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ASSISTANCE TO AFRICAN COUNTRIES AND ORGANIZATIONS THROUGH THE PROVISION OF SHORT-TERM TECHNICAL ADVISORY SERVICES

XA/RAF/85/609/51-21-6

REGIONAL AFRICA

Technical report: Presentations to seminars and demonstrations to selected African countries and report on other advisory sub-projects undertaken*

Prepared for the Governments of the countries participating in the regional project by the United Nations Industrial Development Organization

Based on the work of UNIDO consultants and staff members

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SECTION III.

This section includes the background paper on the seminar and demonstration in basic technologies prepared prior to launching this programme and was intended to initiate the countries in Africa to the proposed programme. The technologies presented in different countries have thereafter been presented subject wise either as lecture notes or as the lecture material obtained from the experts. Under the following heads:

(i) Seminar and demonstration of basic technologies: Basic paper.

(ii) Presentation on UNIDO and its technical co-operation.

(iii) Application of plastics in agriculture.

(iv) Production and processing of natural rubber.

(v) Low energy systems in building materials and construction.

(vi) Concepts in biofuels development.

(vii) Development and manufacture of agricultural machinery and implements.

(viii) Role of shore fishery complex in fisheries development.

(ix) Mini-hydro power plants.

(x) Utilization of bentonite for soil conservation.

(xi) Repair and maintenance as a means of entry to manufacturing spare parts for telecommunications equipment in Africa.

(xii) Changing technologies in telecommunications sector - production options in Africa.

(xiii) Deglobalization of self reliance in telecommunications with a view to developing local manufacture of certain sub-systems, components, etc.

(xiv) Importance of PTT in developing telecommunications industry.

Paper No. 1:

SEMINAR AND DEMONSTRATION OF BASIC TECHNOLOGIES

RP/RAF/85/609

UNIDO background paper for programme development

The economic development of most countries in Africa is being designed to meet the requirements of the population for food, shelter and health. These sectors of the economy are fundamental to creating a sound base for sustained economic growth. This presentation accordingly focuses on basic technologies which have been demonstrated in a number of countries and have been found useful in increasing food production, helping the housing development programmes as well as providing the population with effective health and hygiene programmes. The presentation is being made under three heads:

1. Food
2. Water Management
3. Shelter

I. Food

Though fundamental for human survival, the availability of food is the most difficult problem confronting a large number of countries in the African continent. In broad terms, the issues are related to (i) area under cultivation; (ii) adoption of modern agricultural practices; (iii) increasing yields by using fertilizers; and (iv) protection against attack by pests and insects. It is also estimated that the loss of food grains during production, transportation and storage may exceed 35 per cent.

The immediate emphasis therefore, should be placed on:

(a) Increased uses of organic fertilizers and application of non-metallic minerals as soil conditioners which will help save water and fertilizers;

(b) Packaging and conservation of food;

(c) Construction of silos for storage of food.

Brief notes on these subjects are given below:

I.1 Fertilizers and non-metallic minerals

I.1.1 Organic fertilizers dominate the nutrients applied in most countries in Africa, though production of chemical fertilizers in some countries has promoted their use with spectacular results. Use of chemical fertilizers to supplement the organic fertilizers produces the best results while utilizing the indigenous resources to the maximum extent. A number of countries in the region should plan to set up facilities for the production of chemicals based on imported intermediates such as ammonia, phosphoric acid, sulphuric acid, etc. as well as fertilizer blending, granulation and packaging. These units which form the downstream portion of the main fertilizer plants are amenable to being set up in small capacities without seriously losing the advantages of economies of scale. The intermediate chemicals which form the feedstock to these plants are also easily available on the world market on-the-spot or long-term supply basis and in some cases the sources of supply are located in North Africa.

The current levels of consumption of fertilizers in most African countries are quite low though the potential for growth are quite large. The realization of the potential demand apart from the general level of economic development is also dependent upon uninterrupted availability of the same type of fertilizer at the time required by the farmers as well as promotional policies aimed at increasing consumption of fertilizer by the governments such as agricultural credits, crop insurance, remunerative prices of agricultural produce, efficient system of storage and distribution, etc.

It should be most appropriate in such cases to establish the fertilizer industry by setting up downstream units in the first stage which could include: granulation and packaging of fertilizers, storage and processing of intermediate chemicals e.g. ammonia, sulphuric acid, phosporic acid etc. These production plants could thereafter be integrated with upstream production units in a planned manner to synchronize such manufacture with the profile of the emerging demand. This pattern of development could enable the training of local personnel in well-defined phases of plant operations commencing with simpler technologies and ultimately acquiring experience of the complex processes of manufacture employed in the basic fertilizer plants. The possibility of the initial downstream facilities generating cash to partly finance the cost of the upstream plants to be set up later on could be an interesting possibility, and developmental plans can be so designed.

The technical assistance provided by UNIDO has also covered setting up biogas plants based on human and animal and other organic wastes; the pilot units set up in villages have been able to produce gas and compost; the former meeting the fuel needs of the village and the latter used as fertilizer. Such plants, simple in design and easy to maintain have been built for as low as six family units in small farmer communities in India. The biogas generated from such units can be utilized in cottage industries such as dairies, piggeries etc.

I.1.2 The growth of agricultural production is linked directly to systematic soil care and consideration has therefore to be given to the quality of soil which would be a fundamental prerequisite for intensification of large scale agricultural production. It is reported that in Africa, apart from the harsh and contrasting climate, there are substantial portions of rather poor soils. Most African soils are reported to lack mixture of humus and filter which is necessary to accumulate and retain water and plant nutrients. In the absence of these conditions, the fertilizers are leached from the soils with the very first rains and many nutrients are lost. There is also an urgent need to reclaim vast areas of agricultural, sandy and sandy-argillaceous soils. The objectives accordingly mainly aim at raising the yield potential of deficient soils which are low, due to low content of clay particles and of humus. Soil improvement has to be carried out by progressive methods of reclamation based on research of actual conditions, influences on hydro limits and further physical and biochemical properties of soil. The UNIDO-Czechoslovakia joint research programme has in general demonstrated that non-metallic minerals and rocks with a high content of montmorillonite play an important role both in plant growing and animal husbandry by acting as soil conditioners they make plant nutrients more readily available performing in the same manner as humus as well as carriers of chemical and biological agents. The non-metallic minerals include materials such as bentonites, zeolites, perlites, diatomites, tuffs, tuffites and many others. These non-metallic sorbents function in two ways. On the one hand, they reduce the leaching of fertilizers, enhance water retention and rehabilitate the soil from the point of view of the ion exchange. On the other hand, they deliver nutrients direct to plants which increases the yields by 10 to 40 per cent depending on the kind of plant, humus content, acidity and particle size. They also reduce the migration of chemicals to subsoil waters and sometimes to the atmosphere. Some of these non-metallic minerals are found in a number of developing and developed countries. The increase in yield by non-metallic sorbent treatment are presented in table 1 though these results should be taken as comparative as the actual yields will depend on conditions of application, soil, climate, quality and amount applied. Experiments carried out over the past 15 years have shown that by application of 20 tons of bentonite per hectare, the water retention of soil is enhanced to such an extent that irrigation can be reduced to about 4,000 m^3 from 7-8,000 m^3 per hectare within one cropping period, that increased use of mineral fertilizer results in a commensurate increase in crop yield and that under equal conditions of irrigation and fertilization, bentonite addition results in a 20-35 per cent increase in harvest yield depending upon the crop. The widespread occurrence of bentonite or similar montmorillonitic clays and the possibility to apply them with only minimal preparation is a strong argument in favour of their introduction in desert agriculture. An equally strong argument is that their actual application (spreading and ploughing) only has to take place at 7-10 year intervals and that in the course of these years they enhance the build up of humus thus eventually eliminating the need for further active soil reclamation.

In animal husbandry, the addition of sorbents can be used to replace 5-15 per cent of fodder. Its other function is in decelerating the nutrient circulation in the digestive tract of animals and through it a better utilization of albumen and other nutrients. These sorbents as dietetic additives in animal feed reduce the occurrence of diarrhoea and some other diseases. The performance of sorbent feeding for animal husbandry is presented under table 2. The experiments carried out independently by the UNIDO-Czechoslovakia Joint Programme and in Egypt by the Applied Science and Technology-Agriculture Research Group of the Egyptian National Science Centre on the uses of Egyptian Bentonites for Sandy Soils Reclamation, conclusively prove that:

(i) Non-metallic minerals and rocks play an important role in agriculture as fertilizers, sorbents and carriers of chemical and biological agents;

(ii) Application of non-metallic mineral sorbents both for plant growth and animal breeding has achieved very favourable results;

(iii) The most important non-metallic sorbents for agriculture are bentonites, zeolites, perlites, tuffs and tuffites, marl and others, such as diatomaceous earth and tripoli;

(iv) Non-metallic sorbents act positively against different diseases of the digestive tract by regulating the transit of albumen through the body;

(v) Non-metallic minerals applied to some soils decrease the leaching of chemical fertilizers into the sub-soil and reduce losses to atmosphere;

(vi) Apart from their direct economic influence on agriculture, non-metallic sorbents help the national economies by decreasing imports of food and fodder for animals and increasing the chances of each country to accelerate the production of food.

I.2 Packaging and conservation of food

It is reported that around 50 per cent of foodstuffs perish in most developing countries from the time of production up to final consumption. It is also believed that 70-80 per cent of these losses are avoidable and that the prevention of losses will be cost effective.

Most African States have agriculture-based economies with more than 50 per cent of the population engaged in this sector; there is however heavy dependence on food imports due to low productivity. Increased efforts of these States in production of meat, fish, vegetable and cereals will need to be supported with appropriate systems for food processing, conservation and packaging with the protective function serving as the most important criteria of packaging. This effort will also have to be based on development of suitable standards for food packaging as a lot of packages with different formats and weights are not economical and on the contrary create difficulties in comparing different products on the market by the consumer and results in superfluous multiplicity.

