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The Uses of Wood: Long Term Prospects [and Discussion]

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The uses of wood: long term prospects

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The longer term prospects for the use of wood depend upon the continued availability of suitable material and the ability of wood products to compete in cost and performance with comparable products made from other materials. The availability of both hardwoods and softwoods is considered against a background of a world usage which is rising at just under 2 % per annum and the conclusion is reached that sufficient wood will be available to meet the growing demands for the next hundred years or so although the nature and quality of the material available will not be the same as at present. The importance of successful regeneration and renewal of forests, particularly in tropical areas, is emphasized in affecting the future for wood beyond that term.

The competition from other materials has been considered for various usage categories. For structural uses the prospect is good; a number of factors indicate a growth in structural usage, and competition from other structural materials is not likely to be severe while supplies of adequate material are available. The use of timber for joinery, furniture, cladding and utility markets has been reduced in recent years, particularly as a result of developments in plastics technology. There is a need to develop products in which wood is combined with other materials to give the required properties.

It is expected that the use of wood for decorative purposes will continue in high demand.

The importance of developing new products, particularly utilizing the substantial amount of waste available, and of marketing wooden products which are more closely designed to meet consumer needs, is emphasized.

Introduction

My task in this paper is to consider some of the factors that will influence the longer term usage for wood in the U.K. I should make it clear at the beginning that I do not intend to try and make any quantitative predictions as to the extent of future timber usage for there are, in my view, too many qualitative factors which may change and make any prediction grossly wrong. Rather, I intend to consider some of the changes which one can foresee and the ways in which these might affect timber usage. Among these factors I would include the availability of timber to the U.K. from various parts of the world and the changes which are likely to take place in the supply situation, the competition between various materials for some of the traditional end usages, and the role which research and development might play in affecting the results of this competition.

In the end, the decision as to whether wood will be used to make a product or perform a certain function will depend on the cost of achieving the final objective with wood compared with the cost of achieving it using other materials. Although changing relative costs of the materials themselves will be an important factor in the cost they will not necessarily be decisive for many other factors, such as processing, fixing costs and maintenance costs, may be just as important.

The world supply situation

The importance of the world supply situation lies in the fact that we import more than 90 % of our requirements and, so far as we can see, will still be importing 75 % by the year 2000.

The quantity of timber potentially available in the world is enormous and various figures have been given indicating that there is enough to supply world demands for a very long period of time, certainly of the order of several hundred years. However, on a closer look I am not sure that the picture is quite so comforting. An F.A.O. survey (Openshaw 1974) showed that about 46 % of the roundwood production in the world goes as fuel; this is concentrated in the developing countries and in some places the amount of the total timber used which goes as fuel can be as high as 99 %. The consumption of wood in this way will be proportional to the population remaining outside the urban areas, and is likely to continue to increase in view of increases in populations and the price of fossil fuels.

The production of wood as sawn-wood, logs, panel products and pulp-wood has been rising steadily. Calculations based on the F.A.O. *Year Book of Forest Products* (1972) indicate that in the last ten years production has risen at a rate approximating to 1.7 % per year; at this rate of increase the total volume of wood used in this way will double in a period of 42 years. Clearly these figures cannot by their nature be very accurate, and if the rate of increase in world production were 2 % instead of 1.7 % the total volume required would double in 35 years. Within this total the production of panel products is rising at a much faster rate, between 9 and 10 % per annum.

To what extent will material be available to meet this increase in consumption? Lorenzen (1972), in a recent paper to the Institute of Wood Science Conference, has presented data based on the World Forest Inventory of 1963 which indicates that for hardwoods in Asia, Africa and Central and South America the currently acceptable species account for about 15 % only of the exploitable forest volume of commercial size (that is, there is six times the volume potentially available if we can use it). About 67 % of the world's total forest resources are in hardwoods and Lorenzen estimates that the volume of commercial sized hardwood potentially available from these areas is approximately 226×10^9 m^3. Richardson (1972) estimates that if we can use the whole resources of the tropical forests they will last 500 years at the present rate of consumption; however, if the usage continues to grow in the way that I have already indicated this might only suffice for about 100 years.

So far as softwoods are concerned, very large quantities are available in both Canada and Russia and substantial plantations are being established in various parts of the world. Peck (1971) has quoted figures for Russia pointing out that the area of land covered with timber is seven times that existing in the whole of Northern Europe, that their fellings are less than half the net annual increment, and that their exports in 1969 were less than 10 % of their total output. About a quarter of the world production is currently in Russia and quite clearly there is ten times the volume at present exported potentially available from that source. In Canada it has been estimated that a production of between 300 and 400×10^6 m^3 could be achieved in the year 2000 and this would still be below the sustainable yield in that country; this represents a trebling of present production. For comparison, the world production of coniferous roundwood, including that used for saw logs, pit props, pulp-wood and industrial usages, was just over 1000×10^6 m^3 in 1970.

