133 Epoxy chopped pre-preg moulding compounds	D J Martin, Ciba-Geigy Plastics & Additives Co, UK
	Paper 28 *page* 137 DMC – a future or not?	B Cropper, Allen–Bradley Mouldings Ltd, UK
	Paper 29 *page* 141 A new concept for rheological control in thixotropic polyester laminating resins	C J R Eichhorn, NL Industries, Brussels, Belgium, C M Finlayson & T K Mo, NL Industries, Hightstown, New Jersey, USA
12.05	Discussion	
12.30	Lunch	
14.00	**Session 9: Automotive**	*Chairman of Session: A Craig, BTR-Permali RP Ltd*
	Paper 30 *page* 145 The design of composite material replacements for automotive torsion bars	A C Patterson, Engineering Division, AERE Harwell, UK
	Paper 31 *page* 151 Self coloured SMC used to facelift the interior of truck cabs	M J Seamark, Bifort Engineering Ltd, UK
	Paper 32 *page* 155 Glass fibre reinforced plastics in the European & North American transportation market	J C Palermo, Owens-Corning Fiberglas European Operations, Belgium
	Paper 33 *page* 159 Achieving the impossible – plastic intake manifold	E M Rowbotham & G Suthurst, Ford Motor Company Ltd, UK

15.20	Discussion	
15.30	Tea	
15.45	**Session 10 : Moulding Materials**	*Chairman of Session: D Moffat, British Industrial Plastics*
	Paper 34 *page* 161 Organic peroxide initiator selection for hot press moulding	K J Izzard & G P Newton, Interox Chemicals Ltd, UK
	Paper 35 *page* 169 Glass reinforcement adaptation to the final requirements of the material in the field of SMC applications	C Choudin, D Guillon, Vertrotex, France
	Paper 36 *page* 173 Inmould Coating for SMC & DMC	R L E van Gasse, C M Alfrink & A Verwer, Decostone BV, Holland
	Paper 37 *page* 177 Automated painting processes for automotive parts	D Lewis, Sonneborn & Rieck Ltd, UK
16.45	Discussion	
17.00	Session ends	
10.45	**Concurrent session held in County Suite 11: Environmental Properties**	
	Concurrent Session	*Chairman of Session : K R Dines, Akzo Chemie Ltd*
	Paper 38 *page* 181 The mechanical properties of resins & laminates in hot, wet conditions	H P Abeysinghe & Geoffrey Pritchard, Kingston Polytechnic, UK
	Paper 39 *page* 185 Blister performance of GRP systems in aqueous environments	L S Norwood, Scott Bader Co Ltd D W Edgell, A G Hankin, Fibreglass Ltd, UK
	Paper 40 *page* 195 The effect of high temperature on physico-mechanical properties of epoxy resin	Prut E V, Zelenetsky A N, Karmilova L V, Topolkaraev V A, Knunyants M I Zarkhin L S Nechvolodova E M & Enikolopyan N S, The Institute of Chemical Physics of the Academy of Sciences, USSR
12.05	Discussion	
12.30	Lunch	
14.00	**Concurrent Session 12 : Mechanical Properties**	*Chairman of Session: C Furse, Fibreglass Ltd*
	Paper 41 *page* 199 Experimental studies on the effects of manufacturing imperfections on stress distributions in GRP shell-type structures	I H Marshall, Paisley College of Technology, UK. J Rhodes, University of Strathclyde, UK
	Paper 42 *page* 201 Biaxial strength behaviour of glass fabric reinforced polyester resins	M J Owen, & D J Rice, University of Nottingham, UK
	Paper 43 *page* 213 GRP sandwich panels — design method & experimental results	Prof. S Roccoli, Genova University & Eng. M Mazzola, Snia Viscosa CTAR, Italy
	Paper 44 *page* 215 The effect of post-cure on environmental stress corrosion of vinyl-ester laminates and gel coat layers	M Birch-Kisbenyi, D Harrison, D M Eyre, G P Marshall. Manchester Polytechnic. UK R Pinzelli, Dow Chemical, Europe.