It could be most suitable to arrange a special presentation on the evaluation of different technologies for processing and packaging of foods which could include inter alia, the following:

(i) Programmes and activities of centres of excellence in food and biotechnology with which UNIDO associates and which could assist other developing countries in providing the required back-up;

(ii) Preservation of foods by heat, giving principles of the processes employed and those of the process times by several methods;

(iii) Sterilizing equipment: existing, new and potential future methods;

(iv) Aseptic packaging of foods: with a critical review of aseptic systems, their potential applications, their advantages and disadvantages. Methods for sterilizing packaging materials and system for processing of liquid products. Potential systems for aseptically packaging particular products stressing the need for a dependable quality control programme could be of interest to some countries;

(v) Use of flexible packaging materials for preservation of foods; methods of preparation, filling, air removal, and thermal processing are pertinent. Methods of heating, quality control aspects pertaining to packaging materials as well as filling, sealing and processing could be detailed;

(vi) Modified atmospheric packaging systems: including basic principles of controlled and modified atmosphere to extend storage life of perishable foods. It normally includes the application of modified atmospheric packaging systems for fresh fruits and vegetables as well as fresh meat and fish;

(vii) Other packaging systems: includes the bag in box systems, carton packages, composite cans, etc.;

(viii) Shelf-life of foods: a brief analysis on how to approach the evaluation of shelf life of various foods.

The options available for packaging food stuffs have to be examined by analysis of the technological aspects; the selection of technology will be governed by its appropriateness and compatibility to the infrastructure in the country concerned as well as the suitability and acceptability of the packing by the target market. The systems of packaging in the world are being modified to suit the changing consumer taste and requirements and in the process becoming quite sophisticated. Such options have, however, to be carefully analysed for their suitability in any developing country and more particularly in some African States where appropriate industrial infrastructure does not exist.

The packaging of perishable vegetables, fruits, fish and meat in collapsible crates/containers has been employed and moved over long distance without any damage in specially designed packings made of high density polyethylene (HDPE), and polypropylene (PP) plastics. The collapsible character of these packings permits their return for reuse utilizing least volume when empty. These arrangements have successfully provided better return to the farmer, reduced losses and helped improve quality of deliveries to consumer markets. These are relatively inexpensive devices and indicate that there are a wide range of possibilities of using plastic materials in storage of grain, and other agricultural produce. In most cases, however, the designs require modifications to suit the local environmental and social needs.

I.3 Construction of silos for storage

A number of systems, suiting the local needs of the country concerned, have been developed for crop storage. These systems though rather inexpensive provide adequate protection through the use of plastics in some form.

Galvanized wire mesh silos have been constructed for the storage of grain and are lined with LDPE film. Some of these designs include facilities for removal of the grain by use of a mechanical auger. This is a low cost and effective means of rapidly providing additional crop storage facility. Like all other such systems applied in the domain of agriculture, further development is desirable in each country to ensure the most economic and suitable design meeting the specific needs and requirements.

The agricultural scientists in India developed the 'PUSA' bin which is an outstanding example of intermediate technology. The traditional mud-brick-built grain storage unit of 2-3 tons capacity suffers from penetration of moisture and air. Thus the grain storage can deteriorate during a period of six months or so and losses of up to 14 per cent have been recorded. By sandwiching a LDPE film between the two mud-brick layers forming the wall of the bin, suitably sealed at the joints by heat sealing, an air-tight and moisture-proof bin has been achieved. The whole operation was designed so that local farmers could carry out the construction by themselves.

A filament wound FRP silo has been constructed for grain storage in Hungary. It has a capacity of several hundred tons. This example merely indicates the great strength that can be achieved with FRP composite when correctly designed. The emergency storage of grain, in India, has been in jute bags built into stacks of about 40 tons on wooden pallets, and covered by large LDPE sheets. These sheets were secured against wind damage, due to flapping of the film, by plastics net and cords. The stacks are periodically vented and fumigated to prevent losses. Several million tons of grain have been stored in open-weather conditions by this technique with losses reported to be smaller than under conventional storage.

A small flexible container of about 2 ton capacity has also been developed in India which is fabricated from HDPE film.

II. Water management

Increasing population in all developing countries and the growing demand on land for higher yields of food has brought about the necessity for optimum use of the resources, and management of the available water resources is being given top priority. The major areas of activities covered by UNIDO in this sector relate to (a) improvement in the water utilization through better agricultural practices, (b) reducing the water losses during storage, application and transportation, and (c) improved methods of production and distribution of water. These objectives are achieved through the institution of the following arrangements.

II.1 Use of plastics in agriculture

The use of plastics in agriculture is a relatively new technology; its assimilation has been greatly facilitated through efforts at the national level usually organized under National Committee for Plastics in Agriculture jointly by the plastics industry, Government departments, financial institutions, research workers, farmers and associations of growers etc. A number of developed and developing countries have such apex bodies operating very effectively and have provided the necessary centralized institutional facilities whereby knowledge and experience could be pooled and exchanged, enabling a wider promotion of the use of plastics in agriculture. The international committee for plastics in agriculture operating from Paris provides opportunity to the national-level committees through their membership of the international body to have access to information and experience at the international level as well as provides contact with national and international institutions and experts. Experience has shown that the formation of national committees has been followed by a positive upsurge in the use of these materials in agriculture bringing with it an improvement in agricultural output, quality and utilization of nutrients and water.

In many developed countries the use of plastics in agriculture applications was and still is being determined by experimental field scale trials. Such trials are conducted at governmental as well as private enterprise supported "agricultural experimental stations" as a part of a continuing programme in the general development and improvement of agricultural technology. Plastic demonstration trials are used to establish the most effective technology of the application of plastics in agriculture in relation to local environmental conditions and agricultural practices. These trials enable various factors to be evaluated, such as the effect of type and quality of plastic product, the method of the application of the plastics to meet specific agricultural requirements, the adoption of agricultural techniques, if required etc. By giving access to these demonstrations trials of all interested parties including farmers and growers and members of the plastic industry, an opportunity is also presented for on-the-spot technical discussions with the station experts. Through these means and supported by use of audio-visual aids, a wider knowledge of the use of plastics in agriculture and applications become known to farmers and growers, plastic industry personnel and also to national agricultural extension experts and to administrators. Through the use of these techniques, a practical knowledge of the technology is disseminated. This technology is now called "PLASTICULTURE" that is the application of plastics to agriculture.

II.2 <u>Water conservation</u>

II.2.1 <u>Reservoirs</u>: The use of LD polyethylene film for large agricultural reservoirs has become a widely accepted practice in a number of developing countries. The basic technique consists of excavating the ground to a predetermined depth, with low sloping sides. This "hole-in-the-ground" is then lined with large sheets of black PE film 250 microns thick, 7.5 metres wide and normally 30 metres long. Jointing between sheets is done by means of a specially formulated mastic, and a PE self-adhesive tape acts as a second line of security. The outer peripheral edges of the film are securely anchored by burial in a trench around the reservoir. The whole LD PE membrane is then covered to a minimum depth of 10 cms and the sides 20 cms. The nature of the back-fill used for this covering operation is unimportant and the excavated material can normally be used. However, if the material is coarse or contains sharpstones, then a layer of sand or soil should first be spread to act as a cushion. The reservoir is then ready for filling.

A PE film-lined reservoir is known to have been constructed in Sudan a few years ago by a UK company using new techniques to protect against termite attack. The main advantage of the technique lies in its low cost compared to more traditional methods of reservoir construction.

Australian-style, circular ponds for water storage for cattle use are constructed of concrete. They inevitably tend to leak and can lead to large water losses. By utilizing large sheets of PE film, development work has shown how, when building these ponds, they can now be made waterproof at relatively low cost. This is a good example of a development to a specific local problem.

II.2.2 Canal linings

The use of LD PE film as a waterproof membrane for the lining of canals, so as to make irrigation systems practicable at low cost, has been undertaken in many parts of the world, including Iraq, Pakistan, India, South America, Australia, Canada and Romania. The purpose of the lining is to prevent seepage and control weed growth. In Canada more than 160 km of canals have been lined with LD PE film. In the Rio Negro province of Argentina a large irrigation canal, more than 30 metres wide, has been successfully lined with plastic film to eliminate water losses. The cost was more economic compared to traditional methods of lining.

In India much detailed work on canal lining has been undertaken since 1960. They have evolved a very economic lining system in which LD PE film is lined on the bottom of the canal, instead of the more usual bottom and sides. The sides are then lined with a double layer of bricks or concrete slabs, in their traditional manner, and the bottom is back-filled with earth on top of the plastics film. There are several variations of this system depending on local conditions etc.

LD PE film which has been in use in India for 22 years has been examined and found to be still water tight and mechanically unchanged. More recently the matter of plastics film-lined canals has been re-activated and papers indicating significant cost benefit have now been published in relation to various types of canal lining systems. More recently it has been decided to use LD PE film lining in canal restoration works.

II.2.3 Fluming

The use of a large diameter plastics layflat tube for transporting low pressure water is called "fluming". This type hose is also known as "Krisni Hose" (farmer's hose) in India. Both PVC and LD PE layflat tubing can be used, of about 40 cm layflat width and 100-200 microns thick. (400-800 gauge). In Argentina one kilometre length was seen in use to transfer irrigation water from one area of a farm to another.

II.2.4 Channel irrigation

The traditional channels used for leading water into the field for furrow irrigation also suffers from severe seepage losses. Lining of such earth constructed channels with LD PE film has been successfully demonstrated in India. In Malaysia, FRP composites have been utilized to form prefabricated irrigation channels. This has been established to shorten the time required to construct new channels required in the expansion of their rice production programme. They also take up less land space than the traditional concrete channels which are extremely time consuming to prepare and install.

II.2.5 Trickle (drip) irrigation

There is an increasing trend to move to piped water supply for irrigation. This is particularly so where trickle irrigation is used. The principle of trickle irrigation (also known as drip irrigation) is to deliver to the plant roots only sufficient water for the plant's needs, thus achieving a more efficient management of limited water resources. The advantages of trickle irrigation are:

- Water economy (30-50 per cent) compared to furrow irrigation, thus larger areas can be watered for any given water resources;
- Improved quality and size of agricultural product;
- Increased yields of 20-40 per cent compared with furrow irrigation and of 10-20 per cent over spray irrigation;
- The possibility of using water with a higher mineral content (saline water) since the salt leads to the periphery of the wetted root zone, permitting root formation within the zone but away from the salt concentration itself;
- Space between the beds is dry and this assists harvesting operations whilst undesirable weed growth is greatly reduced.

