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APPROPRIATE TECHNOLOGY FOR THE MANUFACTURE OF PULP AND PAPER PRODUCTS

PAPER, PAPER PRODUCTS AND PULP MILLS.
Background Paper

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PAPER, PAPER PRODUCTS AND PULP MILLS

by

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1) INTRODUCTION

The subject of this paper is the promotion of the Pulp and Paper Industry in developing countries, or third-world areas to quote another accepted term. Both phrases are generalisations, because there are major differences between countries recognised as conforming to these descriptions arising from significant factors such as size of population, extent of natural resources, per capita income, accessibility etc. etc.. For purposes of this review the common factors can only be the current level of paper consumption per capita plus the present and future requirements necessary for the country concerned to attain reasonable levels of consumption for progress towards a standard of living which is acceptable by modern concepts. It is recognised that there is a correlation between the consumption of paper and the standard of living for any given country. Fundamentally, higher levels of education, particularly technical education, are necessary to raise the earning capacity of the general population and availability of paper is an essential factor in achieving these objectives.

2) STATISTICS OF CONSUMPTION

A study of the statistics recently published by the Pulp and Paper International magazine, in the July 1978 Annual Review issue, will indicate just how wide are the differences in per capita consumption of paper throughout the world. The statistics relate to 1977 and the following extracts are revealing:

Country or Continent	Consumption. Kg capita/annum
N. America	
U.S.A.	273.1
Canada	191.4
Europe	
Sweden	195
U.K.	125.8
Albania	5
* Average	81.4

* The average quoted is simply the arithmetic mean of the published figures and not a true average because the population factors have not been taken into account but for the purposes of this paper it can be considered as representative.

Asia and Oceania

Out of 41 listed countries only three, Japan, New Zealand and Australia consume over 100 Kg/annum/capita and only 3 other countries exceed 40 Kg/annum/capita. Excluding these countries the average consumption, on the same basis as above, is 6.1 Kg. On a true, population-based calculation the average would almost certainly be much less because the values given for such highly populated areas as India and Indonesia, for example, are 2.1 and 2.3 Kg/capita/annum respectively.

Latin America

Out of 28 listed countries no country attains a level of 100 Kg/capita/annum and only four exceed 40 Kg/capita/annum. The average is 22.3 Kg/capita/annum.

Africa

Out of 44 listed countries, no statistics are available for two countries but of the remainder only one, S. Africa, exceeds 40 Kg/capita/annum and only just manages it at 40.25 Kg. This is probably not representative because the minority white population is almost certainly responsible for the greater proportion of consumption. The average for the 42 African countries for which statistics are available is 5.9 Kg/capita/annum.

5) MINIMUM OBJECTIVES

It is difficult to determine where the minimum for reasonable development should be set because, without doubt, the levels of 100 Kg/capita/annum or above pertaining to developed countries contain significant quantities of paper used for packaging, and cosmetic purposes which are not essential for but arise from higher living standards. In the writer's opinion a level of 30 Kg/capita/annum is a minimum to achieve full literacy, adequate communication and educational levels and 40 Kg/capita/annum a desirable objective because some element of packaging should be present for industrial or export purposes. Such a level

would be less than 25% of the N. American minimum or 45% of the European average. If the lower, 30 Kg basis, is accepted it should be recognised that this indicates a 15-fold increase for countries such as India or Indonesia, an 8-fold increase for the African continent and a 50% increase for Latin America. At current population levels it would require the total world production to be doubled to meet this objective. Taking into account population growth and the time factor one is drawn to the conclusion that to attain such an objective it will ultimately be necessary to treble world production, even assuming that the more developed countries will remain around present levels, with no further appreciable growth. The implications are staggering and pose several questions. What fibre resources will be required? How can the machinery requirements be met? What is a practical time-scale? Will current methods of production satisfy such objectives? Must some alternative to paper as a means for raising educational standards be sought? Can the recognised "modern" plant and machinery resources cope with this enormous potential demand?

These questions are not academic and the answers cannot safely be left for unplanned, haphazard evolution. It is no exaggeration to state that world peace will be dependent, in some degree, on the achievement of satisfactory answers. It is a recognised fact that the growth of knowledge is exponential. To a given base will be added over a given time a proportionate increase. Where the base is substantial, as in developed countries, so also is the increase. Where the base is relatively small, as in the under-developed countries, the increase is also proportionately small. Left alone, this irrevocable principle means that under-developed countries can never catch up with their more fortunate neighbours who started earlier. To those who have shall be given: to those who have not shall be taken away even that which they have. This inexorable law is not tenable under modern world circumstances because without check it will meet the same law applying to population and it is inconceivable that a large majority of the world's people will indefinitely accept a reduction in living standards by relative

indices whilst a minority flourish and continue to improve. Realistic answers to the questions posed above must be found and an attempt to indicate means will be developed in this treatise. The same factors apply to commodities other than paper and require equivalent consideration. This contribution is confined to paper, pulp and associated products and will attempt to suggest lines along which potential solutions may be found for that industry.

4) FIBRE RESOURCES

Taking account of the population and consumption statistics for the developing countries it is estimated that to reach the minimum target of 30 Kg/capita/annum on last year's figures, would require some 100,000,000 metric tonnes/annum of additional production immediately, doubling the current world production, allowing for the recycled element used so extensively in developed countries. Assuming the greater use for such an increase to be for writing and printing grades plus newsprint the indications are that approximately 30,000,000 M.T/annum of long-fibre material as pulp and 70,000,000 M.T/annum of equivalent short fibre, hardwood or similar, would be necessary. The latter presents no insuperable difficulties in availability, but considerable problems in exploitation. The former presents great difficulties in availability and exploitation. The capital intensity for the exploitation activities by modern standards would be prohibitive for most developing countries and the scale accepted as economic difficult to absorb domestically. Export as finished material can be ruled out as a practical alternative because of the intense competition from developed countries producing for export. Export of raw or semi-finished material is at best only a temporary expedient because it confers the greatest advantage on the already developed countries, still further widening the gap in industrialisation and retarding the advance in living standards. Recognition of this has already been reached by some developing countries who are attempting to control the export of raw or semi-finished materials, regarding this source of income as, at best, an expedient, short-term measure.

At this point it is appropriate, in the writer's opinion, to consider the whole philosophy of paper and paper products because it has had a very large influence on current and past activities and will have an even greater impact on future development.

