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PRODUCT DESIGN AND PLANT DESIGN [1/]

by

the secretariat of UNIDO

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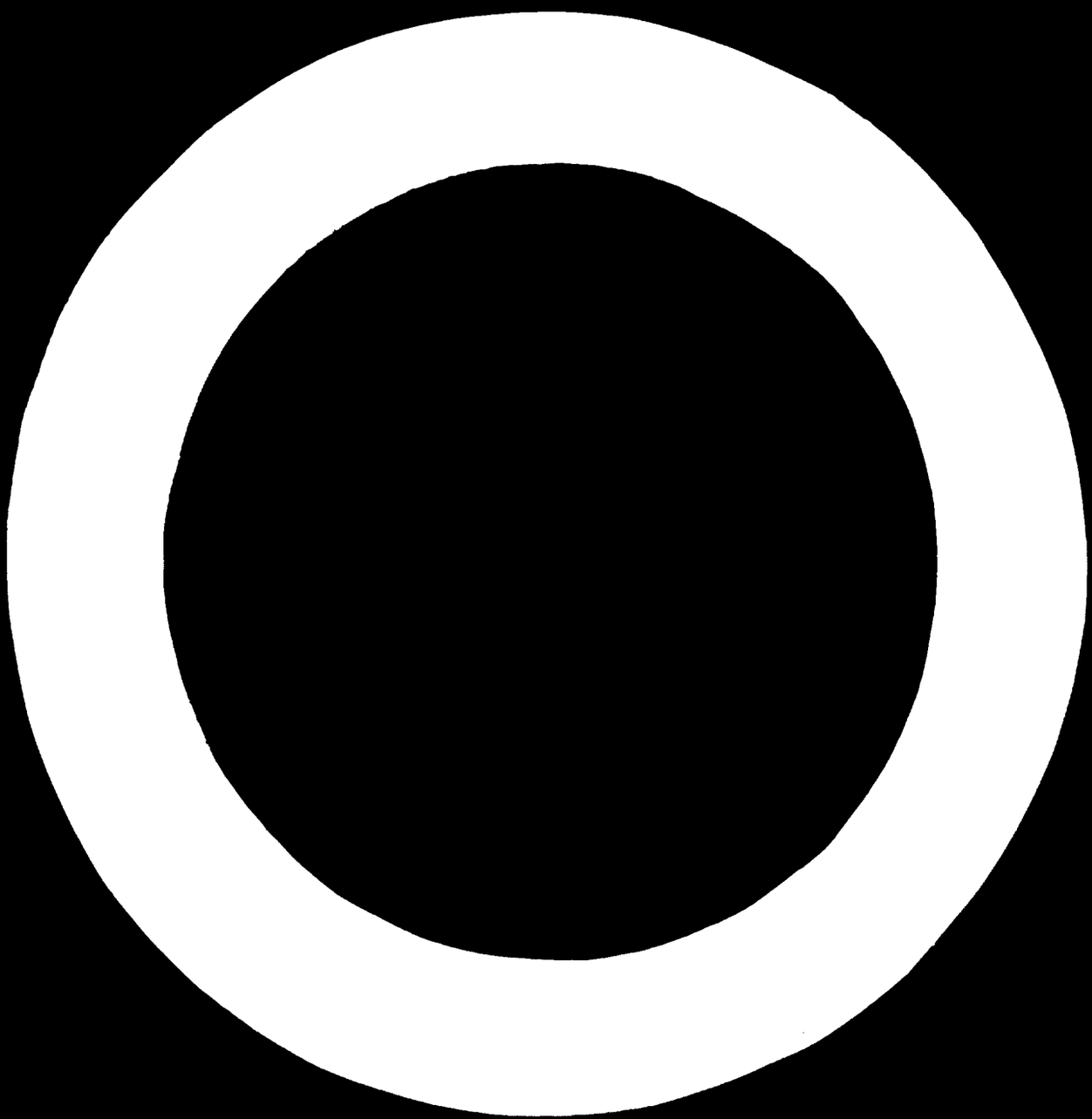

A. Product Design

1. Introduction

The function of product design activities is to provide or adapt products to meet the particular requirements a market associated with a specific area or peoples. The successful application of these activities has an important overall influence on industrial development. Perhaps the most important aspect is the direct question of suitability of products. Take an extreme case the power tiller for paddy rice cultivation in tropical areas. This is almost an impossible job for conventional tractor plows commonly used for dry rice cultivation. Improvement in reliability is another aspect. The redesign of suspension systems of road vehicles for rougher roads is a simple example of improvements that are necessary. While products should be designed for local climatic conditions it is often surprising how this obvious requirements is not fully met. Considerable work has already been done on tropicalisation of equipment and the stage has been reached when most equipment is designed for tropical use as a routine matter. However, adequacy of cooling and ventilation of equipment and vehicles still needs attention.