A wide variety of trickle irrigation systems have been developed which are of two basic types: low pressure and high pressure systems. Low pressure systems are those which operate at pressures below 2.5 Bar (25 psi) and high pressure systems which generally operate at 3.0 Bar and upwards. Each have their own area of application.

Low pressure systems can be utilized with the emitters (drippers) having a relatively wide orifice for the drip. They therefore tend to be free from clogging problems which are more apparent in the high pressure systems where the water orifice is generally of very small diameter. Good filtering systems for the water should be used with both types for trouble-free irrigation.

All the systems involve design mechanisms to reduce the water pressure at the emitter (dripper) so that water is applied on a 'drop by drop' basis to the plant. The initial capital investment cost varies greatly depending on the choice of system and degree of sophistication required. The nature of the systems vary from that designed for use in Indian village farming to completely automated systems used in some developed countries. Sophistication of the process involves the introduction of metered nutrient solutions into the irrigation system for more economical utilization of resources.

Initial development and usage of these systems was in high intensity cropping in greenhouses where the system could be automated and thus lead to a reduction of labour. However, from 1960 onwards various trials have been conducted on open crops, and the system modified to produce satisfactory results under these conditions. The work received an impetus from countries like Israel and Australia where there are water resource limitations which hastened this development. From 1970 serious exploitation of this system of irrigation has been undertaken not only in Israel and Australia but also in Argentina, Germany, India, Italy, Mexico and the USA.

It has been reported that at least 15,000 hectares were now irrigated in the USA by this technique. An indicative cost (1980) of the tube system fitted with drip nozzles was US$500-700 per hectare and this particular system was used for more widely-spaced crops such as fruit trees in orchards.

Flat sheathed and other systems are principally used for close-grown crops such as vegetables in open fields, and food crops and flower crops in greenhouses, and here the costs were US$600-1,200 per hectare of which 50 per cent or more was made up by the mains and secondary pipes which are used for distribution of the water to the sheaths.

There appears to have been little, if any, development work undertaken to attempt to reduce this initial investment cost by reduction of the cost of the pipes used etc., and this is certainly an area which warrants attention.

Some controlled comparison trials of drip and furrow irrigation of tomatoes has been carried out in the USA. It was concluded that drip irrigation used less water and the tomato yields were higher than with furrow irrigation.

Various methods of trickle irrigation in the Arizona desert for growing pecans and lettuce has been evaluated. The water saved by the use of trickle irrigation was significant. Lettuce was produced with only 25 per cent of the water normally required; and three year-old pecans grew with only 20 per cent of the water used in furrow-irrigated plantings. Salt accumulation was less in trickle irrigated plots, and further studies are to be undertaken to find an optimum situation for crop growth.

Of the trickle systems on the market, most have been developed to suit the requirements of developed countries. There are many possibilities to reduce the systems cost; but even at the present investment level the cost benefits are significant.

Trickle irrigation is undoubtedly a technology which developing countries will find produces many benefits for water conservation as well as increased crop yields. The major area of interest traditionally has been in horticultural crops where high returns have been possible, but it is also spreading to citrus and other orchard crops as well as coconut plantations.

II.2.6 Drainage

Water storage, transport and distribution, covered in the foregoing, are all aspects relating to water conservation and usage. Another agricultural technique relating to water conservation is that of drainage. Drainage deals with systems for effecting a reduction of high water tables whether natural or man-made.

The use of plastic pipes and corrugated tubing for land draining is now well established. It competes with traditional tile drains, and has specific advantages of longer useful life since blockage due to silting is slower. Unplasticized PVC is used for this type of application, and it offers complete resistance to all types of soil conditions, being highly chemical resistant. The corrugated tubing is flexible, due to the corrugated nature of its construction, and can be coiled. It can be laid by an adaptation of the standard mole plough technique thus avoiding the need to dig open trenches to lay it as required for clay tile drains.

By the design and installation of suitable drainage systems water-logged ground can be effectively drained to permit such ground to be brought into effective agricultural use.

The economics of drainage have to be carefully balanced. Even the drainage of different areas in the same country can show considerable differences in the system costs involved. This is a specific area where specialized expertise is required to design drainage systems to suit the particular local area conditions. It does not always follow that plastics will be the lowest cost system, but the installation period may be shorter in time and thus enable an additional crop to be grown than might otherwise have been possible. Thus special attention has to be given to the total overall benefits that can be obtained as distinct from just examining a systems cost for drainage.

II.3 Improved methods of production

The foregoing text covers the aspects of water storage, and distribution. In a number of countries with dry climate evaporation of water from the exposed surface of man-made or natural reservoirs represents a serious loss. Novel but simple methods of covering about 3/4th the surface with floating hollow plastic shapes has been employed successfully to reduce the evaporation losses by about 65 per cent. In a number of drought-affected countries in the region a combination of plastic LDPE lined storage with covered surface could be very helpful in the management of water resources.

In a number of countries plans for exploitation of underground water resources are being taken up in a big way to be able to meet the vagaries of nature such as droughts. The conventional tube well system of water extraction is being improved to employ plastic casing pipes as well as the well water sieve located in the water acquafer. The traditional well employing metallic sieves and pipes are known to have a limited life mainly because of the failure of sieve due to corrosion as well as the failure of casing pipes due to corrosion and errosion which used to result from sucking in of sand by them consequent upon failure of sieve. The plastic system apart from being less expensive, hygienic and easy to install is long lasting. The extension of plastic pipes of a wide variety of diameter ranges from less than 1" tube to above 4". Commercial-grade pipes employ simple technologies which could be very suitable for the African States. It is generally desirable to manufacture pipes locally based on imported resin rather than importing pipes which could be expensive to transport due to large volume to weight ratio of the finished pipes.

III. Shelter

The building materials and construction industry represent an important area of socio-economic activity in developing countries primarily by being directly related to the basic need of acquiring adequate shelter. The influence extends into other social and cultural sectors such as education, health, community life and administration and its relevance to the establishment and continuous improvement of basic infrastructure is evident. By and large all developing countries are confronted with the serious problem of providing shelter to poorer sections of their population as well as meeting the growing needs of housing in general. The critical nature in this sector arises mainly from the growing population, general economic environment and the inadequate availability of the construction materials.

Significant proportions of the building materials used in the developing countries are still being imported resulting in a foreign exchange drain of a considerable magnitude. It is widely recognized that from national economic angle, there are enormous benefits to be gained from the development of an integrated local industry for production of building materials and shelter which will have strong links and a high degree of co-ordination with other socio-economic sectors. In the overall context of the socio-economic development of a country this sector can play the role of a pace setter if assigned the appropriate priority. It has a unique capacity and flexibility for generating employment and contributing towards social welfare, particularly through the promotion of labour-intensive systems of manufacture of building materials and construction devices. The objectives of UNIDO's work in this sector are principally covered by:

(a) Developing building materials and construction methods of such a cost and quality so as to bring adequate housing within the reach of the greatest number of people;

(b) Facilitating widespread establishment of schools, hospitals and other public buildings as well as related industries;

(c) Generating maximum employment for jobs in the associated mining, manufacturing and construction sector.

The above approach is designed to support creation of indigenous capacity for a self-sustaining growth. To help the developing countries in achieving these objectives, UNIDO adopted a policy giving priority to the following aspects:

(i) Provision of a balanced supply of a full range of building materials within identified geographical areas.

(ii) Decentralization of industries whenever justified.

(iii) Maximum use of local natural resources including wastes.

(iv) Selection of technologies in keeping with local customs, traditions and building habits as well as the given social and climatic environment.

III.1 Shelter and energy

It is seldom realized that housing is a high energy input sector and large-scale dwelling projects built exclusively by traditional building methods could invariably bring about serious ecological strains. Confronted as they are with rising costs of energy inputs to their economies, the developing countries in general and the countries in Africa in particular have to give serious consideration to employing 'low energy housing systems' to meet the social demands of providing shelter to its people.

Immediately following the major increase in prices of crude oil in early seventies and the consequential increase in cost of all other forms of energy, UNIDO planned an extensive programme on low cost housing aimed at reducing the consumption of raw materials which represent major energy input as well as integration of materials available locally. Demonstrative programmes were successfully executed at the building sites in Cyprus, Ecuador, Mexico, Burkina Faso and Uruguay. Separately, Building Research Establishments studied the effect of weathering on plastics used in housing construction at locations in Ghana and Nigeria; more recently such investigations were undertaken on plastics products, being one of the important component with a large potential for growth in the wide range of building materials, exposed at weathering sites in the United Arab Emirates and in Sierra Leone as well as on their resistance to sand at a site in Kuwait. The knowledge acquired so far, though incomplete at this stage, enables useful guidelines to be given on the behaviour of these materials in the tropics. These investigations addressed the issues of direct interest to most developing countries namely:

- Adaptation of high technologies to local circumstances including lack of a developed infrastructure, unskilled labour and absence of local supply of energy and water;
- Utilization of materials with versatile properties such as composites in combination with raw materials available from local resources;
- Development of designs which will use less materials and energy but offer maximum living space.

III.2 Development of optimized housing system

Apart from the conventional materials of construction, the need for study and development of new building materials and construction techniques, to meet the requirements of expanding house-building activities in developing countries have been the theme of major discussions at several international meetings, conference and seminars.

Major research and development efforts in industrially advanced countries have been directed to polymers and their useful combination with traditional materials such as glass fibres and natural fibres such as jute and sisal.

Plastics have provided new concepts in designs and architectural features of buildings, and solutions to emergency housing and shelters in the event of natural disasters.

Economically, plastics have proved to be competitive with traditional materials. Plastic manufacturers and designers around the world have come forward with new concepts and designs for low-cost housing or economically priced and socially acceptable dwelling units or shelters.

Invariably, in all such cases, the emphasis has been on propagating composite materials in association with polymers and fibres, fillers and traditional materials.

For wider user acceptance and adoption in the building industry, these demand experimentation "demonstration housing projects" with a view to evaluating their performance and user requirements in developing countries.

The interest and involvement of UNIDO in the field are obvious, as these aim at transferring technology of plastics composite materials housing for development and adoption locally in countries of Asia, Africa and Latin America.

Among the several building systems designed using plastics composites, the one which is simple in design, equipment and utilization of materials is that of the "Patfoort Building System".

