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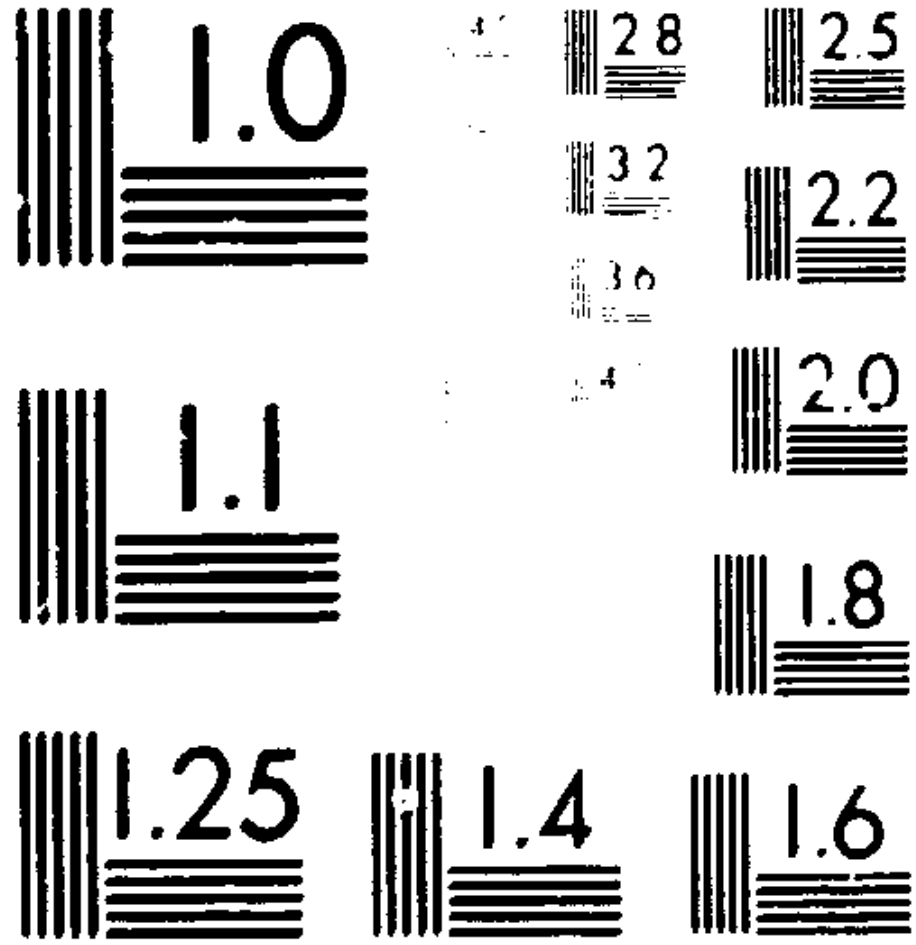

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GUIDELINES FOR SETTING UP ELECTRONIC ASSEMBLY PLANTS IN DEVELOPING COUNTRIES */

Prepared by

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in co-operation with
the Technology Group of UNIDO

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Preface

During 1980 the Industry Council for Development (ICD) brought to the attention of the United Nations Development Programme (UNDP) and subsequently to UNIDO the work carried out by one of its member companies, N.V. Philips' Gloeilampenfabrieken, on the adaptation of electronic assembly techniques and equipment as an alternative to units with highly automated processes and organizational structures. These plants produce electronic products which match, both in terms of sophistication of design as well as quality and reliability, those obtained from large-scale plants using highly automated technology.

In view of the potential interest of such an approach for the developing countries it was agreed to hold a joint UNIDO/UNDP/ICD Workshop with participants from developing countries including entrepreneurs and managers together with engineers, government and banking officials with experience in the establishment and operation of the electronics industry in their countries.

The discussion at the Workshop held in Utrecht, the Netherlands, in May 1981 determined that technological choice could not be separated from the over-all process of investment decision-making in this sector. The participants highlighted certain features of technological choice which overshadowed many of the major issues normally considered for new investments. It was recommended at the final session of the Workshop that in addition to the report on the Workshop [1/] a set of guidelines should be prepared on the issues identified at the Workshop which affect the choice of technology for electronic assembly plants established in the developing countries.