Paper is the classic, perhaps the original, throw-away. Its purpose is to perform the function intended for its use more cheaply than could be performed with any alternative product. When it ceases to be manufactured by this principle, it ceases to be paper in the classic sense and it will ultimately be replaced by something else, less expensive in first cost. So far nothing cheaper than paper has appeared for the applications to which it has been put such as writings, printings, wrappings etc. but it has undergone several changes over its long history and further changes can be expected in the future. Almost all of the changes introduced to date have come about to preserve the fundamental objective, to be the cheapest possible material for the purpose intended. It began as a product made from rags, at least in the modern developed sense. Rag-paper now survives only as an alternative to parchment or similar materials for prints, manuscripts, artistic products etc. where durability is required and even for these uses the proportion of rag involved is now notional only because it is too expensive. Rag paper at the present time is a luxury or status material. It was replaced first by inexpensive vegetable residues, straw, reeds etc. not wholly but as a proportion and not entirely satisfactorily according to the standards established by rag paper. In 1844 groundwood pulp appeared and had a great impact on the industry particularly for newspaper and cheap book production. Within the next ten or fifteen years chemically produced pulp from wood was also introduced and its introduction and progressive development has led to the virtual elimination of rag-based papers as mentioned above. The wood used initially was almost exclusively softwood arising from the vast forest areas of N. America, quickly followed by the Scandinavian countries with large softwood reserves. The consequent rapid growth in consumption of paper products arose

from the lower cost and threatened, by the middle of the present century, even the apparently inexhaustible softwood resources of the world and this motivated a belated effort to halt the profligate destruction of the world's softwood forests. Clear felling and sustainable reafforestation began and as a bye-product, the introduction of hardwood pulps for which the development of pulping techniques was timely. Higher quality standards, particulary for writing and printing grades of paper where opacity is desirable had earlier led to the introduction of short-fibre additives such as esparto grass which was used in considerable quantity until the introduction of hardwoods since when its use has declined to a negligible extent, except where it is indigenious, again because of cost and the permanent pressures for paper to be cheap. Earlier this century, the use of indigenious fibres such as bamboo and reeds was developed but their use was restricted to countries where such materials exist in quantity and labour, for collection, is cheap. More recently the use of bagasse, a bye-product of the sugar-cane industry, has been developed and has made great strides, its technology improving rapidly to the stage that it is now claimed to be a wholly acceptable and competitive material for writing, printing and tissue grades and further development can be expected to increase the range of products manufactured. Two dominating principles in the development of paper may be traced from the above as corollaries to the fundamental concept of absolute lowest cost already indicated. These are:-

(a) To be truly viable and endure paper must always be produced from a waste material of low intrinsic value.

(b) The highest value which can be accepted for paper-making materials at the present and expected levels of consumption is the equivalent fuel cost, value for value delivered, relative to the country concerned.

Taking these principles in order:-

4.1 Waste Materials

With possible temporary exceptions only, all of the materials used for the

manufacture of paper have come from discarded or waste materials. Nothing is, or should be, produced or grown simply for the manufacture of paper. Rags, straw and bagasse obviously follow this principle and so does the recycling of waste paper, now approaching 50% of the consumption for developed countries. The same claim, indirectly, can be made for pulp produced from wood. The initial forests were cleared for development or exploited for lumber and saw-milling. There was, therefore, a surplus of timber, available at very low cost and its disposal for pulp production coincided, at least in N. America, with the need for its removal for land development. The tremendous growth in paper consumption led to the exploitation of forests for paper products alone but this was initially confined to small-tree forests less suitable for the production of lumber and was reduced by the development of chemical pulp using chips, a bye-product of the sawn timber industry. It is significant that groundwood, from whole trees, has now reduced to a very low level of production being replaced by refiner or Thermo-mechanical pulp from chips and that some areas in the world, notably British Columbia, have actually forbidden the use of whole logs for pulp production, insisting on the use of chips surplus to the timber industry. The development of the cant-chipper for mass-production of standard timber sizes with chips as a bye-product is another indication of this trend. The truth is, and will be confirmed in time, that the paper industry cannot afford the whole log concept for raw material. It must be based on waste, or bye-product materials for survival long-term. Existing industries based on whole trees are anachronistic and obsolescent. New pulp mills are normally linked with lumber mills.

4.2 Equivalent Cost of Fuel

The materials used as fibre for the production of pulp and paper are combustible by nature. Wood was extensively used as fuel before it was adopted for paper-making. Bagasse is the normal fuel for the cane-sugar industry and is sold for paper-production on an equivalent fuel linked basis. Even waste paper is now

seriously being considered in some areas of the world as a fuel for central power generation. The four-fold increase in fossil-fuel prices which have come about in recent years and the prospects of diminishing supplies in the foreseeable future are generating ever-increasing interest in alternative fuel sources and this must have a bearing on plans for the manufacture of pulp and paper for developing countries if they are to have a long-term value. It has already been established that it is more economic to use waste wood from the forest as fuel for the paper industry than as a raw material for production provided that the distance from the pulp or paper mill is not greater than 35 miles in countries with fossil-fuel resources. The economic distance increases for countries less fortunately endowed and will increase for all countries as fossil-fuel becomes more scarce and more expensive. The close relationship between fuel prices and the cost of raw materials for pulp and paper production must be taken into account for long-term planning and it should also be recognised that capital-intensive pulp and paper mills are truly viable only on a long-term basis. Paper machines commissioned between 50 and 80 years ago are still operating in many areas of the world and this time-span, which can be expected to apply also to new industrial installations will exceed that forecast for the availability of fossil-fuel resources at present consumption rates.

4.3 General Inferences on Fibre Sources

If the principles adduced in the foregoing are accepted then pulp and paper manufacture for developing countries on a continuing basis should adopt as raw material waste from associated timber or agricultural industries and should recognise the growing value of and the ultimate competition for such materials as fuel. Wood based pulp should wherever possible be associated with the timber industry. Bagasse and straw already satisfy the essential raw material conditions. Reeds, bamboo or other grasses with no other commercial use are more suspect and should be considered only where profusion exists, labour is cheap,

land development and clearance is a feature and more permanent materials can be expected in due course to replace them economically. As the standard of living increases labour costs will also increase and the conditions which initially enable a pulp and paper mill to be established may change unfavourably. Transport costs must also increase disproportionately as fossil-fuels become more expensive and this is also a factor to be considered.

Generally, with the possible exception of long-fibre softwood pulp, in most areas sufficient raw material resources exist for an effective start on the targets specified. Over the time scale necessarily involved for full realisation it should be possible to get much nearer to self-sufficiency and recycling can be brought in to help but for this a strategic, planned approach is advisable, if not essential. The planning should take account of all factors involved, forest resources, agricultural resources, population centres, human skill resources, ecology conditions, power and fuel resources, plus many other less obvious considerations. The dogmatic assumption that "modern" technology and economic scale considerations can be imposed successfully on developing countries is open to criticism and review. As it stands the pulp and paper industry throughout the developed world is not a shining example of unqualified success and those concerned should not pass on to under-developed countries their mistakes in the name of advanced technology.