Already UNIDO was successful in setting up such projects in Cyprus, Uruguay, Ecuador and Burkina Faso.

IV. Technologies with potential for application in Africa

IV.1 Growth of Guayula: Guayula shrubs are known to have been planted in desert area (Arizona, USA) and the shrub has been used to extract natural rubber. The growth of this kind of shrub in the desert areas in Africa could yield important materials otherwise imported in these countries such as natural rubber and cork. In addition it will help control the expansion of desert. UNIDO is already looking into the possibility of assisting countries in the region and have been specifically requested for help by Morocco, Burkina Faso and Guinea.

IV.2 Development of Pesticides: Use of pesticides in Africa is rather limited by availability, in most cases the ready made formulation are imported in bulk and repacked locally in the saleable packages. A few countries have established facilities for formulation of pesticides based on import of active materials.

A number of naturally occurring plants are known to possess pesticidal properties; the existence of pyrethrum is an example. Evaluation of such possibilities could be useful for specific countries where opportunities are indicated.

IV.3 Use of local materials for meeting energy needs: Consumption of energy increases rapidly with the general level of growth and developing countries embarking upon the developmental plans are soon faced with the problem of meeting the growing requirement of energy. In most countries the population resort to using wood as a source of energy with the result that serious problems of deforestation are being faced in a number of developing countries.

UNIDO has supported technological research and development effort in use of agricultural waste and other biomass for generation of energy. Processes for thermo-chemical conversion of agricultural waste have been developed employing simple systems of controlled combustion yielding gas and coke of good combustible quantity. Improved systems of charcoal production from wood results in better utilization of the resources. The fermentation processes result in generation of compost as well as gas used as a combustible. A number of these technologies have been demonstrated in African countries in demonstration plants set up using local materials and skills. The plants are amenable to being set up to cater to small communities avoiding transportation and creating concepts of self-susta n g villages.

Paper No. 2:

UNIDO and scope of its technical co-operation

This short presentation is intended to bring to the participants information on UNIDO - What it is --- and how its services and experience can be obtained by developing countries in their industrial development. It should enable participating countries to obtain UNIDO assistance promptly. Objectives of Seminar in particular form key to the themes on which presentations by eminent UNIDO experts are planned over the next few days. Your understanding of these objectives and the procedures of UNIDO, we hope will pave way for meaningful results from this Seminar and identification of specific projects for technical assistance from UNIDO.

UNIDO

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO is a Specialized Agency in the UN System, exclusively engaged in activities related to industrial development.

TECHNICAL CO-OPERATION is UNIDO's major activity which is designed to assist the developing countries in the process of their industrialization.

Its technical co-operation is very wide in coverage from application of simple grass roots technologies to complex modern technologies in the field of electronics. However, in context of requirements of majority of developing countries emphasis is placed on:

- RURAL DEVELOPMENT
- PROMOTION OF SMALL-SCALE INDUSTRIES
- ENERGY CONSERVATION
- HUMAN RESOURCES DEVELOPMENT

WITH PRIORITY GIVEN TO THE INDUSTRIAL INPUTS TO THE FOLLOWING SECTORS OF ECONOMY

* AGRICULTURE - FOOD
* HEALTH & HYGINE
* BUILDING CONSTRUCTION
* ENERGY
* TRANSPORT - TELECOMMUNICATION

TECHNICAL ADVISORY SERVICES, through presentations and demonstrations, is designed to bring to Africa the UNIDO experience in industrial sectors considered priority by the countries concerned.

Telecommunications with its profound impact on all sectors of the economy as well as amenable to meeting the sectoral emphasis mentioned above is the logical choice for the present regional meeting.

SCOPE OF TECHNICAL CO-OPERATION

- NATIONAL, INDUSTRIAL AND SECTORAL PLANNING

- PREINVESTMENT ACTIVITIES
  - PREFEASIBILITY & FEASIBILITY STUDIES
  - TECHNO-ECONOMIC EVALUATION
  - ADVICE ON TECHNOLOGICAL CHOICE & PILOT PROJECTS

- PROJECT IMPLEMENTATION
  - SPECIFICATION OF PLANT & EQUIPMENT
  - FACTORY LAYOUT, ASSEMBLY, ETC.
  - PROJECT SCHEDULING, ETC.

- OPERATIONAL ASPECTS
  - MANAGEMENT INFORMATION SYSTEM
  - IMPROVEMENT OF PRODUCTIVITY
  - PRODUCT DIVERSIFICATION & ADAPTATION

- COMMON AREAS
  - TRAINING IN ALL ASPECTS OF INDUSTRIAL OPERATIONS
  - RESEARCH & DEVELOPMENT

SOURCES OF FINANCING I

UNDP-IPF is the major source for UNIDO projects and allocated by UNDP in accordance with the priorities set by Governments. It is programmed every five years and therefore established well in advance.

SIS is an important source for projects which could not be planned in advance and are in response to urgent and short-term needs of Government and/or industry. SIS financed projects normally involve 3-6 months expert assistance.

UNIDF comprises of General Pool and Special Purpose contributions. General purpose funds can be allocated at the discretion of UNIDO. However, they are rather limited and preferably utilized to identify larger projects which could be financed from other sources. Special purpose contributions cover projects specifically identified and found acceptable to donor countries or bodies.

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SOURCES OF FINANCING II

SPECIAL ALLOCATION FOR

IDDA is a sum of US$ 5 million a year earmarked for special projects in Africa.

COST SHARING For specific large-scale projects it is increasingly becoming the practice for the Governments to provide the local currency component while UNIDO providing the foreign exchange component.

PROJECT FORMULATION

① REQUEST : A request which may be in the form of a project concept should be submitted to UNDP through a co-ordinating body which is the nominated ministry for national projects or an intergovernmental body at regional or sub-regional level.

② PREPARATORY ASSISTANCE : PA is the activity through which a project can be specified in a substantive manner. During PA, UNIDO staff and international experts work together with the Government counterparts in the country concerned. The output of this activity is normally a well conceived technical assistance project.

③ ELABORATION OF A PROJECT DOCUMENT : A prodoc should include a clear definition of project objective and development objective. The details on relevance of the project to the national, sub-regional or the regional plans should be brought out. UNIDO and Government inputs should be detailed, including the job description of international experts and specifications of equipment (if any). The project document, in the case of UNDP financed projects, has to be mutually agreed by the Government, UNDP and UNIDO.

Objectives of the Seminar

The Seminar is designed to promote the manufacture of equipment including components and spare parts in Africa on national, subregional or regional basis. The approach in this objective is to keep the investment to the minimum and this could be achieved by using the existing resources in terms of men and materials to the maximum extent. The consolidation of existing facilities as well as marginal supplementation could go a long way in the first instant.

In developing these schemes, the assistance would thus be needed in:

- Planning the manufacturing schemes;
- Exploring the markets to implement a reasonable standardization and thereby cater to extended market areas;
- Implementation of the manufacturing plans.

It may be an eminantly suitable exercise to undertake standardization of components and spare parts in as many as possible of the countries in the region. This type of a regional network plan on a continuing basis may lay a sound foundation for promoting local manufacture.

The speakers, experts in their own right on the subjects they will dwell on will bring up issues and possible solutions. UNIDO would be very happy to receive your reaction on the route that would be most appropriate for Africa to follow so that UNIDO assistance can be designed in its support. In summary, it would be most fruitful if at the end of our deliberations we could clearly identify areas in which UNIDO assistance could:

1. Help consolidate your existing resources in the manufacturing sector to better serve the needs of telecommunications industry; and
2. Identify such critical areas in which assistance, however little, could yield important benefits - a typical example could be design and production of inter-phases for different system which will enable a more integrated regional telecommunication system.

Paper No. 3:

Notes on the application of plastic films in agriculture

Plastic films have many uses in agriculture and of the various plastics films available polyethylene is the most commonly used for the following reasons:

(i) It is one of the cheapest plastics per unit area;

(ii) It is made in thicknesses of from around 100 gauge (one thousandth of an inch 0.001" or 25 microns) to ten thousands of an inch (1,000 gauge, 0.01" or 250 microns). Cost is directly related to thickness;

(iii) It is made in seamless widths of 10 metres or more;

(iv) It is non-toxic and biologically inert (i.e. not attacked by bacteria or fungi) and resistant to most aggressive chemicals. Even when buried in soil it has an indefinite length of life.

Cost of polyethylene films

It is understood that polyethylene film is being manufactured in a number of African countries in varying widths above 1.0 metres. Wider sheets than those available would need to be fabricated by heat-sealing.

The current prices of polyethylene film vary widely and need to be ascertained for different ranges of film thicknesses, e.g. 250 microns and 25 microns.

Notes on major agricultural applications

Crop protection

(i) Greenhouses are usually clad with clear (translucent) film in thicknesses of from 125-180 microns. Clear polyethylene films are slowly weakened in sunshine by an ultra violet light fraction of the sun's energy, hence manufacturers of greenhouse films incorporate ultra violet light absorbing chemicals during manufacture. Ultra violet light inhibited polyethylene films are available which will last for at least 3 years even in the sunniest climates.

The supporting structures of most greenhouses usually cost considerably more than the plastic itself.

Greenhouse environment can be modified in several ways - e.g., by using white-pigmented films to reduce internal temperatures, or by shading with whitewash on plastic shade netting.

(ii) Tunnel covers

Raw crops can be protected by thin (30-50 micron) plastic films stretched over supporting heaps of galvanized wire or bamboo. Such protection is inexpensive and the technique can be used to extend the cropping period, or even to protect plants from bird or animal predation.

(iii) Shade areas

In high-light areas structures providing shade can be made from plastic more cheaply than from any other material. Black plastic is used since well-made black film containing about 2 per cent of finely divided carbon is very durable in sunshine.

Because polyethylene is light in weight it can be supported above the crop on a lattice of tensioned wire supported by round-pole timber uprights.

Plastic reservoirs, water storage, canal linings

Make use of films of about 250 microns thickness which are available in seamless widths of 10-12 metres (narrower widths of film could be heat-sealed in the factory to minimize jointing outside when the films are being installed).

For earth reservoirs the wall-slopes should not exceed 3 1/2 horizontal to 1 vertical so that, after installation, the plastic membrane can be covered with a protective layer of soil, to a depth of 20-25 cms.