The less tangible but nevertheless important needs of the market in styling, in higher comfort factors and in acceptable standards of quality play ansignificant part in product design.

One application of product (and plant) design which is often overlooked, is the proper presentation of instruction manuals, and identification makking of parts. This envolves language andeoven one step further in degrees of literacy. In addition, further work in necessary in the design of both equipment and maintenance manuals which are oriented towards simplification of fault diagnosis. These aspects come under the heading of maintainability.

Quite apart from the design or adpation of designs for local markets there is conversely the need of adapt a local design for the export market. An example of this is the export of electrical equipment which has in a particular case, to be redesigned to meet safety and other wiring standards in more than one country.

2. Criteria for product design

We would like now to look at the problems from the manufacturers viewpoint - what are the special criteria in developing countries affecting the design of products.

Perhaps the first and most important factor is the relatively low quantities involved in series production. This frequently leads to rather more fabrication of parts. For example the use of wood for radio and television cabinets as different from plastic cabinets where the initial cost of injection moulding equipment is extremely high. The manufacturer will naturally look to other markets particularly the export market. This brings problems of meeting [illegible] serious

It is not proposed to expand on the design problems associated with climatic conditions since these are not peculiar to manufacturing in developing countries. The point is nevertheless important.

The need to exploit local raw materials and components is frequently a factor to be considered in product design, and one often imposed through import controls. Adaption of designs for these reasons should be a continuous process aimed at supporting allied industries.

One important impediment to local design of products is the inadequacy of local standards. This is important where equipment is to be integrated into a system and those for export. Internationally accepted standards such as those of the International Electrotechnical Commission go a long way in fixing acceptable standards but only in a limited field. While such standards exist it is sometimes not possible to check and formally approve/due to the lack of testing facilities.
product

Product design leading to improved reliability and ease of maintenance is receiving attention, and is becoming increasingly important in most developed countries. Improvement in component reliability is being achieved through studies of failures. The need to improve reliability in developed countries arises from the high cost of labour needed to undertake repairs. The need in developing countries is equally important but arises from a different reason; in this case it is the lack of skilled labour to carry out repair. The degree of reliability required can therefore assumed to be the same. In practice both of these reasons have led to designs having sub-assemblies and simple means of fault identification.

3. Potential for improved product design

The need is to improve product design so that the customer might get a product more suited to his local needs; longer life; better operation under local climatic conditions; improvements in styling, comfort and quality; easier maintenance and one having an export potential. Quite clearly this is a continuous need and the strategies proposed later are aimed at more at promoting and creating design capabilities rather than providing discrete solutions.

For the same reason it is difficult to establish a general level of demand for improved or new products to be designed locally. Perhaps the best approach is for Governments to set realistic targets for levels of local content in goods and for exports. This would, among other things, have the effect of setting levels of achievement necessary in the design field and in turn giving the needs in terms of design services.

4. Strategies to meet the potential need

At policy level perhaps the most effective way to promote local production is through the control of imports. If impartially and effectively applied, this has the effect of obliging or encouraging producers to use locally made parts, which often require adaptation of design of the part or the equipment. This has the indirect advantage of building up local design capabilities. A similar situation exists as far as awards and concessions for exports where the exporter is obliged to meet international standards and higher levels of quality.

At institutional level the action is more direct and can be achieved through one or more avenues as follows: the dissemination of technical knowledge through meetings and publications is an important source of know-how and general information. Professional institutions should be encouraged to assist in the establishment of acceptable standards covering performance, safety and testing. Common facilities for materials testing is also a useful field which is, and can be undertaken in various institutions.