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Richardson estimates that the softwood plantations which are being established on a large scale could give a further 1000×10^6 m^3 per annum. It must be said, however, that various authors hold the view that these plantations will do little more than supply the wood needed for the increase in requirements in the areas in which they grow, and not contribute significantly to the world trade in timber.

Another question mark about world timber supplies is the role of the demand for pulp products. During the period 1961–70, the world production of wood pulp, paper and paper board increased at an average rate of 5 % per annum – that is, a good deal faster than the increase for wood products as a whole – and seems likely to go on increasing unless deliberate policies are introduced to restrict wasteful use of paper. This quickly growing demand could affect the price being asked for logs fit for timber.

Renewal and regeneration

The longer term availability of wood depends upon the extent to which it is possible to continue growing trees in areas from which trees have been felled, and while this appears to be perfectly feasible in the areas where softwoods grow, there are greater problems in some of the tropical hardwood areas, particularly where the natural growth is a large mixture of species. In Southeast Asia, for example, there have been considerable problems of regeneration in cleared forest areas and this type of problem must raise a question about the continued availability of at least some hardwood species in the longer term.

At the moment, about 20 species only are being used with any degree of success for plantation forests. The experience with these shows that rapid wood production can be achieved but there are problems. The investment necessary to establish and manage the plantations means that the cost of the timber will be relatively high. The extent to which plantations are developed will depend to some extent on the policies adopted toward the investment in this resource, and towards the social problems which will arise from a substantial increase in the area of forest in which the native population cannot live and farm.

Changes in nature and quality

Some wood species and products are not now so freely available as they were a short time ago – for example, birch and Douglas fir plywood, afrormosia and utile, and some higher grades of softwood. The price differential between grades and qualities seems likely to increase, particularly as grades become more clearly differentiated in terms of technical properties or end-use requirements. I think we can expect to see an exploration of the scope for using lower qualities of wood in some cases; this is now being successfully done in South Africa and may be possible here if, for example, plastic coated timber can be more widely used for some purposes. If plantation hardwoods replace natural growth timber to a considerable extent we can expect also to have to use different species for some purposes; as new areas are opened up, we may find it necessary to use new species with their particular properties and characteristics instead of more familiar species.

I expect softwoods and hardwoods to become increasingly regarded as alternatives, for prices are likely to draw closer together, especially as specifications become more technical as, for example, through stress grading.

The main conclusion that I draw from all this is that so far as we can see there is likely to be plenty of wood available well into the twenty-first century, although in the not too distant future

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users and distributors may not be able to obtain the species or qualities they would like or are used to. Beyond a hundred years from now, much depends on the success obtained in regeneration or replanting of natural forest areas.

Competition from other materials

The most important factor which will determine whether a wood-based product, or some competing material, will be used is the ratio of cost to performance to which I have already referred. Competition is from traditional materials (steel, concrete and various sheet materials) and plastics, but also from new fibre-reinforced products.

Plastics seem likely to be used when one or more of the following conditions apply:

(*a*) where operational strength, robustness and rigidity can be provided by an integral moulding in plastics which replaces a heavier prefabricated structure in wood;

(*b*) where the ratio of fabrication to raw material cost is high for wood structures;

(*c*) where fittings or attachments are required which can be integrally incorporated into a plastic moulding;

(*d*) where special requirements, such as durability in adverse environments, resistance to micro-organisms, or cleansability apply.

In the longer term we shall be moving into an era where traditional sources of many of our basic mineral raw materials will no longer be available on the same scale and alternative sources will be sought. In so far as these can be found, they will undoubtedly be more expensive and may be different in quality. The fact that timber is a renewable resource will become an increasingly important factor, but the degree of importance will depend upon the extent to which costs have to rise in order to obtain the volume required.

Table 1. Energy consumed in obtaining materials for use in building

	energy consumed				energy cost, as percentage of value (1968)
	10^9 J/tonne	kW h/tonne	10^9 J/£ value (1968)	kW h/£ value (1968)	
cement ...	5.7	1580	1.06	294	19
concrete	1.1	301	0.36	100 (1974)	—
asbestos/cement	5.3–6.8	1480–1900	—	—	—
bricks	0.63–3.7	176–1024	0.54	150 (mean)	9.7
iron and steel	23.8	6600	0.42	117	7.5
aluminium	52.7	14640	0.16	44	2.8
plastic raw materials	10.4†	2900†	0.36	100	6.5
paper and board	35.6	9900	0.40	112	7.2
timber	5.2	1450	0.09	25.2	1.6

† 61.3–90 (17000–25000) if fuel value of the oil used to make the plastic is included.