Membranes in canals are usually covered by bricks on interlocking concrete slabs - then wall slopes near to vertical can be used.

In termite areas, insecticidal protection of the membrane may be required.

Mulching with plastic

Mulching is a technique whereby the crop is grown through a thin plastic film on the soil surface. Sometimes quite remarkable yield increases are obtained. Polyethylene films of from 25 microns thick are generally used.

Potential advantages of mulching are:

(i) Conservation of moisture;

(ii) Black films give complete weed control;

(iii) In wet climates leaching of fertilizer is reduced;

(iv) Soil temperature can be modified - a clear film will increase soil temperatures. A white-pigmented or aluminium coloured film will reduce soil temperature;

(v) Plastic mulches allow crop roots to ramify in the upper surface of the soil - the most fertile layer.

Grain storage

Polyethylene film in the form of sacks in sheeting lends itself to grain storage applications. Large stores can be made by lining earth silos (pits) or cylinders of metal mesh with polyethylene films - usually in the range of 125 microns thick.

Animal shelters

Black polyethylene sheeting can be used as a low cost substitute for corrugated iron or asbestos sheeting. Films with a thickness of 125 or 150 microns are adequate.

Heat-insulated buildings can be made by sandwiching an insulating material (e.g. glass fibre, straw board, coconut matting) between two sheets of plastic films. Such structures have been used for poultry houses - which can be economically air-conditioned in hot climates. They are also used for growing mushrooms in Europe.

Some miscellaneous uses

Pots for plants. Polyethylene film pots or bags for growing plants have now largely replaced traditional clay pots in plant propagation. Black film is used for durability and the thickness used depends on the size of the containers.

Banana shrouds. It has been found that a bag of thin clear polyethylene film put over the developing fruits of banana increases crop weight and prevents damage to the skin as the fruit matures. Thinnest available clear film bags are used.

Grafting tapes. When trees are grafted on the rootstocks (e.g. citrus, prunus, pyrus, malus) strips of polyethylene film about 40-60 microns thick and 2 cms wide are preferable to traditional tying materials. Plastic strips are waterproof and the fact that polyethylene is permeable to carbon dioxide (produced by growing plant tissue) may speed up the union of stock or scion.

Fruit protection. Protection from attack by birds and insects can sometimes be obtained by enclosing individual fruits in thin (and consequently cheap) clear polyethylene film bags. The technique is used particularly when unblemished fruit is required for export markets.

Paper No. 4:

Production and processing of natural rubber

With a population of 80-90 million people the potential local market in Nigeria for market products is large and sufficient to support a prosperous rubber manufacturing industry oriented largely to the domestic market and to those of neighbouring African countries.

There is a rough sound figure that the per capita consumption of rubber is 1 kg of rubber for every US$1,000 GNP per capita. Thus in the Peoples Republic of China with a GNP per capita of US$260 consumes 395,000 tonnes of rubber or 0.31 kg per capita, and in Indonesia with a GNP per capita of US$530 the consumption of rubber is 81,000 tonnes or 0.59 kg per capita, and in the USA with a GNP per capita of US$12,820 consumes 2,657,000 tonnes or 11.56 kg per capita. And there are similar figures for other countries.

I understand that a sound figure for the GNP per capita in Nigeria is about US$1,000. This gives a domestic consumption of rubber goods of about 80,000 tonnes of rubber. However, in addition to satisfying the local market there could be a target for the conversion of a larger proportion of the locally produced natural rubber into products for export either overseas or to neighbouring African countries. This will give not only increased foreign exchange from the value added to the raw material currently exported but also increased employment with all that entails. A determination to drive the rubber products industry forward as a spearhead for the expansion of resource based industries could with the necessary government support and fiscal incentives achieve an increase in exports satisfying a much larger proportion of the total world market.

I think that it is appropriate that we start by considering the natural rubber supply/demand position vis-à-vis that of synthetic rubbers particularly in relation to Nigeria's 4th development plan involving increased production of natural rubber to 100,000 tonnes of rubber a year, and also of increased industrialization with natural rubber as an important natural resource.

To set the scene let us first go back to the 1960's just 20 years ago when there appeared to be three main issues clouding the future of NR. (1) First was one of price, synthetic rubbers were being produced at relatively low prices from very cheap oil feedstocks and were profiting from economies of increased scale of production and from new technology; and NR, as a labour intensive industry, could only envisage increased costs and there were forecasts of the programme erosion of its competitive positions. (2) Second although NR was still the foremost general purpose rubber there seemed to be a good chance that the research and development in polymer industry, which had been so successful in the 1930's, would produce a wonder rubber which would outperform NR. (3) Third from strategic reasons the concentration of production of rubber in SE Asia favoured a synthetic industry based on oil.

Today the picture is quite different. The price of oil has increased manifold and the cost of feedstocks has increased as a result, while increased productivity for natural rubber has been more successful in holding down costs than could have been hoped. No wonder rubber has appeared and the possibility now looks remote. Finally oil supplies are also susceptible to political events.

Throughout the 1970's and at the beginning of the 1980's there was a growing and ultimately a strong feeling of confidence among natural rubber producers that increasing supplies of natural rubber would be required to meet world demand and steps were taken to meet this requirement. These involved the planting of rubber in new areas and replanting existing lower yielding varieties of trees by higher yielding ones and the drawing up of plans, for further increases in rubber production in the 1980's. This is reflected in the 4th Nigerian Development Plan with the projected planting of 11,600 hectares of new rubber and rehabilitation of another 8,100 hectares.

In the longer term the prospects for NR appeared even rosier as the finite resources of oil were progressively used up.

These increased supplies of natural rubber would be required not only to retain its then present portion of the overall market for natural and synthetic rubber of approximately 32 per cent, but also to satisfy an additional requirement resulting from an increase in this percentage and reflecting developments in technology affecting the relative position of natural and synthetic rubbers as demonstrated for example by the trend towards radial ply types. The figure of 32 per cent is not a magic figure it merely reflects the amount of natural rubber produced.

This confidence was reinforced by the world wide International Natural Rubber Agreement set up in 1980 by both consuming and producing countries alike to provide an international price stabilization mechanism for natural rubber.

For consumers the agreement provided the prospect of secure and adequate supplies of NR at fair and reasonable prices. For the producers it provided the prospect that they would receive at least a minimum price for their rubber and thus confidence that in times of world economic disarray the price of natural rubber would not again fall to extremely low values bringing suffering and starvation to small producers.

I am sure that in 1980 when the machinery was set up no one anticipated that a year later by the end of 1981, the price of natural rubber would have fallen below intervention levels. The subsequent prolonged slump in the price of natural rubber is causing some natural rubber producers to question their attitudes towards expansion of production and to wonder whether increased investment in output would not be better directed elsewhere. Thus in Malaysia, a major producer of NR has announced that, after a period of years when NR had been progressively replaced by oil palm, their target is 80 per cent oil palm and 20 per cent NR and others are following suit. This decision has been taken on the grounds of the much greater profitability of oil palms per hectare. The new enemy for NR is not synthetic rubber but whether greater profit can be reaped from the land with an alternative crop.

Given the dependence of natural rubber demand on a sluggish world economy and the related excess capacity for synthetic rubber production it is not difficult to explain the low prices of NR during recent years. But unless the confidence of producers can be maintained the full potential of increasing the growth of its supply will not be reached.

It is not surprising that there are two forecasts of the likely level of NR production by 1990. The first assumes that plans for establishing new planting areas and replanting old trees comes to fruition; this gives about 6.4 million tonnes a year. The second assumes that with a sluggish world economy and low natural rubber prices little of this will happen and gives an estimate of about 5.0 million tonnes a year.

Similar uncertainty, though with different causes, exists in forecasts of world (natural plus synthentic) rubber consumption. Forecasts have been continuously revised downwards and now it appears that consumption is likely to be around 19 million tonnes a year. These figures give natural rubbers percentage ranging from 34 per cent to 28 per cent depending on whether optimistic or the pessimistic figure is taken for NR production.

There is real cause for concern that NR will increasingly become a material in short supply and that additional sources of isoprenic rubber will be required. This could be good news for the remaining suppliers of NR but it would be bad news for the long-term future of an expanding NR producing industry.

Research over the past 50 years has already provided the means for much increased rubber production. Through selection and breeding the yield of rubber has been increased from about 4 to 500 kg/ha to over 3,000 kg/ha while yields of over 5,000 kg/ha have been obtained from new more promising materials. Extensive replanting has increased the average estate yield in Malaysia from about 400 kg/ha to about 1,600 kg/ha but there is much scope for further increase particularly in small holding which supply the bulk of NR supply.

Additionally the yield of trees can be further increased by the use of yield stimulants. This development has been already widely adopted by estates and increases in yield of 40 to 60 per cent are readily achieved. Improvements in other agronomic techniques such as reduction in the period of immaturity of rubber trees, the three part tree, increased density of planting, and new tapping techniques provide further increases in productivity.

Let me now turn from the production of natural rubber to the requirements of the consuming industry.

Processing

Processing is the key consideration in the manufacture of virtually every rubber product. Uniformity of processing is essential not only for consistency of the finished articles but also for the smooth flow of material through the factory. In the past when processing units were small then difficulties which occurred could be overcome at the expense of loss of production as the materials were treated to remedy their faults, but in larger units with more efficient, more complex equipment processing difficulties cannot be tolerated in the same way. These include variable viscosity with possible longer mixing cycles and non uniform extrusion; scorch and variable cure.

The demand is for natural rubber with improved cleanliness, improved uniformity and improved consistency.

The establishment of technical specification schemes for natural rubber in the 1960's was an important step in this direction. It was then clear that the competitive position of natural against synthetic rubbers was adversely affected by its relatively poor packing and the lack of technical specifications. Now about 40 per cent of world production of NR is marketed as TSR (70 per cent Indonesia, 50 per cent Malaysia).