At enterprise level the creation and effective use of independent commercial consulting services is perhaps the most potentially fruitful field for improving product design. Development can also be accelerated through manufacturing under license and this approach should not be discouraged at policy or enterprise levels. Equally important in all industry is the establishment of local design capabilities either through central design centers or within the enterprise itself. It should be noted that these approaches are not mutually exclusive and in practice various combinations of all three are used.

The new field of technological forecasting will be an important tool in establishing long range plans in the near future.

5. Examples of strategies

UNIDO is active in promoting all the strategies mentioned above - export promotion, dissemination of technical know-how, establishment of standards and quality control, provision of consulting services, assistance in licensing and in the establishment of design centers.

It is not proposed to elaborate on each of these aspects but it is perhaps useful to examine the work of a typical design centre since this is most directly applicable to subject presently under consideration, namely product design.

It is proposed to take as an example the Research Institute for Instrument Design in Bulgaria. The main objectives of the Institute for Instrument Design are scientific research, design and development in the field of instrumentation for the automation of industrial processes. Between now and 1975 the Bulgarian Government proposes to establish a further ten factories, directly or indirectly involved in the field of industrial instrumentation, so that by 1975 twenty such factories will rely on the Institute for Instruments Design, for technical assistance and guidance.

By performing those various functions it is expecteddthat the Institute will substantially reduce the country's importation of both ready-made components and raw materials, and will, moreover, stimulate industrial growth in fields related to instrument manufacture.

The Institute will be organized in four divisions, namely, Research and Development, Engineering, Quality and Reliability, and Administration. The Research and Development Division will comprise of five departments (Electro-Mechanical, Hydraulic-Pneumatic, Physical-Chemical, Industrial Electronics and Design Office).
The services required of the Institute will include:

a) the development of new and the improvement of existing designs for industrial automation instruments and control devices;
b) the translation of such designs into manufacturing terms by the preparation of complete technical documentation;
c) assistance to manufacturers in commencing production of new items, in improving production capacity and in quality control;
d) the provision of testing and laboratory facilities for manufacturers;
e) the development of training programmes in instrument design and manufacture;
f) continuous research and studies designed to assess the country's future needs for industrial automation instrumentation and control devices.

2. [redacted] Design

1. Introduction

In the following chapter the problems concerning plant design are considered. For the purpose of this article plant design includes design of the factory and production technology.

Developing countries have different requirements for plant design of which the scale of production is the most important. To be competitive, it is necessary to look seriously at existing practices and adopt these where practicable to the actual conditions. In the paragraphs which follow these special considerations on plant design are highlighted.

2. Criteria for more appropriate plant design

As mentioned above the most important consideration is reaching a minimum level of output for economical production. This is coupled closely with the need to provide employment possibilities, a factor which is quite the opposite in developed countries. It is extremely difficult to achieve economical production at low output levels even making use of low cost labour and an expansion and diversification of the market offers the only real solution. The use of a low level of automation provides employment opportunities but does not necessarily lead to lower costs. It does however generally lead to simpler technology and lower equipment maintenance problems and therefore is more suited to situations where labour is relatively unskilled.

An example of this is found in preparing a plant design for dry batteries where the filling of the batteries can be done initially by hand with possible addition of fully automated filling at some future date. There is a saving in initial capital required to set up the factory but the problems of quality control are aggravated. In general equipment grouping by process rather than product provides a flexibility and increasing efficiency but this is a rather special case and not universally applicable.

3. Other Special Factors in Plant Design

Considerations of plant location, layout and construction are of major importance to all industries. These are classic interdependent problems however as before it is not proposed to examine them as such but to highlight the special considerations which may arise in developing countries.

Plant location is by far the most important management decision to be made since a later move is costly. The normal considerations such as nearness to sources of material, market, labour services and housing hold for developing countries however, the conditions affecting them are often rather more fluid than in the developed countries. For example a town plan may not have been evolved and later reorganising of industrial areas may require the isolation or moving of a plant. Nearness to the market is also an important consideration generally because it is more costly to transport finished articles than equal weights of raw materials. However large concentrations of population are not particularly common in developing countries which are characteristically rural and the decision on selection of location is not as clear cut and in fact frequently influenced by political rather than economic considerations.

The availability and stability of manpower is also an important factor in considering plant location.