5) MACHINERY AND PLANT CONSIDERATIONS

5.1 Paper Machine

Over the past 70 years the paper machine has increased in width operating from approximately 2 metres to around 10 metres and the operating speeds have been improved from about 100 metres/min to 900 metres/min (1250 Metres/min for tissue machines). In 1927 the largest and fastest machine in the world was commissioned in U.K. It was 5.5 metres wide and capable of operating at speeds up to 250 metres/minute. In 1957 the largest machine in the world was just over 9 metres in width and capable of operating at speeds of up to 425 metres/minute. Both

of these machines were designed primarily for newsprint production. Each is sti in operation but not producing newsprint. Printing and writing papers have been substituted by relatively minor modifications. The significance of this statement is not so much to prove that even greater widths and speeds are essential for the economic production of newsprint but toshow that there is much greater versatility in the product range of a paper machine than is generally recognised. In fact most of the earlier, smaller machines were originally designed for newsprint production and those still in operation (a considerable proportion) are making other products over quite a wide range. In terms of annual productive capacity as newsprint the single machine has moved from approximately 5,000 MT/annum to upwards of 150,000 MT/annum. The foregoing statements could be used to illustrate progress and in terms of mechanical achievement this cannot be denied but to assume that these dramatic changes have brought about more economic production would be an extrapolation unjustified by the facts. In £ sterling (because both of the machines noted above were of British manufacture) the cost of the machines have since 1937 increased 50/60 times in terms of width and around 30 times in terms of cost per annual tonne of product, taking into account the speed difference (which at the higher levels is seldom achieved consistently). Over the same period the selling price of the product, newsprint has increased 20 times. One would have expected the reverse to occur but the facts disprove it and indicate that it is becoming less and less economic to invest in new paper machines, except for special circumstances. In terms of a complete mill, excluding pulp manufacture, over the past 25 years, the cost per annual tonne has increased ten-fold and the selling price of paper three to four-fold. If this is progress the industry would be better off without it because over the same period interest rates have also more than doubled. As a result investment for new machines in countries not endowed with low cost raw material resources has been drastically reduced. Production is maintained by upgrading products and keeping written-down machines operating. This is

economic, under such circumstances, because the sheer cost of money for new machines now exceeds the profit margin available from the sale of the product in many cases. The sheer quantity of money required is also such that after tax, private investment simply cannot support the burden from reserves and only governments or multi-national companies can raise the funds required. It is no argument that this state of affairs is consistent with world trends because if it is not viable for small industry it is only viable for large industry or governments after a sufficient time has elapsed for the money burden to reduce and selling prices to increase and until this state of affairs has been realised there must be losses.

It is worth examining this situation in detail to avoid arriving at the same situation for developing countries where, as has been indicated earlier, very large investments must sooner or later be made to reach an acceptable standard. To accept import as the practical solution is self-defeating; Costs will be higher, availability lower and the balance of payments effect unacceptable. It is a paradox that with world consumption steadily increasing and facing much more rapid expansion requirements.investment in new plant cannot be justified. This situation does not apply to the converter of paper, the printer, the merchant, the box-maker, the carton manufacturer and should not apply to the fundamental material manufacturer.

There are a number of reasons why this situation has come about and the following are, in the author's opinion, significant.

(i) The laws of inflation bear more heavily on the manufacturing costs and selling prices of machinery than on the selling price of paper, because of the continuing pressure on paper costs referred to earlier.

(ii) The impact of very large units on the market has had a depressing effect on the selling price of paper.

(iii) The problems of labour control, cost and efficiency increase disproportionately with size.

(iv) The intrinsic cost of the machines per unit of production increases disproportionately above a given width and still further above a given speed. These cost increases are no longer justified by compensating reductions in overheads or labour costs. Increased width and speed have required increases in sophistication, material costs and ancillary costs for plant and increased costs for distribution because of the greater volume involved.

(v) The four-fold increase in energy costs has made speed less economic.

About 15 years ago the author, who had been continuously engaged in the building of new mills for many years and had been involved in many feasibility studies was struck by the changing situation, that investment could seldom be justified for paper production compared with corresponding investment in other industry and began to investigate the circumstances. Scale was suspect from the start because market growth which could be absorbed effectively was so often a limiting factor and only growth, not improved efficiency or reduced costs, was able to justify new plant.

Accordingly several leading manufacturers of paper machines were approached and asked if they could provide information which would enable the optimum machine capacity to be established in terms of capital cost per unit of production. Surprisingly, none of the suppliers contacted could give this information without a costly investigation which they were not prepared to undertake. The assumption was that bigger and faster must be more economic but no facts to support this assumption were available.

The next step was, therefore, to obtain quotations for various sizes of machine from several suppliers and to use these, with previous data, to obtain some guidance. The results were surprising; for orthodox, modern type machines of Fourdrinier type it appeared that overall, including drive (which for the smaller machine could be of simple mechanical lineshaft type up to 600 metres/min) the lowest capital cost per tonne of product was for machines between 2.2 metres and

5.5 metres wide, with very slight differences over this range. For tissue machines, based largely on actual installations varying from 10 to 100 tonnes/day the optimum size appeared to be 20 tonnes/day.

A corresponding investigation into the operational efficiencies of all the machines operating within the group represented by the author revealed another equally surprising fact; the most efficient in terms of availability and productive efficiencies were also around 2.5 to 3 metres wide, largely because the time required for major roll change or breakdown was least at this size and the smaller machines enjoy more uniformity of product. The efficiency factor still further enhanced the emerging case for the smaller machine.

These indications encouraged us to include machines around this size as alternatives in three serious feasibility studies which were undertaken.

The first was for a mill of approximately 100,000 TPA capacity as coated, publication grade paper. One single machine of 7.5 metres width with an off-machine coater of half-width was compared with three 2.5 metre machines and two coaters of equivalent width. The analysis, which was fairly done and based on actual quotations shewed that the smaller machine concept would be intrinsically less expensive and operationally more viable. One striking example of the economies available was presented by the supercalenders involved. Five small supercalenders, could be installed for the cost of one large unit, including spares. Since two supercalenders were considered a minimum for continuity the smaller units scored heavily in this aspect.

The operational costs for the small machine concept were enhanced by the circumstances that the specified capacity, 100,000 TPA could not, for market reasons, be realised for several years after commissioning. The small machines could be installed sequentially with cash flow and operating cost benefits. The project was not commissioned, for reasons unconnected with costs but had it been - without doubt the smaller unit concept would have been adopted.

The second case was for a mill of approximately 55,000 TPA capacity as writing and printing papers based on imported pulp. Here, two machines of approximately 3

metres effective width were compared with one of 5.5 metres width. Again, the study, based on firm quotations, indicated that the best case, in terms of capital and operational costs was presented by the two small machines. The operational costs were influenced by the number of grade changes involved and the ability of the smaller machines to halve these requirements by selection but this is a fact of life and one even more likely to apply to developing countries with initially small markets and a wide range. This project did not materialise either because neither concept presented a sufficiently attractive case at the time.

From these two studies one interesting and significant fact emerged. Two machines, identical in construction can be offered for approximately 10% less in cost than a single one if ordered at the same time. The reductions are due to design costs and repetitive tooling.

These results were encouraging but were not regarded as fully indicative because the manufacturers selected were tooled for larger machines and it was thought that the machining overheads for such machine tools on a single-shift basis were unrealistically high. We therefore embarked on a serious study to investigate all the factors thought to be involved. Resulting from this a paper on the subject was presented by D. Harris, then a member of our staff, to the Institute of Mechanical Engineers, London in November 1972. This paper developed mathematically, with illustrating curves the estimated capital cost of machines per unit of production and concluded that the point of minimum capital cost lies between 4.0 and 6.0 metres width. The work was based on deriving the minimum weight of metal required plus the machining requirements. The paper included also estimate bases for ancillary plant and the buildings. He concluded that a two-storey building is less expensive than a single storey building. Similar investigations were carried out earlier by E.H. Karl Schmidt and K.F. Schoenemann and their findings in respect of the weight of metal required coincide very nearly with the

results of D. Harris's work except that Karl Schmidt established a sharper minimum weight curve bottoming at 3.0 metre width.