Specifications give information on contaminants, material adventitiously added to the rubber, dirt is principal parameter, also information is given on ash and nitrogen content, volatile matter of which wet rubber skill provides problems and demands from consumers particularly tyre companies to improve tests to detect virgin rubber, PRI provides a measure of oxidation resistance (Cu and Mu). Information on cure behaviour is provided by modules, as for premium grades cure rate information by the Rheometer. Most recent development is the introduction of SMRGP by Malaysia. This results from a 60/40 blend of latex and field coagulum. This radical departure from traditional production procedures which always separated latex and field coagula is intended to encourage a move towards higher quality NR. At present 70-80 per cent TSR are in grade 20 or below but consumer requirements are for higher performance.

The purpose is to provide a larger volume general purpose TSR grade of high quality (basically TSR 10). The blending is highly beneficial in obtaining intra- and inter-batch consistency. To increase acceptability to consumers SMRGP is viscosity stabilized with a viscosity of 60-65 Mooney thus giving a rubber with easy processing characteristics. Cure behaviour is indicated by rheometer tests.

But there is continuing pressure for still further development. These are the demands. There has been severe competition in tyre industry during recent years with requirements for increased durability of tyres. This places suppliers of raw materials under pressure to provide more consistent high quality rubbers. This involves provision of better consistency in terms both of processing and final product properties. This demands better tests than dirt and of PRI as primary determinants in the current scheme. Unfortunately consumers have not been able to indicate what tests are needed and there is little doubt that most of them do not make much use of information on cure rate and viscosity already provided.

Trends in the rubber manufacturing industry involve a steady movement towards more highly automated processes. These provide (i) savings in energy and labour as batch processes are replaced by streamlined continuous processes, and (ii) increased uniformity of properties and performance of end products. Progress is however relatively slow due no doubt to the very high capital cost of equipment. This is typical of the rubber industry for example the radial tyre was clearly established in 1950's as the tyre of the future, but the high cost of conversion of cross-ply type equipment led to the major companies in USA resisting its adoption throughout the 1960's and beginning of 1970's. Now thirty years later in Europe and USA over 90 per cent conversion to radial ply tyres.

Nevertheless there is a popular concept of the highly automated factory of the future which abandons bales and involves the use of free flowing pre-compounded powdered or liquid rubbers able to be directly moulded or more radically or thermoplastic rubbers capable of dispensing with both the mixing and vulcanization stages. Here the basic motives are savings in labour and energy and improvements in quality control.

Here the recent developments of micro processors are providing the key to the design of a new generation of more versatile machines. The development is the production of mini computers at relatively trivial cost which are capable of controlling operations carried out with greater reliability and accuracy and able to be programmed automatically to adjust operations for optimum performance in response to information from sensing devices incorporated into equipment.

We can confidently predict that by the end of this decade and certainly before the end of the century that the rubber product manufacturing industry will be much more highly automated and that the new technology developed to meet its needs will involve significant advances both in equipment and raw materials.

For example it is already clear that machinery and processes will have become increasingly dedicated to the use of rubber capable of being handled as fluids in liquid or powder form. Use of such materials would permit simplification and consequent economies in transport, handling, storage and fabrication.

Powdered rubbers are not new but until recently their use had largely been confined to the adhesive industry. The prospect is of powdered rubber being metered with other compounding ingredients into rapid and low cost powder mixers and continuously fed to the hoppers of continuous mixer extruders, or injection moulding machines with savings of energy, labour and reduced complexity of operations. Capital costs are greatly reduced by the elimination of conventional warehouses, fork-lift trucks, internal mixers, sheet-off mills and so on.

In the factory powdered rubber offers alternative processing routes.

With conventional machinery - existing internal mixers and sheet-off mills can handle more material, savings in mixing costs can be considerable if a multistage process can be reduced to a single stage process. (One example in which a two stage process was reduced to a single stage process led to a 38 per cent reduction in mixing costs). Existing machinery can handle more material and so provide the possibility of savings in capital expenditure required for additional machinery. The use of powdered rubber also gives lower mixing temperatures with the associated advantage of increased scorch safety of compounds.

With machinery specifically designed for powder material. This of course enables the fullest advantages to be obtained. The first stage involves a simple relatively cheap powder blender in which the rubber is loosely mixed with the compounding ingredients including sulphur and accelerators. The powder blend is then compacted and thoroughly mixed in a further high shear rate process. Various new continuous mixer-extenders have been specifically developed for this high shear rate operation. Probably the two most successful of these new machines are the Farrel Bridge MVX and the Werner Pfleiderer EVK Machines.

The essential features of both of these machines are (i) a means for compacting the powder rubber, (ii) carrying out mixing at relatively low temperatures, (iii) withdrawing air and other volatile materials and (iv) extending precision sections.

Farrel Bridge MVX Machine. This Mixing Venting Extruder has an air operated mixing ram which feeds the mixing chamber under pressure. The vacuum vented mixing chamber contains two delta rotors tranversely above the mixing chamber which is relatively short (4 to 5D). The distribution of ingredients is done at room temperature in a premixer. Trend is to blend all powders, waxes, oils and curatives in premixed premix rubber in premixer B (to break up powder agglomerates). Feed to weigh hopper by screw feed conveyors controlled by microprocessors and then to MVX itself via the feed hopper which is a reciprocating air operated plunger which stuffs rubber into mixing chamber. The mixing chamber has two three blade rotors which counter rotated and is filled between 60 per cent and 80 per cent, so venting can occur and gases escape up the feed jacket. Then to the extruder screw - the screw can go into reverse to divert material during start up and then door closed for normal operation. The operations of different sections automatically synchronized with the output rate determined by screw speed. The machines operations can be adjusted to suit the temperature and viscosity of mixed materials and the output can be in strip sheet or pelletized form.

The whole process is ideally suited for microprocessor control with visual display of temperature, speed, power, discharge temp., output. The MVX can work fully automatically with control of screw speed to watch output, degree of mixing, and temperature of mix and scan of information every 5 or 10 seconds. Smaller production units can run continuously and the output can be of strip sheet or pelletized form.

Werner Pfleiderer EVK Machine. This machine has a built-in screw compacting and feed arrangement leading to a long (24.5D) vented extruder. It is here that mixing takes place and it relies on the special design of the extruder screw with a number of shear clamp which create intensive shear and permit flow in neighbouring flight channels.

The machines allow the mixing and direct shaping of extended products such as hose, direct covering of bead wires with Mooney viscosity of materials up to 120. If the products are then passed to a liquid curing media (LCM) bath or to a microwave curer then overall technique offers important savings. However, at present, it is more common for strip or diced materials to be fed to a conventional extender for conventional production or continuous curing of hose, cables, or profiles. Strip or diced material can also be fed direct to existing conventional injection moulding machines or via mould blanking machines to compression presses.

Experience in the industrial use of both of these machines confirm lower energy of mixing, higher output, high level of physical properties (this normally involves higher Mooney compound viscosity and higher hardness and modulus of vulcanizates). Dispersion of difficult to disperse carbon blacks are adequate but not as good as can be achieved by conventional blending.

One of the reasons why powdered rubber has not become popular is that maximum savings are only achieved in powder processing equipment specially designed for the purpose. The prospect of carbon black master batches in powder form prepared from NR latex and carbon black slurry offer much promise. SBR/carbon black powdered master batches are already available from Chemische Werke Huls and development work on NR/carbon black master batches is already at a pilot plant stage.

Cavity Transfer Mixer. A more recent development is the Cavity Transfer Mixer. This increases the efficiency of mixing by cutting the material in an extruder and turning it before subjecting it to more shear. The device is fitted as an extension to an extruder barrel and its use is not restricted to powdered materials. It is a combination of a cylindrical rotor which is attached to the output end of an extruder screw and rotates within a stator. Both units have their surfaces filled with an array of hemispherical hollows. As the compound is pushed through the CTM it simulates the cutting and turning action of a two-roll mill and ensures thorough blending and mixing and can be used in any extruder mixing process.

In view of its advantages rubber powder technology should make an important contribution to future rubber manufacturing industry. At the moment producers and consumers alike lack the initiative - there is a chicken and egg situation - where each will not move without the other. But the stepwise introduction of powdered raw materials initially perhaps communicated by consumer and the transition from conventional to continuous processing techniques appears to be only a question of time.

Liquid rubbers

Like powdered rubbers, liquid rubbers have been available for many years. Liquid castable polyurethanes have been used for almost twenty years and have shown steady growth in their use in foam, microcellular and solid articles and recently in the production of cast pneumatic tyres. Liquid butadiene, butadiene styrene and butadiene acylonitrile rubbers have also been developed.

At present the market for liquid natural rubber is a few hundred tonnes a year. It is used in adhesives, paints and inks and in the production of soft mould and prepared by the oxidative depolymerization of a solution of natural rubber. A new development has been the production of liquid natural rubber from latex and a pilot plant has just been constructed in the Ivory Coast in a programme of work carried out by UNIDO and IRCA. This involves the depolymerization of latex using a redox system - air and phenylhydrazine. The ammonia is first removed then the latex stabilized using vulcastab LS, then depolymerization, precipitation and drying. It has an appearance and viscosity of honey with a MWt between 5,000 and 20,000 depending on conditions.

Up to now it has not been possible to reinforce liquid natural rubber with fillers such as carbon black and the properties of solid articles made from liquid natural rubber are inferior to their high MWt counterparts.

Until ways are developed for self-reinforcement and chain extension the use of liquid natural rubber will be restricted to special applications and it will not challenge general purpose rubbers. In addition, the cost of the modification to produce liquid rubber is substantial and approximately doubles the cost of the raw material.

Nevertheless interest is being shown in its possible use in a number of relatively low volume applications and it is probable that it will be able to find a niche where its special properties meet specific industrial needs - in adhesives, paints, inks, as a non-extractable plasticizer (reactive) possibly for addition at latex stage to provide easier processing of rubbers as additives to brittle plastics to give greatest impact resistance for coating rubber ingredients.

The pilot plant in the Ivory Coast is currently supplying sufficient quantities for large scale commercial evaluation and during the next year a clearer picture should evolve of the industrial interest and requirement for liquid natural rubber. If there is demand modified forms of liquid natural rubber can be made available and here special interest is being shown in chlorinated liquid natural rubber particularly for paints and coatings.

In longer term a viable method of producing liquid natural rubber and improving its properties to match general purpose rubber could be of vital importance for the continued acceptability of NR. But this depends on SR developments.