There is at present a shortage of various raw materials, and this and the high cost of oil and other forms of energy are giving rise to a change in attitudes among users. Some are becoming more conscious of the need for flexibility and are anxious to be able to use various different materials for the same job. Thus the possibility of building houses containing very much less wood and more products derived from indigenous sources is now being studied, not necessarily with the object of building a high proportion of houses in this way, but to provide the knowledge which makes it possible to do so if difficulties in supply or cost of certain materials so dictate.

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New fibre-reinforced cement products may play a part in this connection. Also, in the mining industry, it has been found that a particular design of metal-reinforced concrete block can perform satisfactorily the task now being served by wooden chocks, and with but a marginal difference in price. I suspect that a part of these markets will be satisfied by materials other than timber in the near future.

The price of fuel seems likely to rise faster than that of most other materials and the contribution that energy makes to material costs is now being studied. The energy required to manufacture various building materials has been calculated, and also the proportion of the cost that is due to energy. The figures we have obtained are given in table 1; they cannot be very accurate because of the way in which they are compiled, but by comparing data from a number of sources I am satisfied that they do indicate approximately the relative energy-dependence of the various materials. It is obvious that, in this respect, timber is in a very advantageous position compared with other materials.

It seems likely that the cost of those processes which result in the production of environmentally undesirable waste products will rise because of the philosophy that the polluter should pay. This should result in a further price differential in favour of wood products compared to those based on metals.

Wood usage

More than two-thirds of the timber used in the U.K. goes into building and construction in one way or another, some as a structural material, some for joinery and other utility purposes including much maintenance and home improvements, and some for internal finishing and decoration. Other major usages are in furniture, which takes about a quarter of the sheet material used, pallets and packaging, and mining.

Structural use

Timber is used as a structural material mostly for housing and low rise prefabricated building. Its competition is from steel and concrete, and it seems unlikely that against a background of the general factors already discussed, and given the improvements in design and usage now becoming possible through stress grading and end jointing, that timber will lose any large proportion of its market to these materials. However, there are new materials now being developed which may well pose a threat. These are composite materials incorporating glass and perhaps other fibres, and made from indigenous materials, such as cement and gypsum, and often making use of industrial wastes. Research at the Building Research Establishment has shown that these can be formed into cladding, shuttering, and whole floor or bridge units, and no doubt ways will be found to form other components. The technical properties of these materials are good and although they are high density products this will not matter for some purposes. Costs are fairly high at present.

The Princes Risborough Laboratory is engaged on a series of comparative design studies to examine the implications of constructing parts of buildings in different materials. A comparison has been made (Chan 1974) of the costs of building a roof to the same standard using wood, steel, concrete and aluminium as the structural materials, and a variety of materials for the roof covering. Some of the results are summarized in table 2. For pitched roofs, the now 'normal' trussed rafter construction was by far the cheapest, being 20–100% cheaper than the

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alternatives. For flat roofs, the differences were less, but for most combinations of materials the timber structure is still the cheapest. If built-up wooden beams are needed, costs rise sharply. Comparable studies on floors and walls are also being undertaken.

It is interesting to note that the more traditional timber roof is appreciably more expensive than the trussed rafter roof, and comparable in price to a steel structure. This illustrates the value and importance of research to improve the efficiency both of wood utilization and of manufacturing processes in retaining the markets for wood. I am sure that there is a potential for further savings in the design of timber structures and for new ways of using wood products. For example, work we have carried out suggests that fibre building boards can sometimes be used instead of plywood in structural units, with good performance and a substantial reduction in cost, and work at the Furniture Industry Research Association on fibreboard sandwich structures for furniture is giving similar indications.