Chapter I of the guidelines briefly reviews the general conclusions which were arrived at by the participants relating to choice of technology as well as the roles of the entrepreneur, the supplier and government and their dynamic interrelation in this decision-making process.

Chapter II constitutes the formal guidelines; these highlight the importance of product technology selection and the relationship of this to the electronic assembly process. In addition the link between acquisition of technology and development of local capability in technological, management and other essential disciplines in considered.

1/ UNIDO document, ID/WG.339/16. Report of the Workshop on Selection of Technology for Assembly of Electronic and Electrical Products in Developing Countries.

Chapter III describes the roles of the supplier and the government in the broader context of developing a viable electronic industry. In addition, the interrelationship among the parties involved and the questions to be considered in making decisions are also examined.

Chapter IV brings out the future opportunities in electronic-related fields, with special emphasis on the information processing industry.

The guidelines have been prepared by Mr. B. Nasiruddin, Bangladesh, (a participant at the Workshop) under the direction of the Workshop's Executive Committee which included representatives of UNIDO, UNDP and ICD. The late Professor Frank Bradbury of the University of Stirling, Scotland, who was the Chairman of the Workshop, also made important contributions to both the preparation and organization of the Workshop as well as the content of these guidelines.

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INTRODUCTION

The Guidelines that have been developed are essentially qualitative and are not intended to take the place of detailed planning required when initiating industrial ventures. However, they will offer the necessary background information and guidance for entrepreneurs and others involved in the negotiations and detailed planning for electronic assembly plants in the developing countries and similar high technology industries.

I. THE WORKSHOP

The analysis and discussion at the Workshop centred on a black and white TV receiver with a 40 cm screen. This was selected by the hosts as a typical product well-suited to the purpose of the exercise. This receiver was based essentially on use of discrete and solid state components, having a relatively simple circuitry. It was realized fairly early on, that this was not the most advanced and complex circuitry currently available in this field and that the production techniques that would apply to this particular item may not be fully relevant if a TV receiver involving current technology was to be selected. Keeping this constraint in view, and also that a number of broad issues were independent of actual product selection, the assembly project for this item was analysed for the following three types of market:

1. A country with a large internal market, of say 200,000 to 300,000 television receivers per year;

2. A country with a small internal market, of say 25,000 to 50,000 television sets per year;

3. A country with a small internal market, but with large export potential; the export base would probably be roughly around 100,000 sets per year to start with.

The Workshop was divided into three groups, each group being assigned to one of the above markets. The findings of each of these groups are reviewed in the UNIDO report and form the basis of these guidelines. 1/

The working group with a large internal market and perhaps some export potential (market 1 listed above) opted for simplified technology using discrete components in the product for the first few years. This would make substitution of locally made components easier - this being usually the government policy for countries with such markets - but it was noted that there was a risk in becoming dependent upon components that might become obsolete in the near future. Product competitiveness, in the context of similar imported goods, was not considered too important as there would be market protection until such time as the industry became fully viable. Exports, when developed, would need to be subsidized by the internal market.

Emphasis was put on selection of production technology most suited to local environments, but keeping it flexible enough to accommodate new product technologies. The report of this working group is available as a UNIDO document. 2/

The group responsible for a small internal market (market 2) felt that, based on certain limited criteria (e.g. consumer interest, foreign exchange saving, etc.), such an undertaking (assembly of television receivers) could not claim priority on the limited resources available in countries where such markets are typical. However, in the context of long-term technological benefits - exposure to modern electronic developments - television assembly could be a good starting point. This group would in any case go for "current" technology, using integrated circuits. This choice, apart from other pragmatic considerations, was made easier as component substitution from local sources was not likely to be significant. This group concluded that from a purely financial point of view such an undertaking could be quite viable, and could indeed form a base for high technology industries for the future. This report is also available from UNIDO. 3/

The entrepreneur operating in a market geared essentially to export to neighbouring areas (market 3) has much more freedom of manoeuvre than his counterparts in the other two markets. His basic concern would be competitiveness - both as to quality and price in the international market he intends to service. This group also intended to start off using simplified technology and then move on quickly to a more sophisticated technology. They felt that this approach would provide an acceptable learning curve and make it easier to compete in the markets in prospect. The government role (unlike the markets 1 and 2) was limited to providing land, building and investment capital at subsidized rates, and probably tax holiday during the first few years of operations. The full text of this report is also available as a UNIDO document. 4/

The choice of technology, the acquisition of technology and the commercial and financial aspects were judged common to all markets and are considered in detail in the next chapter.