Thermoplastic rubbers

The expanding use of thermoplastic rubbers is much more certain. Rubber product manufacturers have for long looked with envy at the simple one shot manufacture of products from thermoplastics. The attraction is the elimination of the expensive vulcanization process with its related scorch problems and difficulties in recycling scrap. Already there are a number of SR thermoplastic rubbers available and their growing acceptance indicates an industrial need.

Thermoplastic rubbers are having an increasing share of the rubber and plastics markets. They have a growth rate of about 20 per cent a year and this year they are expected to reach a world wide figure of over 500,000 tonnes. They have been seized upon by the rubber manufacturer as a route to high speed production and by the plastics industry because of their high impact strength. They are used in a wide range of applications footwear, adhesives, automobile components, hose, wire, cables, modification of brittle plastics, flooring, etc.

So far the greatest usage and future potential is for types based on mechanical blends of rubber and a crystalline polyolefins, as in automobile components such as bumpers and flexible panels for which materials of hardness of approximately 90 Shore A to 60 Shore D.

Other contenders for these applications are thermoplastic polyurethanes, RIM polyurethanes, polycarbonates, polyester STIC, saturated mix block styrene copolymers (Kroton 9) and fibre reinforced vulcanized EPDM.

Thermoplastic rubber blends can be tailored to these requirements by varying the proportion of the rubber and the polyolefin resin.

It is obviously important that thermoplastic forms of NR should take their place in this new technology and in a programme of work sponsored by UNIDO and carried out by the MRRDB. It was possible to demonstrate successfully that natural rubber polypropylene blends have the necessary properties and could be prepared at lower cost than their wholly synthetic counterparts.

Much of the work on thermoplastic natural rubber blends has been done with automotive applications in mind. Here one important attraction is light weight but they can be used for many other products such as pipe joints, footwear, sports goods and electrical fittings, tank and pipe linings.

The preferred method is a batch process employing Baubury type mixers. The polymers must be blended above the melting point of the polyolefin (165-175°C in the case of polypropylene) and high speed is generally advantageous.

The heat build up during mixing is considerable and the required temperature is normally reached in 2 to 3 minutes. With small scale mixers it can be advantageous to raise the temperature of the mixer by steam heating but not found necessary in 3D Baubury or Shaw K2A (25 litres). While still hot it is sheeted on a mill and left to cool as slabs 8 mm thick. It should not remain on cool mill more than few seconds otherwise it crumbles and is difficult to handle. It must not be left in lumps before sheeting as it is then impossible to granulate.

Material granulated on rotary outlet using a small quantity of talc, other methods of pelletizing such as extension and chopping can be used.

Generally all materials such as antioxidants pigments as well as two polymers added at start of mixing cycle. With blends containing more than 65 per cent NR (softer materials) partial crosslinking of rubber improves the physical properties. When a crosslinking agent is used its addition is delayed until the polymers have melted and if organic peroxide used as partial crosslinker the addition of the antioxidant is left until the crosslinking reaction is virtually complete. 0.2 parts peroxide reduces compression set and removes tackiness of softer materials. The presence of peroxide may have adverse effect on weatherability and another crosslinker should be used.

TPNR blends are resistant to ozone cracking. Small amounts of fillers are useful to make minor adjustments to properties. Carbon black gives resistance to UV light and improve mouldability as surface finish and makes antistatic and suitable for electrostatic painting. Silica improves abrasion resistance of white or coloured articles. Calcium carbonate reduces shrinkage. Relatively large amounts of filler may be used to reduce cost but this leads to increased density.

In short TPNR can be added to the list of thermoplastic rubbers which are making inroads into traditional rubber and plastics applications and also into entirely new product areas. It is more than competitive in price and properties. It can be manufactured in conventional rubber mixing equipment and tailored to specifications for automotive bumpers and filler panels.

The fact that can be manufactured in house provides an economic advantage particularly overseas where shipping of granules is more expensive but in Nigeria can correctly be made by a custom compounder for distribution within the country.

<u>Endowments and resources</u>

Let us now consider the expansion of the Nigerian rubber products manufacturing industry.

Raw materials

There is a wide variety of products requiring a wide variety of compounds and raw materials. A typical tyre or engineering compound is:

Rubber	100	parts by weight	55%	by cost
Carbon black	50	"	29%	"
Zinc oxide	5	"	3%	"
Process oil	5	"	3%	"
Stearic acid	2	"	1%	"
Antioxidant	2	"	8%	"
Sulphur	2.5	"	1%	"
Accelerator	0.5	"	2%	"

Natural rubber is available to product manufacturers in Nigeria as a natural resource and its use should be favoured compared with synthetic rubbers.

Synthetic rubber is imported. But with a developing petrochemical industry locally produced synthetic rubber could correctly become a resource in the future. A viable small plant would be of 30 to 50 thousand tonnes of rubber. This would involve the industry growing to consume approximately 100,000 tonnes of rubber.

Carbon black

Carbon black is a major item typically 30 per cent of the cost. Here again a small carbon black plant capable of producing 20,000 tonnes and using local oil should be viable as soon as the industry consumes approximately 50,000 tonnes of rubber.

Zinc oxide

Zinc oxide is already available from local manufacturers.

Stearic acid

This could be produced locally from palm oil.

Other fillers

Clay and whiting should be available locally; silicas, silicates and resins are also required.

Other chemicals

These are used in relatively small proportions but they contribute significantly to the cost. Local manufacture is not really viable as the individual quantitites are small but with expansion of the industry para-phenylene diamine antioxidants and thiazole accelerators could offer promise for local manufacture.

Before discussing other resources and requirements such as manpower, training of manpower, regional dispersal of the industry product quality and quality control, acquisition of new technology, and identification of products for development. It would be helpful to consider what is the Nigerian policy for its rubber product manufacturing industry? Or perhaps what should be its policy?

Whether its target is one of converting a much larger proportion of the locally produced natural rubber to satisfy not only the local market but also for export overseas to give increased foreign exchange and value added? Or whether its target is a less ambitious one aimed at reducing imports by their substitution with locally made products thus saving foreign exchange?

The industry is at present in a rudimentary stage of development and initially a target of expansion progressively to substitute imports and ultimately to satisfy the requirements of the domestic market and export to neighbouring African countries appears to be an appropriate one.

If this policy is adopted then it will require the industry to expand considerably and to manufacture a much wider range of products some of which will require higher technology and a wider range of raw materials.

With this as a target we can now go back and talk of the factors involved. After raw materials it is appropriate to talk about manpower.

Manpower

There is obviously a plentiful supply of labour. In most developing countries wishing to increase their exports the availability of cheap labour provides an important contribution to the cost competitiveness of the industry but this aspect is not of prime concern if the domestic market only is of importance. Many developing countries have high manning levels, high turnover of staff and high rate of absenteeism all of which militate against the efficient use of labour, but again not an aspect initially of prime concern.

However there will be an urgent need to train a sufficient number of technical staff of the required calibre particularly rubber technologists and managers. This is an ongoing requirement and demands the provision of training in schools, polytechnics and universities. For an industry consuming 40,000 tons of rubber, an annual input of about ten technologists, ten engineers, ten applied scientists, ten diploma technologists, ten technicians would be an average type requirement in Europe. Necessary for industrialists and educationalists to get together to provide a statement of manpower and training requirements.

The larger companies will no doubt provide in-house training to give requisite basic technical skills.

As the industry expands increasing numbers will be required and the output of qualified personnel will need to accelerate.

Regional dispersal

The industry is material intensive and requires large amounts of energy - electricity and oil - and of water and thus its natural development would be in industrial centres close to urban development. These factors together with good road and telecommunications are important in any future expansion and provide constraints on the dispersal of the industry in programmes of regional development.

Acquisition of new technology

One route is to seek foreign or joint venture companies who obtain their technology from their parent companies. These offer a good route to modern technology and equipment and to the manufacture of articles of quality particularly if foreign markets are envisaged. In addition they can play an important role in the provision of marketing skills and market entry overseas. But for domestic markets licence arrangements can provide a satisfactory alternative.

Product quality

This is an item of extreme importance if export to world markets is envisaged. But even if only domestic markets are considered there is a need for factories to be adequately equipped and staffed for quality control. The planned expansion of the industry will require upgrading of plant and machinery and quality control.

Products for development

The rubber industry world wide is dominated by the use of rubber in tyres. Almost 70 per cent of natural rubber and about 50 per cent SR goes into tyres. And if we consider other automotive uses the figure is much larger. The breakdown of world consumption is:

Passenger car tyres	27%
Truck and bus tyres	19%
Industrial tyres	4%
Retreads	4%
Latex products	9%
Footwear	4%
Belting	2%
Hose	2%
Wire and cables	1%
Other products	27%

The Nigerian breakdown will be different and to identify products within the industry suitable for development it is necessary to consider:

The market requirement, its potential;

The technology capability;

For export the comparative advantage.

Although not strictly a product premixed compound which is imported must be the first target for substitution.

Then tyres are dominant. The move to radial-ply tyres has already occurred and the cross-ply tyres are in dire straits and any new capacity in Nigeria should be for radial-ply tyres.

Precured retreads with a high natural rubber content would be suitable for both the domestic and export market.

There is an obvious domestic requirement for footwear which could be readily satisfied and here thermoplastic rubber could be important.

Belting, hose and automotive components are also targets for import substitution.

Engineering components are precision articles with high natural rubber content and high value added. These include bridge bearings, dock fenders, engine mountings.

Latex dipped goods are made entirely from natural rubber and have a most attractive export potential.

The need is for expansion and diversification into wider range of products. This will require the easy import of the necessary raw materials such as different types of synthetic rubber, rubber chemicals, fabrics and tyre cord materials, and the creation of simple flexible import procedures is important. But when the industry becomes of sufficient size the development of ancillary and supporting industries becomes logical.

The factories need not necessarily be large - except for tyres where there is larger capital expenditure and advantage in size. Smaller companies employing less than 100 workers with paid up capital of less than a quarter of a million dollars could provide a large sector of the industry certainly in the number of companies. Big tyre companies involve much more capital of tens of millions of dollars and employ 500 or more staff.

The challenge then is to expand and diversify the Nigerian rubber product manufacturing industry to satisfy more of its domestic re[illegible]ments and to reduce imports of rubber goods. The next stage of a drive to export its products would follow naturally as industry grew.