Clearly climate is a factor peculiar to each location. It may lead to simplification of design through open type construction in the warmer climates or conversely may require expensive air treatment. Different peoples have differing needs when measured in terms of comfort factors. For example people accustomed to humid tropical conditions do not react well to relatively low temperatures but prefer dehumidification rather than lower temperatures. The temperature climates found in higher altitudes in the tropics do not have these extremes problems but on the other hand capacities of cooling fans have to be increased to allow for the lower density of the air.

The rapid growth of demand for electrical power brings with it the problems of the expansion of the distibution network and of voltage regulation. This may result in the stop gap need for the installation of local generating plant in the first case and voltage regulation in the second, both of which add to the capital and operating costs and maintenance problems.

The use of local materials and building techniques can lead to lower labour costs than those associated with more advanced materials and techniques. This however holds only where tolerances in the building are not critical and frequently a combination of both is used to keep the costs down. Care is needed in the design of the buildings to keep them reasonably within the capabilities of local building contractors many of whose staff would not be able to read a detailed architectural drawing. An elementary example of this problem is that is is frequently easier to have a duct cut in a wall after it is erected than provide it initially in the formwork. Additional supervision is required for items such as special concrete formulations whose strength depends critically upon the mix of the concrete - an operation normally carried out by unskilled labour.

Local packaging methods should be mentioned in passing as it affects the actual plant design. This is perhaps a passing phase, with growing international standardization of packaging.

4. Potential for Improved Plant Design

There is a permanent need for knowhow on plant design and production technology for any factory to maintain its position in face of competition. In the previous paragraphs a series of conflicting requirements were set out. When these are considered together with long-term necessity to introduce more and more automation both for reasons of quality and because of increasing output, it is preferable to prepare both short-term as well as long term-plans. The short-term plan can meet the initial requirements of small market, low capital investments and provision of employment opportunities. However, it should be so designed to permit in the long-term a higher level of technology.

Having set the targets for products mentioned in paragraph A.3. and the projection of future demand for goods in various industries one could arrive at short- and long-term target capacity figures for these industries. This would indicate in general terms the need for manufacturing plant and in turn the order for the requirements for plant design.

5. Strategies to Meet the Potential Need

It is now of interest to see what strategies might be applied on a policy level, institutional level and enterprise level.

Firstly at policy level the expansion and development of the infrastructure of the country communication and public utilities is probably the first and most important consideration. Apart from emphasising its importance it is not proposed to elaborate on these general problems in this article. In addition and as a general policy the governments should assist institutions and enterprises to carry out the following activities.

At institutional level promotion of training at all levels is the first in order of importance. Since plant design is rather specialized and is normally carried out by the plant manufacturers or commercial consulting and architectural services, the opportunities for gaining extensive experience in this field is limited to the more developed of the developing countries. It would appear reasonable to include in feasibility studies and subsequent plant design some provision for local training of personnel by way of case studies. This work could also form a part of a general exchange of information which should be achieved through professionnal institutions. Also at this level promotion of use of local materials and techniques particularly in the building trade is desirable. This might take the form of design services, for example timber roof trusses, disseminating information on drying of timber, and training in the building trades. On the design side the promotion of local standards for buildings covering such things as safety standards, standards for air treatment and staff amenities should be encouraged.

The engineering as such is anxious quite naturally to get the best possible advice on its plant design and will in general seek the assistance of the plant manufacturer.

6. Example of Directories

Basically the problem of plant design is a conceptional one and UNIDO's role starts with the assembly and dissemination of information on design problems. A practical example of this has been the preparation of a study on Analysis of Factory Planning for Hand Operated and Animal drawn Agricultural Machinery Plant (31 December 1969). This report examines the conditions for setting up a factory, an analysis of the plant, proposed layout, financial analysis and specification of products to be manufactured.

In metallurgical industries the design of the process and plant is the more important as re-design of the product composition is rarely undertaken.

It is estimated that, in the course of the next decade, developing countries will invest in the development of their metallurgical industry about $20 billion (including infrastructure investment), a sizeable portion of which will be utilised for the acquisition of direct and indirect know-how. Many developing countries feel that they cannot afford to remain dependent on commercial imports of required know-how. UNIDO plans to assist in the development of local know-how so that a

substantial amount of the required investment can be supplied from domestic sources of know-how and equipment. In other instances, the need for nationally based know-how arises from special conditions when the national economy is esp cially dependent on exports of certain metallurgical products. With this in mind UNIDO is planning a workshop on creation and transfer of know-how in metallurgy.