2/ ID/WG.339/13. Findings of Working Group I.

3/ ID/WG.339/14. Findings of Working Group II.

4/ ID/WG.339/15. Findings of Working Group III.

II. GUIDELINES

This section examines the issues referred to above in more detail from the entrepreneurs viewpoint; it is hoped that the guidelines developed from them will be generally applicable to all the three types of markets referred to in the previous chapter, with particular relevance to market types 1 and 2.

In these guidelines, special attention is drawn to some unique aspects of an industry involving modern electronic technology, and where it differs from other classical engineering industries. Lack of awareness of these aspects can have limiting or even terminal effect on an electronic enterprise.

Choice of Technology

In classical engineering, the technology changes tend to be incremental, and it is relatively simple - at least conceptually - to move from a lower stage of product sophistication to one higher. Any major innovation takes about two decades to develop fully, and can therefore be slowly integrated into a product line.

In modern electronic technology, however, radical changes can take place in a time span of five years, or even less. The criteria for the selection of technology are in some important aspects quite different from what would apply to other types of engineering.

Technology choice involves both product technology (the extent to which the product incorporates the technical developments available), and production technology (the way the product is assembled from its components). These will be examined below.

Product Technology

Selection of appropriate product technology is obviously important in any industry. In the high technology electronic field, because of its extremely fast changing pace, it is imperative that as far as practicable one operates within the state of the art at any given time. The production technology, which is discussed in more detail later, must be flexible enough to accommodate such changes.

Since developing countries are likely to be involved in assembly rather than manufacture of basic electronic hardware, they have an inbuilt advantage in going for the most current product technology that is available. The view that such countries should select an intermediate, or even an early technological process because it might be an easier way to move up the ladder may be valid in some industrial sectors but it is almost always wrong in this context. If a country were to find itself - for whatever reasons - not quite ready to work within the scope of technology relevant to the goods, it would be in its interest to avoid production of such goods altogether.

In the specific case of television receiver assembly, for example, product technologies could involve:

Hybrid circuits (almost obsolete);

Solid state, but mostly discrete components;

Solid state, but mostly medium/large scale integrated circuits.

Where the overall objective is to set up a line ab initio for television receiver production, there would be little point in choosing anything but the third option. As mentioned earlier, this decision is easier for a developing country because there is possibly little or no vested interest in older technologies. One must be careful in not putting unwarranted emphasis on the use of local material and components if this leads to outmoded technology and no accompanying price advantage. Such an approach would be against the interest of consumers, the country, and eventually the entrepreneur.

Since a developing country - and even relatively developed ones - must of necessity associate themselves with the suppliers who can provide the technology, in the form of goods (components, say) and/or service (know-how and management) the receiving country will have to be careful to avoid becoming locked into obsolete product technology. Quite often it might be in a particular supplier's interest to offer older products and methods, and the recipient might find it economically attractive in the short-run to join in with this approach. Sooner or later, the price for starting from behind has to be paid: apart from the fact that product performance may not be up to current standards, there might

also be problems associated with purchasing of components for assembly and maintenance of products which relate to an older system. The cost of moving on to new technology at a subsequent date could also be quite substantial.

Assembly Technology

Market acceptability of a product largely depends upon its quality and price which are basically related to the product technology. However it should be noted that the assembly technology also has an important influence on the viability of the project. This can be considered in two areas, firstly, the methods of production; and secondly the management of production.

The choice of production methodology depends upon several factors:

Product technology;
Availability of finance and its cost;
Quality and cost of local manpower;
Production runs or series;
Availability of spare parts;
Existence of subcontractors and their availability.