These works are valuable in demonstrating that in terms of metal, fabrication and machining there is an optimum size for a paper machine and it falls far short of the mammoths being imposed upon the industry. The conclusions are not surprising - fundamentally a paper machine is a bridge between two soleplates costing more as the span increases by a non-linear ratio which is further increased if speed is included as a factor because the critical speed is a function of the deflection. The work was indicative but the case for smaller machines and single-storey buildings is capable of further improvement. Other factors could also be considered. The machining costs were obtained from established manufacturers and would undoubtedly be lower based on machine tools of appropriate size. Electric drives were included, an unnecessary expense except where high speed is involved, ie above 600 m/min.

The greatest economy however arises from standardisation of design and components and the works referred to above do not deal with this aspect or the costs of site erection, which by existing standards of construction must be undertaken piecemeal at site often under difficult conditions. At the present time paper machines represent individual designs and manufacture, are not assembled or tested prior to despatch and the period of assembly with expensive labour together with the costs of commissioning and adjustment represent a substantial addition to prime costs up to 15% of total cost.

Speed is a factor which should also be considered. It is axiomatic that a small machine, in terms of width can run as fast as its larger brothers and the Harris paper shewed by taking two speeds as criteria that capital costs per unit of production reduce, for the paper machine, as speed increases. However, there is an operating cost consideration also to be taken into account. High speeds involve more sophistication, greater skills or experience from the operators,

higher standards of maintenance and higher levels of energy consumption. The introduction of synthetic wet felts has permitted higher speeds and press loadings but the vacumm requirements in terms of power have trebled and this, coupled with the four-fold increase in energy costs, now makes speed a costly feature, one to be taken into overall account.

The third study undertaken by our company dealt with a machine to produce waste-based liner board or corrugating medium at the rate of 45,000 TPA. A comparison was made between one single machine capable of operating at speeds up to 300 metres/minute and two former type machines of 2.2 metres width limited to 180 metres/minute because of the vacuum-less formers selected. Here again the study was based on firm quotations and gave the two small machines as the most economic solution. The power requirements were a telling factor plus the abilit to minimise grade change requirements.

From a review of all these factors the author now believes that the industry would benefit from the development and mass-production of paper machines standard in width at around 2.5 metres and designed for speeds up to 200 metres/minut Such machines would be versatile and could be made more so by the optional addition of one or two simple, vacuum-less formers. The substance range would be 40 g.s.m. to 350 g.s.m. with the formers, or 40 g.s.m. to 200 g.s.m. with the Fourdrinier alone. A simple mechanical drive, preferably turbine driven because of the greater speed range and lower cost would suffice. The machine should be designed for modular, pre-assembled construction to minimise site assembly requirements. It is not difficult to consider the entire machine house and preparation plant also as standard, for modular construction, with pre-assembly including preparation plant, piping, steam and power services, built in boiler and power plant, water and effluent services, chests etc as a truly packaged unit. No paper converter requires reels in excess of the width suggested so that the winder can be eliminated, with a simple rewinder for reclaim. The relatively low speed and width would minimise sophistication without losing

quality A study for such a concept is now being undertaken and preliminary indications are that a paper mill designed and produced in quantity to such a specification can achieve capital cost savings around 50%, can be operated by labour with a minimum of training obtained on identical plant, can be self-sufficient as an entity, versatile and competitive in operation costs with the giants. The annual production from such machines would range from 7,000 MT to 20,000 MT according to substance and as such would suit a growing market. It is believed that mills of this nature would find a receptive market in developing countries and could also have attraction in developed countries for growth, without market disturbance, economically.

The concept can be considered as turning back the clock because in the early years of this century many mills with machines to a similar specification were built. The industry could, indeed, be said to be founded on such machines. The concept presented, however, takes advantage of genuine improvements such as combi-press pick-up, grooved or fabric presses, substance and moisture control. It is possible to outrun viability by over-design. The world will not see Queen Mary liners again. Concorde is unlikely to have mass acceptance and when the situation is reached, as it now has been, where established paper manufacturers, in a growing market, cannot afford to renew their plant after more years of service than other industries and on a fully-utilised round-the-clock working basis it is time to review the standards and manufacturing conditions. The world needs cheap paper which in turn requires less expensive machines. Production of such machines, under licence, would not be beyond the resources of developing countries and the spares situation could be reduced to a minimum with substantial operating economies in terms of cost and continuity.

The author does not claim that the standard machine or mill outlined above is a universal solution applicable to all requirements wheresoever. There will obviously be situations where installations of larger capacity may more

economically suit the conditions and "modern" concepts are more acceptable. Such cases must be treated on their merits; it may be most practical to multiply the number of standard machines or, for minimising space and building requirements to consider the larger, tailor-made equivalent. One objection which has been made to the relatively small capacity, standard machine approach is that labour requirements would be increased for mills above the capacity represented by a single unit. It is not a serious objection because in any mill the number of machine operators relative to the total number of mill employees is small. Where labour is cheap and employment scarce the increase may indeed be beneficial. It is also possible, if labour economy is desirable, to operate with one crew between two machines. There is precedent for an operation of this kind. However, in the opinion of the author, the case for the large-capacity, highly sophisticated mill for developing countries is not to be taken as automatic because a feasibility study which does not consider alternatives has recommended it. All too often, such studies, based on "modern" Western world technology, end with a project which is viable only if protected by tariffs or subsidies and this is not a long-term solution. Paper must be cheap and available in sufficient quantity to the poorest; tariffs and duties defeat this objective and should be regarded as a temporary expedient at best. The real objective is to be competitive against imports; ocean and overland transport costs should provide such protection as is necessary.

There will also, in many areas of the developing world, be situations which call for labour-intensive installations of capacity even smaller than that indicated by the standard mill described above. It is a feature of developing countries that the bulk of the population, being agriculturally based, is located in villages remote from the major towns. The number of established towns relative to total population is, indeed, very small by comparison with the same relationship in developed countries and communications are often less than adequate.

Transport costs from large mills remote from such villages are likely to be high and increase with time. In such cases local industry, based on locally available material could be the most economic and desirable solution taking into account all the factors pertaining. Under such circumstances very small mills, with minimum energy requirements, could provide the most practical and economic solution and there is a case for developing the 5/10 tonne per day unit also as something standard and available at low cost.

It is believed that the standard, one reel width installation, competitive in nature, is a priority. It is also believed that the potential market for it is such that mass-production of such units is a real, practical possibility. The third world cannot satisfy its existing and potential requirements by the huge tailor-made installations now presented by "modern" Western technology. They suit neither the market, the timing or the pockets of developing countries. The established machinery manufacturers are not likely to initiate or support this concept because it is opposed to their vested interests and the scale of their existing machinery. The major consultants are also unlikely to endorse this policy because, again, it is contrary to their business expectations. The lead should come in an organised manner from the potential customers and independent advisors. The magnitude of the requirements over an acceptable time scale requires a change in tactics. Paper machines should be produced more like cars except that full standardisation can be aimed at over the full range of ancilliaries as well as the basic machine. An effective design would attract manufacturers and is worth sponsoring.