TABLE 2. COMPARATIVE COSTS OF ROOF STRUCTURES

			structural material				
roof type	external covering	deck	timber	steel	aluminium	*in situ* concrete	precast concrete
pitched 22½°	tile	—	1.0	1.6	1.8	—	—
	felt	plywood	1.4	2.0	2.2	—	—
	aluminium	—	1.3	1.9	2.1	—	—
flat	felt	plywood	1.8	1.8	2.1	—	—
	felt	strawboard	1.5	1.6	1.9	—	—
	felt	—	—	—	—	1.6	1.7
	asphalt	plywood	1.9	1.9	2.2	—	—
	asphalt	strawboard	1.6	1.7	2.0	—	—
	asphalt	—	—	—	—	1.7	1.8

The rapid rate of change throughout the world is leading to all kinds of financial problems, and builders are now keenly anxious to find ways of completing buildings more quickly and recovering their capital outlay. This is one of the main factors leading to a substantial increase in interest in timber housing in the U.K. The reduction in labour costs which can be achieved through well organized production of prefabricated units is a further incentive, and providing the supply of suitable quality material does not give problems, I think we can expect this usage to grow. Again, I think it will be necessary to develop techniques for prefabrication on a modest scale of operation in order to keep costs down.

Joinery and utility uses

This is the category of usage that is most liable to meet competition from new materials or new combinations of materials. Plastic products have already made some impact by becoming accepted for items such as toys, tool handles, interior trim in buildings, parts of furniture, and some joinery items. The new materials are often preferred more because of low processing costs or low maintenance and better durability than because of materials costs *per se* or inadequate technical properties in wood products. We see signs that better appearance, better durability and low maintenance are becoming much more significant to users. However, price is important, and between 1954 and 1968 the price index for plastic furniture for windows, for example, fell by 15% while the price for softwood rose by 33%.

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Although 15 % of the new windows in Germany are in polyvinyl chloride, the penetration of plastics into joinery and furniture, both major timber markets, has so far been quite small in the U.K. The reasons are interesting. All plastic or plastic coated wood windows of a satisfactory standard of performance are now available and have the advantage that once made they need no painting and require no maintenance for many years; this is an advantage that clients seem willing to pay for. However, there are problems in installing them in the building without spoiling or damage, and this limits their acceptability by the building contractor for traditional building. They are easily used and fitted in timber-framed buildings or others based on dry methods of construction, and it is interesting that PVC coated wood is being quite widely used for the 'dry' construction in Clasp (Consortium of Local Authorities Special Programme) schools. Designers are now beginning to produce windows with rounded corners – for these are much easier to make in plastics than the more normal rectangular design.

Over the past seven or eight years the use of plastics for various parts of furniture has been explored; moulded chair shells, laminate surfaces which imitate veneers, extruded drawer sides and various small cabinet items have all been tried, but only the moulded chair shells seem to have been a major success. An assessment by F.I.R.A. (Merrick 1970) has concluded that plastics will only replace wood products if furniture is made in such a way that the mass of plastic used is less than wood, or the labour involved in manufacturing is significantly reduced.

In recent years, developments in structural foams resulting in improvements in impact resistance, rigidity, thermal stability and fire resistance have been very significant, and new manufacturing techniques, such as the I.C.I. sandwich process, have been developed. There are now indications that moulded plastics are being used to introduce curved or sculptured shapes in furniture design, something that cannot easily be done using chipboard at the moment although it used to be done with plywood. Industry now has the ability to produce larger plastic mouldings and has greatly increased capacity for production. My own view is that plastics are unlikely to make a larger impact on the market for wood in furniture until designers try to create furniture designed to make full use of the properties and manufacturing possibilities of plastics rather than copying wooden furniture in plastics. Even then, the present trend in prices may inhibit success. The use of mouldable components, many of which will be covered in upholstery, still seems to be the most likely way in which plastics will capture part of the market for wood in furniture, for design and appearance are at least as important as cost in this market.

Interior trim, used for architraves, skirting boards and door frames, is available in extruded polyvinyl chloride and is being fairly widely used. One of the advantages is that these products can be made so that they are easily used with clip-on fixing systems which are both flexible and convenient. Because no painting is required, prices have been competitive at least until quite recently.

Exterior cladding is a usage where a very wide variety of materials is now being employed. Cladding materials in sheet and strip form are gradually supplanting brick for reasons of speed, convenience, and the high labour cost of bricklaying. About 15–20 % of houses have some form of cladding, and at the moment a growing proportion of this is plastic. We estimate that wood products have 10–15 % of the cladding market, mostly in housing and small prefabricated buildings. But various metals, sometimes in combination with wood products, special concretes and asbestos products are also widely used. In this field I am sure that good impact resistance, high durability and low maintenance requirements and ease of fixing are at a premium, and

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there is probably room for a good deal of development work on these aspects and scope for new combinations of materials.