That production technology should to a certain extent depend upon product technology involved is obvious. What is not always realised is that there is a wide range of options available. Here again, the interest of the supplier may not always be the same as that of the entrepreneur. In products where development cycles are relatively short - as in all electronic industries - it is very important to ensure that production line hardware can be tailored to such development changes with minimum cost in money and time.

This leads to the key question: what sort of production hardware should one select? It must naturally be geared to the output envisaged and subject to achieving the required quality level, should lead to lowest unit costs. This is very important where the market is cost sensitive; reduced market off-takes can lead to spiralling production costs.

In addition to these considerations, certain other points are relevant:

Dedicated hardware i.e. those specifically designed for a single purpose should be avoided as far as possible. All the equipment used in production must be adaptable to conform to possible product variations;

Equipment used should not be unnecessarily sophisticated. Machinery that requires complicated programming or setting up and difficult maintenance ends up spending most of its time off the operating schedule;

All equipment chosen must be environment tolerant, including possible abuse by operators.

The production methods must also make the optimal match between jobs that are best done by machines and jobs that are done best by people.

One trap to avoid is that of assuming that merely because labour is cheap it is also cost effective. Jobs that require short cycle repetitive operations, and those where human operators are liable to make mistakes are best left to machines (probably still run under human controls). Typical of the first example could be punching holes in a bracket, and of the second example, circuit board soldering. In assembly operations all components and sub-assemblies must be keyed to eliminate the need for operators to decide the way items should be put together. This is as important in electronics assembly where mistakes are less obvious as in purely mechanical products.

The above comments are necessarily generalized but since there are more opportunities to trade-off between equipment and labour in television receivers assembly, production planning must be very carefully thought out and must suit local conditions. The views of the supplier however cannot always provide the optimum answer.

Another point to note: the scale of production, i.e. the number of units produced in a given period, has less bearing on assembly technology, i.e. the selection of production methods in electronics assembly industry than in most mechanical engineering industries. In many cases mere duplication of assembly lines can provide for increased output; except for additional space needed for future expansion, capital should not therefore be tied up in fixed installations not immediately needed.

Now for the management of production. Inefficient management is a common reason for over-all poor performance, particularly in developing countries. In a closed market this may not be too critical at the beginning but over a long period the effects would certainly show up in loss of profits, poor market reputation, government interference, etc.

The major contribution from a supplier in such cases could indeed be more in providing the managerial expertise rather than product technology. Where these aspects are accepted by both parties, the venture would have contributed in genuine transfer of know-how.

In practice, production management involves the entire spectrum between material input and product output. The key points are:

Inventory control

It is not unusual to find production brought to a stand-still because of a shortage of trivial components; fasteners, grommets etc. Computerization is not necessarily the short answer to proper inventory control - this can create bigger hold ups as once incorrect or incomplete data are fed into the system, they go unnoticed until they show up in incorrect provisioning, i.e. too late. Processing of licence formalities for import of components and maintenance spares can take longer than generally realized; planning must be realistic to allow sufficient lead time for such imports. Provision of maintenance spares should be carefully monitored - any oversight here can shut down the entire production line.

Quality control

No product should move down the line unless it is known to be within the operating tolerances. The view that since labour is cheap, one can afford to turn around a defective end product for rectification is especially inappropriate in the electronics field; to rectify a fault in an assembled product is very expensive and sometimes nearly impossible. On-line inspection or process control, as far as practical, should use instruments with simple go/no-go indications. Qualitative assessment requirements by the operator should be limited to occasions only when this is not possible.

While various formalized concepts and techniques have been developed for quality control, e.g. quality circles, zero-defect etc., the eventual results depend on the attitude of the production personnel towards achieving excellence. This is as important as the testing hardware used.

Cost control

No matter how closed the market is, it will not tolerate increases in costs beyond a certain point. Paper exercises when planning a project have numerous ways of going wrong; in particular a distinction should be made between costs that can be controlled by good housekeeping and management and those that depend on external conditions. Typical of the first would be the percentage of rejects at the end of the line: exemplifying the second are costs of materials, rates of government levies etc. In products where local value addition is relatively significant, the high proportion of local costs that go into the end price can, and should be under close scrutiny and control.