6) PULP MILLS

6.1 Wood-based

It is accepted that the economic scale for a wood-based pulp mill is now 600 TPD as a minimum and installations up to 1,000 TPD exist. Unfortunately it is more difficult to challenge this basic assertion than it is to challenge the corresponding assumption for paper mills. As a superficial analogy it has already

been stressed that a paper machine is a bridge, increasing in intrinsic cost disportionately as it gets wider. A pulp mill is more similar to a container, where the material cost reduces with scale. The limit, in fact, is more nearly for a wood-based pulp mill, the washer size where the bridge concept pertains and this is under attack from diffusion or the newer, high consistency stacked washers.

However, although this fundamental fact must be accepted for developed countries and is mandatory where export is a feature it does not necessarily apply with the same emphasis toless developed countries because it is based on the principle of capital cost per unit of production relative to the pulp mill alone and even in developed countries no scale would be economic without a supporting timber mill infrastructure, going right back to the forest.

If a forest exists and there are abundant forest areas in almost all under-developed countries it is first desirable, if not strictly necessary, to establish a saw-milling industry and its size depends on the market it can serve. Such forests as exist are almost exclusively natural forests of mixed hardwoods which initially at least, restricts the timber market. The North Americans were fortunate in having enormous softwood reserves and an exploding market for softwood timber to meet housing requirements for a rapidly expanding population. These conditions are unlikely to apply to the developing countries to a similar extent and the world is not lacking in hardwood or likely to be short of hardwood pulp. Except, therefore, where the hardwood timber species has export potential and is near enough to a port to realise it, the saw-milling industry is likely to be gradual in growth and relatively small in scale As it develops, reafforestation with softwoods will improve the situation but, although this should be planned wherever possible, there is, inevitably, a time-scale involved. It should be recognised, however, that almost 60% of the total wood used for a sawmilling operation is available for pulp (particularly where the cant chipper techniques are used) and approximately 15% for fuel-raising,

with dry-barking. Where pulp otherwise has to be imported, therefore, an economic case can often be made for pulping operations on a smaller than recognised scale and the recent turn-back to static digester pulping makes it possible to consider small installations at least as a beginning.

The above comments apply to pulp, Kraft or high-yield, for writing and printing papers. For semi-chemical pulp much smaller scale is acceptable, from 80 TPD upwards and proximity to a forest or sawmill is not essential. Scrub-wood, over a relatively wide area can be used. For all pulps, of course, chemical and water resources are essential and chemical recovery with other ecological provisions should also be incorporated. Transport of finished product to the consumer may also be a problem.

It is the author's view that from the forest exploitation aspect, in terms of timber and pulp, the activity should be based on producing semi-finished material for conversion nearer to the centres of population, which are the principal consumer areas in terms of final product. Unless particularly favourable circumstances apply the large wood-based pulpmill should not include a paper-mill, particularly for the printing, writing and associated grades which, unless export possibilities for other grades exist, must be the priority grades.

The reasoning behind this statement is, for paper, first that for some time to come it would seem that a proportion of the furnish must be imported as long-fibre and access to a port and the avoidance of long hauls twice (first as pulp then as paper) should be avoided. Secondly, small self-contained paper mills can be located in populated areas without ecological impact if properly designed and this is more difficult and expensive for pulp mills.

Thirdly, it is always advisable with paper of this nature to be near the customer, the printer or converter and to be able to offer quick and effective service over the range of reel or sheet sizes involved.

Fourthly, populated areas provide a practical basis for the recovery and reprocessing of waste paper, as a constituent of other furnish or for wholly waste-based products and a potential reduction in imports. Recycling must be considered in any future planning. These arguments apply also to timber. The manufacture of consumer products such as furniture is also labour-intensive and the arising waste is available for fuel or conversion to pulp by local non-polluting processes.

Finally, with industrialisation and more advanced, less labour-intensive agriculture, the established centres of population will grow and new ones can be expected to emerge. Already, the influx of population from country to town is a problem for developing countries as it was for countries in Europe over the Industrial Revolution period. The paper-mill and the associated conversion activities are more labour intensive than pulp manufacture, wood-based and can provide employment where it is most needed. It can also centralise technical instruction and training.

6.2 Non-Wood Fibre Pulp

6.2.1 Bagasse

Where the sugar-cane industry is established, the manufacture of paper from the residual bagasse should be considered because it is almost always viable, given a home market for the product. It is competitive, at relatively low scale, if the bagasse does not have to be carried too far and has positive economic advantages if the paper mill can be located adjacent to the sugar mill, to avoid baling and double-handling. The problem of equivalent fuel arises and has retarded progress in bagasse based papers because the sugar-mill normally satisfies its process steam requirements by burning the bagasse in boilers designed for this purpose. In the author's view, this problem is overstated in most cases and could, with some self-financing initial assistance, be overcome. First, about one-third of the bagasse can be returned for fuel as pith, although this may require boiler modification

at the sugar-mill. Alternatively, the paper-mill can purchase pith-burning boilers for its own process needs but this introduces the problem of pith storage. There is also need for an efficient pith-burning boiler to be designed. Existing ones are adaptations of waste-burning boilers primarily designed for other materials and capable of improvement in reliability and efficiency of combustion. By pre-drying the pith using waste heat, the fuel value of pith, or bagasse can be doubled. Finally, for nearly all sugar-mills there is a surplus of bagasse in fuel terms which is disposed of by incineration through the boilers disregarding steam-generating efficiency.

As a paper-making fibre, with applied technology already available, bagasse is competitive in terms of cost and quality of product, is versatile in end-use and requires less long-fibre support than hardwood pulps generally. Direct application of technology to the bagasse field of operations is now being applied and can be expected to enhance still further its desirable properties.

A similar application of technical effort should now be applied to the fuel balance and utilisation aspects which are undoubtedly limiting the exploitation of what is probably the third world's most promising and rewarding source of fibre. With the simple soda process chemical recovery is practical at pulp production levels from 50 TPD upwards and paper-production viable at about the same level.

6.2.3. Straw Pulp

Straw, from wheat or rice, is an established raw material for paper production and has advantages in opacity but requires greater long-fibre support and is more difficult from the aspect of chemical-recovery because of its slow-draining characteristics and also on account of the high silica content. For these reasons its acceptability in developed countries is low, even where there is a scarcity of other indigenious materials. For the developing countries however its use is increasing and several specially designed mills

are successfully operating. It is suitable for small-scale operations and can be considered for larger-scale activities where market and other considerations are favourable. A continuous process can be employed but batch pulping is more common.

6.2.3 Other Materials

Bamboo, reeds, hemp, jute, flax, esparto, sisal, cotton kenaf and other vegetable fibres can all be used for paper-making purposes. Some of these, such as hemp, flax, cotton and jute have particular properties which are valuable for specialty papers and could have export value. Bamboo has for many years made a significant contribution to the paper requirements of India and considerable expertise has been developed in exploiting the use of this material which presents difficulties not present to the same degree in other fibrous raw material sources. Kenaf has a particular attraction as offering long-fibre prospects and the opportunity for eliminating the need to import softwood.