Fencing is a large user of timber; quite often fencing is not regarded as very important and low grade material is used without adequate treatment. This results in too short a life, high maintenance costs, and a poor reputation. Plastic ranch style fencing has been used in some situations where appearance is important, the initial cost being higher but costs being the same after a first repainting. Concrete posts with metal fencing are now often comparable in price with wooden fencing.

Pallets

This has become a large market for U.K. timber. Despite the design and production of plastic pallets, their higher first cost and the problems of return and re-use have prevented them from taking an increasing part of the market. There seems no reason to expect a significant change in this market.

Decorative uses

Internal panelling and decorative veneers are the main products under this heading and, despite the tremendous advances in grain printing on to fibreboard, veneers and plastic laminates, the experience in recent years suggests that a substantial market for the natural products will remain. As our affluence increases, our demand for pleasant and civilized surroundings will increase also, and we shall be able to pay the price for the variation in pattern and grain that one can only get by using natural products. New species not now being used may well add to the range of colours and features available, and although the size of the market will be at the whim of changes in fashion, it is surprising what can be achieved by good marketing techniques. It should be technically possible to glue wood veneers on to quite a wide range of substrates so that if new sheet materials are eventually developed, for example as one way of using waste materials, they could still be made attractive by the use of decorative veneers.

Pulp and paper products

The main competition has come from plastics, which will become more expensive. However, price differentials in the future are difficult to assess. Pulp and pulp products will become more expensive because of the costs of dealing with or avoiding environmental pollution and the generally rising demand level.

Future use of wood-based materials

The rapid growth in the use of sheet materials rather than solid wood has resulted in the same volume of material producing more value and a larger volume of desirable product. We have one very good example of a new wood-based product which has emerged from a lowly beginning as a not very good material made from waste, to one which is not only respectable but now in high and rapidly growing demand, namely chipboard. There is a powerful incentive for us to use more of our waste and small sized material, including some bark and sawdust, and making board products is one way of doing to. The continued growth of the markets for these products, particularly in building, depends in my view on an improvement in technical properties so that they can be used in new ways; for example, in situations where they may become wet. There is evidence that fibreboards can be more widely used for structural purposes than they are at present and with cost savings. I think there is scope for further market developments in wood-based sheet materials, and perhaps in moulded products; for some applications more

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specialized, user-orientated products will need to be developed with good technical specifications. In other cases, such as the wider use of fibreboard in furniture, it is more a case of design and product development.

There are a number of ways in which the efficiency of wood utilization and the competitive position of wood could be improved in relation to other materials. Some I have mentioned, but there are others: making use of a greater proportion of the tree (although I am not a strong believer in whole-tree utilization), developing better systems for prolonging the life of wood products and thus cutting overall costs, developing ways of making good quality products from low quality wood, developing a more positive approach to the use of new species and to forest regeneration or replanting. It seems to me that there is a good long term prospect for the continued use of wood as an industrial material but, in view of the strength of the competition, more effort will need to be invested in new developments and marketing, and in making optimum use of available supplies.

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Discussion

J. L. Finney (*Crystallography Department, Birkbeck College, Malet St, WC1E 7HX*)

Both Mr Palmer and Dr Gibson consider forests a *renewable* resource, but only Dr Gibson qualified this by saying that we do not understand the problems of regeneration of tropical rain forests, which play a large part in Mr Palmer's assessment of available resources. I would like to underline strongly our lack of knowledge of the tropical rain forest, and stress the difficulties of undertaking sustained yield forestry with such a deficiency existing in our understanding of that ecological system. Regeneration of a cleared area depends on the type of area in terms of both rainfall and topography. Where precipitation is marginal, the drying out which may occur after clearing may entirely prevent regrowth, while we are also seeing in many areas the same problems of erosion as have resulted from careless temperate forest cutting in fragile areas. Moreover, we should be aware that replanting cleared tropical forest areas with single species is eliminating the extreme natural diversity of both the flora and fauna of the original forest. To continue to do this extensively is likely to have severe ecological consequences.

The science of tropical forestry is in its infancy, and those problems peculiar to tropical rain forest are little understood. In the absence of basic knowledge, sound forestry practices are unlikely, and are in danger of being ignored in the rush to exploit the tropical forests. Until we understand these problems a little better, there would seem to be some obligation on the part of the timber companies themselves to tread carefully, in order to retain the renewability of the forest resources.

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H. C. Dawkins (*Department of Forestry, Oxford*)

In discussing published studies of changes in production between plantation rotations, you do not mention the confounding factor of genetic constitution. Have plantations ever been replaced by seed from precisely the same source as that of the preceding crop? If not, then differences between rotations cannot safely be attributed to changes in soil or crop treatment.

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