Acquisition of technology

Acquiring technologies related to the product and production varies with the circumstances. Four fundamental considerations are:

Do not attempt to develop technologies that are extant and proven; it is cheaper to buy than re-invent all over again;

Go for long-term benefits (in the context of the product) rather than short-term cost advantage;

Pay the going price for the know-how; the cost of this (licence fee, royalties or cost of foreign experts) might turn out to be the best investment in the project altogether;

Find a supplier who is experienced in your type of operation, and whose people speak your technological language. It is not always the case that the biggest are the best in this context. The key factor is the reputation of the organization for fair dealing and their ability to work successfully in a developing country.

The acquisition of technology is a continuing process and the initial know-how transactions are only the take-off point. The real base for technological progress is provided by good training and development programmes.

There must be opportunities for training personnel in both the technical as well as managerial aspects of production. As far as possible such training facilities should be provided on site in the developing country rather than in the supplier's country. This approach is not only cheaper it is of greater value by being more related to local conditions. However, it is important that management personnel also receive overseas training.

The temptation to get into basic research should be resisted. In any case, association with a competent supplier group ought to make it unnecessary. Applied research and engineering development, however, can be of great value provided that such research has the specific aims of:

Adapting the product more closely to suit local conditions;

Being up to date with new developments in the field;

Reviewing the production techniques in order to make more effective use of local resources;

In the long term developing new product ranges that could be tied-in to the existing facilities, sometimes modifying such facilities where needed.

No matter how close the collaboration with the supplier is for the know-how, the entrepreneur must be in a position to find out for himself what goes on elsewhere in his areas of interest. At times the task of acquiring, and collating the relevant technical information might appear formidable. In this instance co-operation with government and other scientific institutions in the country would be of great value.

Awareness of current developments in own and associated fields is of greater significance than generally realized. In markets where competition is limited, there is danger of the introvert approach, and it is easy to miss out on new developments directly related to the product, and opportunities in other similar areas. These are too important to be left to suppliers initiatives.

Adaptation of the product to local needs, and production techniques to match local resources are areas where the receiving group in the developing countries can contribute substantially to over-all cost effectiveness. In the case of television receivers, for example there is scope for simplifying the product without degrading its performance (elimination of some of the automatic controls, for example) as there is for redesign (making the set tolerant to wider input voltage excursions etc.). In particular the local design and production of cabinets as well as packaging offers advantages.

The supplier would generally not be interested in designing specific products for limited local application - here again such an engineering development team can substantially enlarge the local company's future prospects.

Training and development programmes, to be effective, must be funded adequately, and be served by really competent people. If resources are limited - as they generally are - the tendency might be to run such programmes on limited resources and achieve very little. The entrepreneur must assess the long-term benefits of properly run training and development programmes, and give these the support needed. He should also ensure that such programmes are purposeful, and result oriented. Apart from working closely with the supplier, he should also co-ordinate with specialized government institutions (available in many countries) who could help considerably.

Commercial and Financial Aspects

Any planning for an industrial undertaking should start with detailed analyses of:

Market potential;
Investment demands and profit projections;
Cash flow.

The market analysis should set out to establish as closely as possible the real market size, customer preference for product variant, and price tolerance.

In economies where government controls limit the free import the demand volume often appears exaggerated. If the market survey indicates a large spread between upper and lower demand limits, the production line should be conservatively planned on the lower of these figures. Where the market size is sensitive to the selling price, the entrepreneur, in establishing his scale of production, must provide for the contingency that actual ex-factory transfer is likely to exceed planned figures by 15-20 per cent at least during initial periods of operation.

Selecting the right product range is very important; a bad guess here can be expensive. The working group studying market 2 (see page 6) found, for example, that in one case an entrepreneur, partly on the advice of the suppliers, had selected 16" and 20" screen sizes for the receivers (there was a price jump for the next size), but it was later found that demand was almost entirely for 22" size, with some going up to 26".

The key question that the entrepreneur, during the planning stage, must ask: will the project - as planned - make money. The answer generally is "yes", in environments where the industry will have a large measure of protection from the government; the producers of television receivers are on a very good footing as the protection level increases with the quantum of imported material that go into the product. It should be obvious that the viability of the operation should continue when such protective measures have been discontinued.