The distinction between these materials as serious prospects for a large and self-sustaining industry lies in the availability. Where, as in the case of bamboo and reeds, the material is used because it happens to be available and would not be deliberately planted - the use can only be regarded as temporary although the time scale may be long. The same applies to materials which are planted and harvested, such as hemp, jute, flax etc but for a higher added value industry and the material used for paper is the prime material, not a waste residue. Cotton linter is a waste product but has an intrinsic value for higher grade, special purpose pulp which, except where distance to a port is prohibitive, makes it too good for normal papers. There is a less valuable linter element arising from dust and sweepings etc from cotton-processing factories which has been shown by trial and experiment to have some value as furnish components to cheaper wrapping papers but the quantity

is not large. For continuing viability paper should be made from waste residues available in quantity from other businesses for which primarily the basic material is collected. This raises possibilities which have not, so far been exploited because the cost of the essential preliminary investigation work could not find local support to a sufficient extent. Rubber plant residues, banana stalks and leaves and coconut husks are examples where the vegetable residues are available in quantity regularly, have no alternative use capable of absorbing the quantity arising and actually present disposal problems in some areas. Work could be done on these materials to establish whether or not they are serious subjects for development. Some preliminary work has been done and the initial results are discouraging as indicating lower than normal yields and the need for the development of new techniques. Understandably, these early efforts do not inspire sufficient confidence in private investors to spend considerable sums on what could be speculation - the chances of being competitive are small for the pioneers in any field. In view of the need to find raw materials in developing countries which are available in quantity, as otherwise waste materials, the author believes that the work done to date is superficial and worthy of deeper consideration but funds for such work need to come from national, or international sources. It cannot be expected from the prime industry resources, already coping with their particular financing problems.

6.2.4. Pulping Machinery and Processes

For wood-based, bagasse-based, straw or reed-based pulps the essential plant and processes are already developed and available. Progress in development can also be expected to continue because commercial plants based on these materials are operating successfully in many areas of the world, using Western technology as available or adapted. Sufficient instances exist to learn the particular problems and how best to surmount them. Such plants

are, relatively speaking, large, covering a range from 60 to 250 TPD for the bagasse, reeds, straw etc materials and up to 1000 TPD for wood-based materials. The Western technology has little to offer which is modern or competitive in any practical sense for pulping plant of smaller scale although their paper industry was originally founded on mills of this order. Yet there is a need, and a strong one, for such equipment in the underdeveloped countries, to use locally available materials in the more remote, agricu turally based, village areas. It may be, over the whole spectrum of progress required, a temporary need but the author believes the time-scale would justify many such installations and that they could be the nucleus for the ultimate, more permanent mills. By absolute standards they may be uncompetitive, labour-intensive and produce to lower than internationally recognised standards of quality but they would satisfy a need which otherwise could fail by default, provide employment for many and play an important part in the progress of industrialisation. All the criticisms mentioned above could be levelled at the earlier Western technology if it was judged by modern Western standards but it sufficed in its time. The developing world, in many areas, has not yet reached a comparable time and needs the more primitive plant to begin with, if only to meet the human requirements for the future. If it has to wait until it can establish and operate a paper industry conforming in scale and technology with "modern" practice, the time scale will be extended to a totally unacceptable degree, as will be shewn later.

Fortunately, this has been recognised in some areas of the developing world and a number of such small mills are operating - and successfully operating - by their local standards although based on relatively primitive, labour-intensive but capitally inexpensive machinery and services. This is particularly true of India and it is to this country that we should now look for guidance and example. The subject is worth a study, to determine what can

be done and how to design and manufacture standard equipment for this need, improving where modern technology has a valid contribution to offer.

7) TIME-SCALE

In the early section of this paper the author suggested that a consumption level of 30 Kg/capita/annum is a minimum target to achieve the fundamental requirements for literacy, communications and a basis to serve the needs of industrialisation. It it interesting to note that this level was reached in the U.K. around the year 1900 so it cannot be said to be an over-ambitious target. The level for U.K. about that time was sufficient to build from as events have shown and it was largely used for the purposes outlined above. Wrappings and cosmetic uses for paper were involved to a relatively minor degree.

It is equally interesting to examine the official forecasts for growth. They are available from the publication "F.A.O. World Pulp and Paper Consumption Outlook" published in 1977. The following statistics are given:-

	World Consumption	Per capita/world population
1975	149,500,000 MT	37.6 Kg
1980	179,800,000 MT	41.1 Kg
1990	255,100,000 MT	48.4 Kg

This forecast predicts an increase in per capita consumption world-wide of approximately 29% in 15 years. The increase in absolute consumption overall is 71% or approximately 5% /annum compared with the increase per capita of 2% /annum and the discrepancy is obviously due to an adjustment for population increase. The average consumption figures quoted have to be viewed in the context of existing levels for developed countries of over 100 Kg/capita/annum and the corresponding levels for the major less developed Eastern countries nearer to 5 Kg/capita/annum. The overall forecast increase, if universally shared, would raise the level for the less developed countries

to around 10 Kg/capita/annum by 1990, far short of the target but the forecast does not predict equal sharing. It forecasts an allocation of the overall increase 2½ times as great for the already developed countries as that for all of the less developed countries.

For the Eastern less developed block the forecast assumes an increase from the level of 3,900,000 MT in 1975 to 20,000,000 MT by 1990, only 10% of the world increase although the population levels predicted far outweigh those for the developed world.

If this forecast has any substance at all nothing could more clearly demonstrate the exponential law that to those who have shall be given in proportion to what they have and the gap between the "haves" and "have-nots" as growing wider with time. If left to such "natural" laws there is no foreseeable period over which it can be forecast that the minimum target specified will be reached for developed areas of the world.

The forecast, if taken seriously, shows what can only be described as a hopeless, despairing situation and nothing could more clearly demonstrate the urgent need for a change in tactics. The prediction is almost certainly based on an extrapolation of modern Western technology and accepted economic forces. This does not meet the challenge and clearly indicates the need for a change in strategy.

Assistance in sufficient degree cannot be expected from the developed world along the lines of their own established technology. It has a part to play without doubt but there is, in the opinion of the author, a further part to be contributed by a "new" intermediate technology, emerging from within the countries involved. Resources of manpower and material exist and must be more fully utilised by those in immediate need. The methods may not conform with accepted modern standards but the contribution is urgently required.

In the author's view the minimum target should be reached by the end of this century, and every available means of reaching this objective should be utilised. It ought not to be an impossible target.

The F.A.O. forecasts are based on the established correlation of paper consumption and G.N.P. An acceleration of the former should be instrumental in promoting the latter.

8) SUMMARY

8.1 Current Situation

8.1.1. Disparity of Consumption Levels Worldwide

For developed countries consumption levels upwards of 100 Kg/capita/annum exist and are steadily increasing at around 5% per annum rate, with temporary periods of recession followed by boom years of progress.

The corresponding levels for third-world, developing countries range from 20 Kg/capita/annum to as low as 2 Kg/capita/annum with the greater proportion in the lower brackets 2 to 6 Kg/capita/annum. The rate of increase in these areas is negligible; population growth quickly absorbs such production increases as can be afforded from the limited resources available.