The workshop, planned for a duration of five days in Vienna in 1971, is expected to provide an assessment of the needs for know-how in developing countries and to make recommendations on how to meet these needs. An evaluation will be made of the advisability of setting up or assisting local establishments to prepare feasibility studies and projects, to carry out research and to develop new metallurgical processes and products. Consideration will be given to factors governing the development of national sources of know-how such as training of specialists, incentives and appropriate mechanisms for acquiring know-how.

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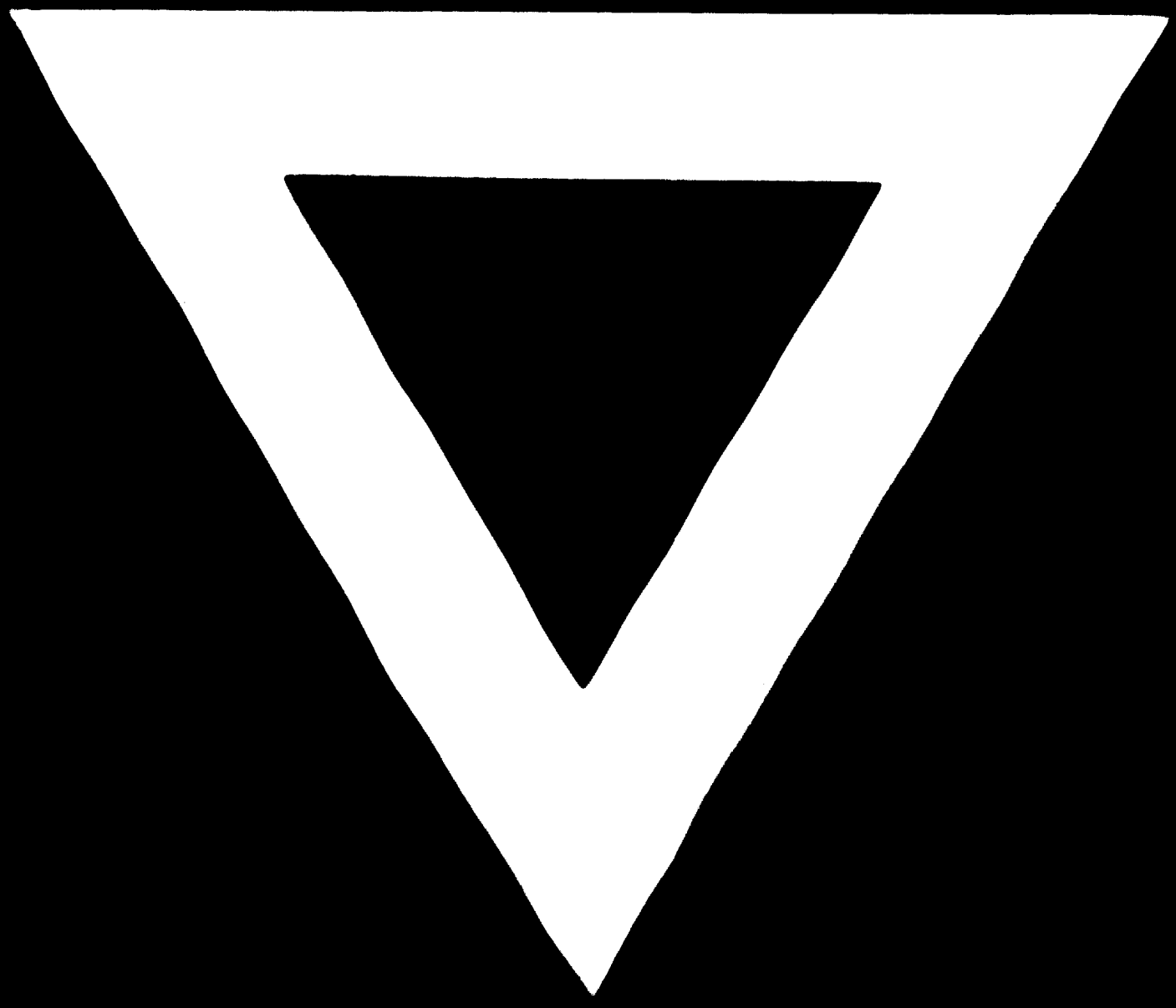

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