At this point one reaches a very important aspect of planning, i.e. cash flow requirements. Since the capital for fixed assets in developing countries can be obtained easily and at subsidized rates, the working capital needs are frequently underestimated - sometimes grossly. Since a very large proportion of cash is required for materials most projects in such cases are under-financed with limited collaterals and the scale of operations therefore must be geared to the ability to finance working capital tied up in stocks and goods and credits to customers. Cash reserves must be available to meet short-term commitments and fluctuations in financial requirements.

The warning to the entrepreneur cannot be put too strongly - while almost any industry in a protected economy is likely to show profit, badly-planned financing is likely to kill it.

In the case of electronic assembly industry, the ratio of current inventory cost to cost of fixed assets is especially high - a figure of 10 is not unusual. During the Workshop, financial models for several typical television receiver assembly plants were programmed into a simple computer to calculate the cash flow. In the computer printouts appearing on pages 43 and 44 of the UNIDO report quoted earlier [1/] the cashflow positions for two different sets of working parameters are clearly exhibited. This, incidentally is one area where computer assistance would be very useful; one could vary the parameters so that the financing requirements turn out to be realistic.

III. THE ROLE OF THE SUPPLIER AND THE GOVERNMENT

So far, the issues have been examined principally from the entrepreneur's point of view; equally important are the perspectives of the supplier, and the government, and the interrelationship between all three.

Both the entrepreneur and also the supplier are primarily concerned with profitability of the operation and to safeguard its continuity. The supplier in addition has an interest in maintaining a stable presence in an area, and a reputation for any product bearing his mark. The government is also interested in the continuity of the project in order to obtain income from duties and taxes and to maintain employment; thus on the one hand government has to support local industry whilst at the same time observing over-all national interests. The government has therefore to play the dual roles of facilitating and regulating.

The goals of the three participant groups whilst interrelated are to a certain extent incompatible and this fact must be recognized. This aspect given the right attitude, need not be a telling handicap. It can even be turned around to mutual advantages when all three parties achieve the objectives referred to above.

The Supplier

This designation has been used interchangeably to refer both to the party providing the technical know-how and the equipment and the party selling the imported components and sub-assemblies going into the product. In practically all cases, one entity serves as both parties. However components can be purchased from a variety of international sources.

When the supplier has a joint role it would be correct to separate the two aspects; this distinction is the only way to establish whether one is paying the right price for the goods and services one is buying. In certain cases existing regulations make it more difficult to obtain foreign exchange for services than it is for the import of goods; the government must take the view that if a license agreement is worth having, it must be worth paying for. Where the licensor sells his know-how cheap, or even appears to give it away, the matter must be suspect - the real charges are sure to be added somewhere else.

Equally, many suppliers, faced with a variety of regulatory constraints when doing business with developing countries, may be tempted to depart from the normal business practices. There may be some short-term benefit in departing from expected conduct - but on the whole, he will find that it would be to his advantage if he can establish his reputation not only for technical excellence, but also business rectitude.

The Government

While the role of the government in industrial development in a developing economy tends to be very pervasive, quite often it may not be really effective in areas where positive participation is required. Government's main responsibility is both to protect and promote national interests. This includes consumer protection and ensuring that industry makes the best use of available resources, and that it helps in extending technological horizons in terms of national growth priorities.

In a free market economy and also in a centrally planned or managed economy where the government may be the entrepreneur there is an obligation to make certain that the consumer does not have to carry an unwarranted burden to develop and maintain an industry. This is not to say that there could not be a case where the consumer pays more for a locally assembled product if there are other tangible benefits for the nation that follow from such ventures. Here the government has a distinct role in establishing the criteria that such production must meet. These criteria generally include:

Creation of employment;
Acquisition of technology;
Foreign exchange savings;
Over-all benefit to the country.