8.1.2. Desirable Level of Consumption

For full literacy, technical education and the needs of emerging industry the author suggests a minimum level of 30 Kg/capita/annum to be essential and the level of 40 Kg/capita/annum to be desirable. The minimum rate suggested is, in fact, equivalent to that which was attained in developing Western countries by the very early 1900's and cannot therefore be regarded as over-ambitious.

8.1.3. Time-Scale

At current levels of increase it cannot be foreseen that the under-developed countries, particularly in the African or Far-East areas, will attain a level of 10 Kg/capita/annum by the end of the current century. Of the overall, total world increase in production officially forecast over this period only 20% is predicted to be available for the under-developed areas. The forecast follows

traditional, exponential laws relating consumption to industrialisation and the utilisation of "modern" technology applied to "non-modern" emerging resources. A change in outlook is essential because without modification the gap between the developed and under-developed areas of the world in terms of living standards will widen still further. In the author's view tacit acceptance of this situation is morally and socially unjustifiable and a threat to world peace.

4.1.4. Fibre Resources

Modern technology looks principally to the forests and large installations based on such concentrated resources. Forest areas should be considered for developing areas and will undoubtedly have a significant part to play in the ultimate attainment of the desired objectives but they should not be considered in isolation or only to the "accepted" scale values. Other fibre resources are available and although they are generally less appropriate to the "modern scale" technology, they have advantages in many other directions such as size of market, initial capital cost, distribution, etc. The author challenges the unproven assumption that scale and overall economy are inseparably linked.

The wood-based fibre resources of under-developed countries are mainly tropical hardwoods more difficult to exploit than softwoods and from the pulping point of view less self-sufficient. Exploitation on the grand scale requires a considerable infrastructure and is highly capital-intensive. If the strategy is not reconsidered installations of this nature may for these reasons alone, have to take lower priority in the overall industrial programming, creating a vicious spiral because the paper and associated technical knowledge requirements are both significant elements in industrial progress.

The utilisation of alternative fibre resources to an appropriate scale is recommended. In general, waste materials arising from industry or agriculture and ultimately from the recycling of waste paper should be exploited wherever possible.

8.1.5. Paper-making Machinery - "Modern" Concept

Scale, in terms of size and speed, together with over-sophistication largely arising from the need to maintain quality standards more difficult to realise because of scale, have increased capital costs per unit of production at a rate higher than the ultimate consumer is prepared to accept for the product selling prices. In consequence, new installations to the "modern" scale are now beyond the resources of all but governments or multi-national companies and even in these circumstances are seldom viable over the early years of operation. In the author's view, this type of technical advance has outrun economic justification except where particularly favourable circumstances apply. Private industry, even in developped countries of the world, can no longer afford to renew their machines and the industry world-wide is heavily dependent on machines built to earlier technological standards, largely written down, but competitive because the cost of money, at current interest rates, is often greater per unit of production than the margin between product cost and selling price can sustain. The Western world should not pass on to developing countries "modern" technology which does not satisfy its own basic needs and cannot hope to provide the requirements for a greater and needier population within an acceptable time-scale.

8.1.6. Paper-making Machinery - Alternative Concepts

The capital cost advantages of scale have been questioned by several authorities who concur by mathematical analysis that for material and machining considerations alone, the economic scale lies between 4.5 and 6 metres width, considerably less than that of the "economic" giants which are emerging. These investigations have not considered in depth other factors such as standard construction, market penetration and growth, simplicity of operation and maintenance and the limitations of human skills. These factors apply to most countries but have particular emphasis for developing countries where the need is greatest. The author believes there is a case for designing and building in numbers a standard machine of 2.5 metres width which would suit the largest reel or sheet size

used anywhere) limited to 300 metres/minute in speed, which would be economic in terms of energy requirements and eliminate the necessity for sophistication. It can utilise the truly valuable modern advances in technology available and be competitive in terms of quality and operating costs. Modular, ship-yard type construction of the whole mill can be considered with advantages in erection and commissioning costs. A study based on such a concept has already been commissioned and preliminary findings indicate a reduction in capital costs in the order of 30% per unit of production. Paper-machines are much more versatile in product than is generally recognised and machines of the type suggested could be built in developing countries without the need for highly expensive machine tools. They would be more appropriate to a developing market, to the utilisation of local materials at relatively low scale and to the human resources, for operations and maintenance, likely to be available. Training needs would be minimised and available from identical installations, seldom the case in "modern" installations. The need for on-going, expensive highly-skilled expatriate support would be greatly reduced, if not eliminated. Such machines would have efficient, competitive capacity of 5,000 to 20,000 TPA according to product, over a very wide range.

There is also a case for even smaller units of production down to 5/10 TPD capacity and, again, repetitive production of a suitable unit would greatly reduce cost and improve reliability. Labour-intensity is more of a benefit than a handicap for such machines intended for village utilisation and the development of industry in remote areas.

Economies cannot be judged by the arbitary standards of scale alone. As it stands, the modern pulp and paper industry developed and quickly grew from units much smaller and slower but suited to the pace of the times. Developing countries need the same intermediate or smaller technology at minimum to complement the more grandiose plants as they can be afforded.

8.1.7. Pulp-Producing Machinery

For wood-based pulp the advantages of scale on intrinsic capital costs are more difficult to challenge but overall site economics can modify those offered by capital costs alone. Even the modern large-scale installations are, on today's prices, economic only when supplied by otherwise waste wood arising from complementary saw-milling operations and the presence of the latter, in circumstances appropriate to local industry in developing countries can often, in conjunction with other factors provide an economic basis for installations of less than recognised scale. Modern advances in batch digester and washing techniques have made smaller scale installations more practical to consider. For non-wood, vegetable fibres such as bagasse and straw, smaller scale installations, appropriate to the local resources over a reasonable distance have already proved themselves to be competitive in terms of quality and viability and development can be expected to improved this situation. There is a case, as for the paper-machine, to be made for very small pulp mills to suit village or similar locations. The basic technology involved reverts to the 19th, rather than the 20th century and little in the form of technical assistance can be expected from the Western, developed technology. In terms of installations and machinery more can be learned from the developing countries, in particular India, where a number of small-scale mills, viable by their standards are believed to be operating successfully. There would be merit in examining in detail such installations to provide basic plant design data for similar applications elsewhere in under-developed areas and it is believed that this represents a much greater than currently recognised demand.

8.1.8. Labour Intensity

Where, as in the Western, developed world, labour is expensive, not by merit but to conform with standards of living achieved by industry, there is a case for labour-saving design and capital cost increases to justify it. For developing countries, where labour is inexpensive and plentiful, the opposite

is more likely to apply and to the strictly operational considerations should be added the less quantifiable benefits that by such installations the creation of an industrial climate can be established at a rate which can be more readily absorbed.

8.1. . Energy

It should be recognised that virtually all raw materials used for the manufacture of pulp and paper are potential fuels and that competition in this respect can be expected to increase as fossil-fuels become more scarce and expensive. This fact influences the strategy of deployment but it should also inspire research and investigation into the optimum energy utilisation of waste-based fuel/fibre materials, such as wood or bagasse. Improved techniques will be required and a capacity/energy relationship may, in the foreseeable future, influence scale economics to a considerable degree, most probably favouring the smaller installation.

8.2 Policy Considerations

8.2.1. Product Cost

Paper and associated products must be cheap to be available in sufficient quantity to the poorest. Capital costs with the high interest rates prevailing and unnecessarily high quality standards represent the most obvious lines of approach for developing countries to challenge expensive product cost. Where high tariff protection is considered necessary to support a new installation its permanent viability should be re-examined because the end-product will not be cheap to the consumer. Alleviation of difficult balance of trade conditions may justify temporary protection but full competivity should be the aim. Freight and inland transport costs should present sufficient protection against fair competition; dumping is a subject for international regulation.

8.2.2. Product Priorities

The higher added value products should be first in priority because they can justify lower scale in diverse situations where local materials may be limited and because they include writing, printing and industrial papers which are a

priority need. Utilisation of some local materials, such as hemp (for cigarette paper) and cotton linter (for high-alpha pulp) can, indeed, offer export possibilities.

8. . . Locations

For wood-based mills consideration should be given to confining the activities to pulp and bul timber for ultimate conversion to paper or timber products at the centres of population where the advantages in employment, proximity to the customer and concentrated educational resources exist and are likely to expand. Future recycling of waste paper is also accelerated by this strategy.

For major non-wood-based materials full integration is more desirable and, by nature of the scale imposed and the association of other industry e.g. sugar or agricultural products, distribution and the creation of population centres is a real potential, leading to other supporting industries.

There are grounds for considering also the very small village installation for local distribution and the upgrading of technical skills towards the levels ultimately required by fuller industrialisation.

8.2.7. Low-Cost Standard Plant

The case for the development of low cost, standard but versatile paper-machines, competitive in product cost and quality is very strong but it cannot be expected to arise from established machinery manufacturers or leading consultants because the concept is contrary to their vested interests. Although some start on this aspect has been made, full implementation will require support from developing country policy-makers and independent advisors. The greatest and most urgent need for such machinery to be available is in the under-developed areas not simply because of the cost but also on account of the greater suitability for emerging markets and the lower requirements for highly technical operating and maintenance personnel. The possibilities of production for such machinery in the country concerned are an added attraction. A unified effort and support to the concept which is fundamentally based on production in quantity should come from the developing world where the problems and need

are most acute. It cannot be expected to surface within the desired time-scale unaided.

These comments apply also to the very small, village installations where developing countries are now most experienced in the plant and operational techniques involved. There would be benefit in pooling such knowledge to develop and preserve the best.

8.2.5. Time-Scale

Without a change in strategy and a planned approach to the problems utilising all effective resources (temporarily where necessary but directed always to permanent installations) no acceptable time-scale can be forecast. The gravity of the situation and the relatively unexploited resources and tactics outlined in this paper are believed to offer a substantial potential for improvement at a controlled rate within the means available. Acceptance of Western technology as it can be afforded is not enough as their own industry proves. If this paper provokes sufficient interest for the policy-makers to re-examine the prospects and support that which has merit, it will have achieved its prime purpose. The author's views are based on a life-time's experience in building paper and pulp mills, the latter part devoted principally to installations in developing countries. The need for adjusting prevailing policies has arisen from this experience and a growing sense of the urgency to do something positive.

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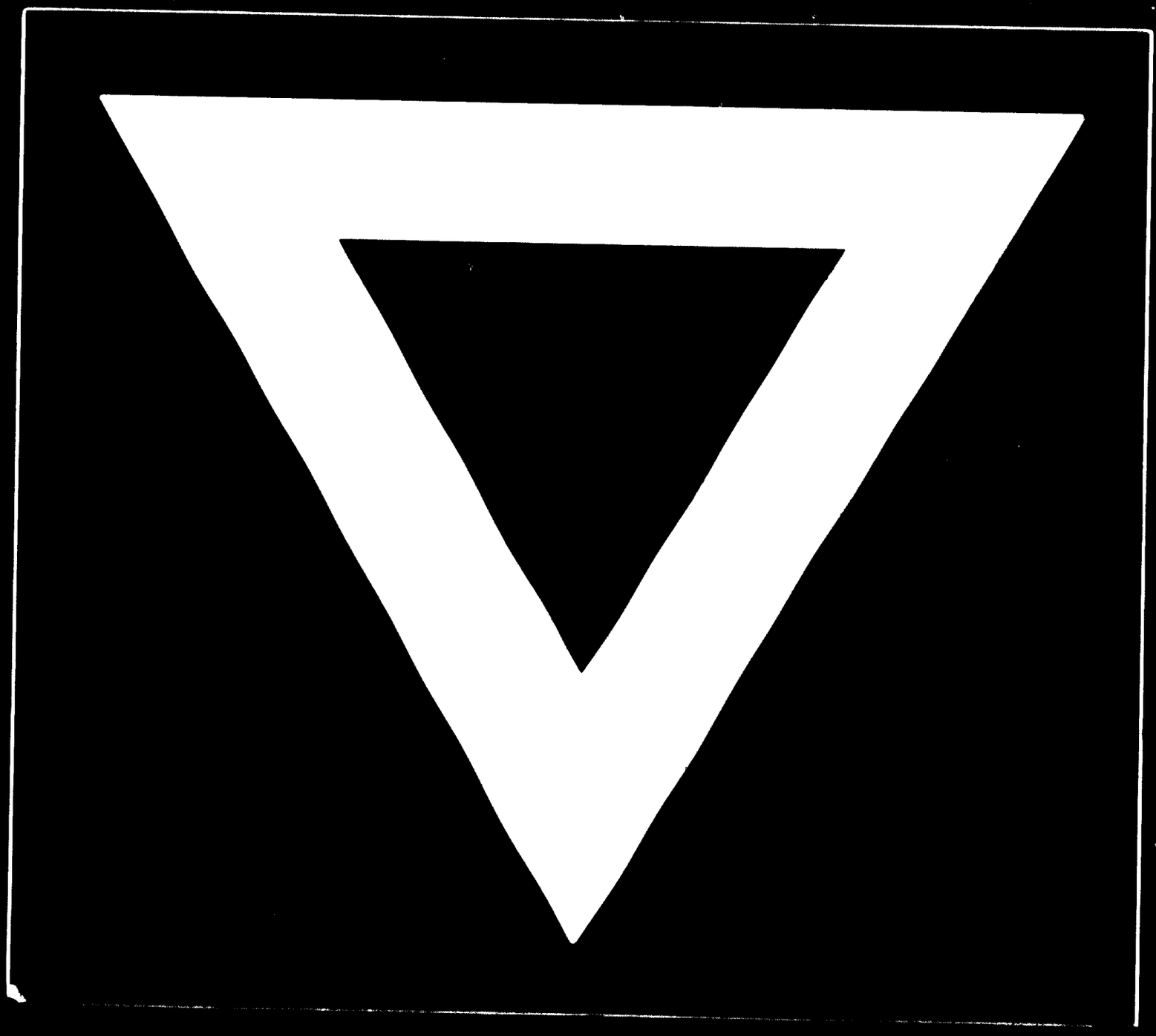

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