In considering creation of employment it should be noted that the assembly of electronic products using highly automated technology does not call for extensive labour; any attempt to make plant of this type labour-intensive would lead to unacceptable cost and quality penalties. The industry, however, will of its own create jobs in service sectors directly related to the product (in selling and product support); there will also be employment opportunities in the local manufacture of ancillary equipment such as antennae, boosters etc. In the case of television receivers there will be the possibility of local subcontracting for cabinets and packaging materials and some plastic and metal parts. While absolute numbers of jobs so created might not be very large, they will all demand a fair degree of skill and initiative.

Acquisition of technology would appear to be a compelling reason for local assembly - but it does not automatically follow that handling high technology components in itself would provide access to the know-how. Indeed, one could produce an electronic watch, a calculator, etc. using the most modern components such as MSI/LSI circuits without needing any comprehension of the workings. To be able to achieve anything meaningful in this area a proper training and development programme is needed (as detailed earlier), as well as a close collaboration between the entrepreneur, the supplier, and the government.

As for foreign exchange savings, too much emphasis is often put on this aspect - a better criterion here would be the value-added factor. If an imported component or product provides better value overall to the country than when locally produced, there are strong arguments that one should go ahead and import it. Foreign exchange is only one of the numerous resources; and decisions should be taken so as to optimize the use of all available resources.

The over-all benefit to the country can only be a subjective assessment, but it must be made with a reasonable degree of concern for the consumer.

It is hoped that the Guidelines formulated in Chapter II and developed in this chapter will help the decision makers maintain a balanced approach in the assessment of investment proposals in the electronic assembly sectors in developing countries. A more promotional viewpoint is expressed in the following chapter which discusses the advisability of developing countries entering into the expanding information processing field "informatics". However, as has been pointed out, the final decision rests, of course, with the particular government of developing countries and to a varying degree the entrepreneur.

Governments in developing countries are certainly aware, even if in a general way, of the importance of the up-and-coming information technology processing developments. The television assembly industry if properly exploited can provide access to information processing technologies. Currently any decision by a government, or recommendation by an organization such as UNIDO, for the development of electronic assembly capacity should on the one hand not only be considered in the context of the guidelines which have been presented and discussed in this document so far but also on the other hand be assessed with a view to the future potential in information processing equipment and in the use and application of information processing techniques.

IV. LOOKING INTO THE FUTURE

While our considerations so far have been based principally on a television receiver, one should also look ahead to future possibilities, and even needs, of developing countries in the general field of modern electronic technology. (In our present context, "future" is only a decade or so away.)

Taking the view that a television receiver merely processes a complex set of information in a specific way, one could move ahead from this to other types of information processing. Certainly by the end of the current decade, management of information using modern electronic techniques (informatics) would play a vital role in a country's administrative and development infrastructure. Any country, in order to communicate with others, to run its own affairs efficiently, and to take advantage of current breakthroughs in science, must possess competence and expertise in this field. It will have to learn, and use, the new "electronics language", or else risk being illiterate in the coming decades.

Thus, the need for developing countries to be sufficiently involved in the informatics field is obvious. But to what extent can such countries meet their own requirements, and at what cost? As we will see below, it is possible, for perhaps the first time in industrial history, even for people with modest means to participate in a high technology industry, and develop it to meet their own needs.

Earlier, we had referred to several rather special aspects of electronic technology (when compared with other fields of engineering products and processes). For our discussions, the relevant ones are:

Most of the major components applied in the hardware items are universal in application and are widely available at relatively low cost;

The assembly of components and ancillaries into the finished product calls for relatively low investment, but can still provide substantial value addition;

There is a very wide scope for developing product packages that are tailored to one's specific requirements. This involves mostly software design - an area requiring relatively modest outlay in engineering hardware, but demanding a high degree of human skill.

Thus the way is open, in principle, for innovative groups anywhere to get into this vast new field of information technology. But, to be able to do this, that is build a meangingful package suited to the country's needs around cheaply obtained electronic hardware, one requires an investment in special scientific and mathematical disciplines. This is no easy task, but given the will, it would be far more within the competence of most countries than say the setting-up of an efficient plant to produce cars or refrigerators. If this view is kept in mind, any in-depth involvement in an industry using modern electronic building blocks, be it television receivers or calculators, can create a base from where take-off into the information software systems could become possible. Other considerations aside, this alone could be a suitable justification for getting on with the business of television assembly.