To assist to this end a technical centre with staff and equipment to provide information and expertise on product manufacture, standards and testing and especially quality control would be a correct early development. The existence of a Rubber Institute would seem to make it inappropriate to create a new centre but to strengthen it by providing adequate facilities and staff.

Paper No. 5:

NOTE ON APPLICATION OF LOW ENERGY SYSTEMS IN BUILDING MATERIALS AND CONSTRUCTION INDUSTRY

1. The building materials and construction industry represents an important area of socio-economic activity in a developing country being primarily related to the basic needs of acquiring shelter. Its influence extends further to other social and cultural sectors such as education, health, community life and administration. Significant proportions of the building materials used in the developing countries are still being imported resulting in foreign exchange expenditure of considerable magnitude. From a national economic point of view, there would be enormous benefits to gain in the development of an integrated local building materials industry.

Every product is made from raw materials through sequence of operations requiring input of energy; even the commercial and administrative operations connected with the subsequent utilization of the products consume large quantities of energy. The summation of all energy needed for each operation is the "integrated energy input". To obtain the integrated energy input per time unit, one has to divide by the life time of the product. The energy savings can thus be realized by reducing the energy input or by increasing the lifetime.

2. As a matter of interest, it is proved that the integrated energy input for a normal motor car is nearly 5-6 times the total equivalent quantity of petrol that the car will consume during the whole period of its use without even considering the social costs or the transport infrastructure. This is indicative of the kind of topic on which efforts are needed to promote energy saving. The magnitude of the energy consumption can be gauged from the fact that one litre of oil has an energy equivalent of 10,000 k.cal. whereas a man is able to produce 500 k.cal. a day. The energy value of one litre of oil is thus equivalent to the work produced by a man during one whole month. Manufacture of one cubic decimeter of steel

requires 10 litres of oil. This small quantity of metal is nearly equivalent to the work of a man for one year. A brick or a glass bottle corresponds to more than one week of human labour.

It is even established that modern high agricultural inputs in developed countries by way of fertilizers, machinery, energy, transport etc. does not produce the amount of calories that are put into the ground and consequently it has a negative energy balance.

Authoritative opinions give warning that serious problems will arise before the end of the century and possibly even earlier if no solutions are found. The position of the developing countries which are continuously increasing the input of energy consequent upon the economic development programmes could be seriously affected by the shortages of energy and raw materials. The solutions to this dilemma must be provided by the technological solutions to the basic requirements.

3. An innovative technological approach to these problems has been supported by UNIDO since 1971. A typical example of a product with high energy input is housing. The broad areas of activity covered:

- Polymerized clays
- Low energy housing systems
- Low energy storage silos.

4. Polymerized clays

A useful but not quite a scientific subdivision of construction materials could be: metals, ceramics and polymers.

Each of these three families of materials have common properties, metals conduct electricity and heat, ceramics are hard and brittle, polymers have low specific gravity, are poor conductors of heat and electricity, have poor temperature resistance but present large scale versatile mechanical properties. They can be rubbery, visco elastic, rigid though elastic.

At the Free University, Brussels, experiments have been conducted on a pilot plant scale to employ low energy technologies for polymerizing the clays. The experiments included kaolinitic and lateritic clays. The process uses only 20 per cent of water and an alkali like caustic soda - NAOH or Lithium hydroxide or lime depending on availability. In Europe, caustic soda is available very cheap and various concentration could range in 5 per cent or so. The clay dough can be converted into shapes of brick or blocks of desired sizes by hand presses or even the conventional extruder system - if so desired from the point of view of production output. In the existing brick kilns the existing system of brick moulding can be continued to be employed. These moulded clay forms are exposed to temperatures of 80-85°C. For such temperatures the existing system of heating is possible to be employed but it is not necessary and it is in fact possible to use the solar energy. The time of polymerization depends on the temperature to which the moulded clay is exposed to usually a few hours (up to 24 hours) but at higher temperatures of 120-130°C it can be in minutes. The solar heating system which is central to the energy saving objective is quite simple and in the pilot scale an inexpensive system as detailed below could be adopted:

4.1 Solar system: A tin or aluminium plate available from any existing operation such as printing would be adequate. The plate with a primer on it can be easily painted black to serve as a black body. The black body has to be covered by a transparent sheet which could be a cheap polyethylene clear film which normally has a life of up to 2 years or a Tetlar which is rather expensive but may have a life of up 20 years or even glass which has the disadvantage of being breakable. Air circulating on the black plate continuously removes the heat absorbed and it is made to pass over stones which are usually of definite dimension to enable air flow with least pressure drop but absorb maximum heat. The stone boxes act as a heat sumps which enables supply of heat continuously for polymerization of the clay for the required period of time. The system of heat storage could be underground with insulation by foam polystyrene to control any losses of heat. Counter current system of heating and cooling has to be employed to enable a continuous supply and an efficient heat delivery, a co-current flow will not work. Normally it is not at all difficult to reach a temperature of 85°C. However, higher temperatures are also attainable by supplementing the solar system of heating with auxiliary firing if the situation so demands though this is not necessary for the process. The solar energy system may cost around US$13 for m^2 of the surface required.

4.2 Adoption of the system for bricks and blocks: Before considering the adoption of this scheme, it is necessary that a short survey of the country including geological assessment of its clays and their properties is undertaken. In practically all cases it is advisable to obtain the samples of clay and have them analysed and tested in an experienced laboratory which can only thereafter develop a scheme of production. The quality of clay determines the quantity of water and alkali to be added whereas the temperature to which the clay moulds are to be exposed to will determine the polymerization time. These have to be developed for each clay in the laboratory before undertaking production on the field.

The process and scheme is amenable to adoption to the local conditions and needs. Depending upon the climatic requirements different pigments could be added to produce for example white coloured houses. The materials produced have the benefit of complete dimensional stability. The dimensions of the moulded clay do not undergo any change during the course of polymerization. If the moulding is uniform and good quality the product should be correspondingly the best quality. Furthermore, the process does not have any wastage unlike in the conventional kilns whose overburnt or underburnt as well as deformed products are quite common to come by. It is essential, however, that the dough which is at room temperature must be moulded in 10 to 15 hours for best results. The dough can contain foaming materials to produce products with varying densities which are highly desirable in construction of tall buildings.

4.3 Reinforcement of clays with fibres: The fibres holding potential for reinforcement of clays can be divided into the following three categories:

(i) High technology fibres: these include glass, polypropylene fibres, aramide, carbon fibre, etc.

(ii) Textile fibres: these include cotton, wool and flex, etc.

(iii) Waste fibres: these are thick and cannot be spun, such as coconut fibres, baggasse, etc.

The first and second category are most expensive and have other high value uses such as industrial and apparel. From the point of view of cost the third category would be the most suitable, without fatigue the natural fibres could be as strong as the glass fibre. Trials on clay fibre composites are underway with interesting results. In the meantime, fibre from coconut has been bonded with phenol formaldehyde resin very suitably and can be used for panels or ceiling board. This will utilize the local materials to the extent of over 80 per cent of value and displace imports up to that value accordingly. These composites help avoid bacterial attack on the natural materials, improve brittleness and make them tough and impart ductile properties to ceramics. The local building materials may be tried in due course, these include national products such as latex.

5. Low energy housing systems

In most developing countries low cost housing schemes enjoy the highest priority and in quite a few places these have become synonymous with low quality housing.

Extensive programmes on low cost housing using less raw materials with low energy input were accordingly launched by UNIDO in mid seventies. The investigation led to the deployment of composites which met the requirements and the objectives set.

5.1 Composite systems: Composite materials are developed from components on the basic assumption that the properties of the whole are different from and represent more than the sum of properties of the components. The composites have one more important property. The relationship between the components are more important than their intrinsic properties in determining the nature of the whole. The composite acquires a certain degree of independence from its components. Accordingly a component having similar relations with the others may act as a substitute for the original in spite of its being different. Some examples may illustrate this aspect.

An insulating material is composed of a binder like a polymeric matrix and air inclusions. The composites have insulating properties that cannot possibly be obtained from the separate components. It is also possible to substitute materials such as polystyrene or polyurethane or any other polymer in the matrix. In the same way it could be possible to replace air by any other inert gas without changing very much the insulating properties.

A fibre reinforced composite is developed from a matrix - polymer, cement, gypsum and a reinforcing fibre. The mechanical properties of a fibre reinforced polyester do not have any comparison at all with the properties of either of the components. It is now possible to develop alternative composites with other matrices and other fibre reinforcements, without changing the principle of the composite system. An insulating plate of foamed polyurethane with its protective skin can insulate 25 times better than a brick wall of the same thickness and its weight is 750 times less. The application of composites systems allows to lower drastically the amount of raw materials and the non-renewable energy in doing the job.

It is quite evident that a methodology has been discovered in development of materials which overrides the traditional dependency of materials and properties. The raw materials used, till now, in construction have been limited to restrictive classes such as metals, ceramics, glass and polymers. These materials have specific properties which are suitable for certain application and would need improvement in others in order to be utilized in the best manner. The materials as an example are either good or bad conductors of electricity and heat, the semi-conductors are elaborated materials. It is general experience that some important needed properties are completely absent such as the absence of unbreakable, insulating temperature and crash resistant material for dishes. In general, the flexibility of changing properties of materials has been greatly limited.

It should, however, be noted that nature has always used the principle of composites - in structural applications: wood, bones. The model of reinforced polyester or metallic alloys, etc. is the human imitation of the structures existing in nature but the exploitation of this principle in general terms and to the grass roots level has been neglected. There is vast scope for exploitation of this concept and its application is oriented to suit the environment and availability of local resources in the developing countries. One would be faced with choice of materials which have increased their technological and intellectual qualities hundred of times. But their properties have no longer to be determined and have to be reinvented for each application.

It is recognized that for the development and design of products out of the composite materials, new creative methods have to be worked out. Innovation in composite systems is not limited to adding and assembling elements. On the contrary, development of composite products tries to study and to understand global and integrated problems and to consider the components in their mutual relationship and the structure as a whole. Even the traditional strength calculation has to be reconsidered. In most cases the composite structures do not fail by lack of tensile or compressive strength of the material they are made of, but the stress concentration, influence of the environment, lack of fracture energy or by fatigue. These factors are usually more dependent on structural information, interactions and relations between the different components than on the specific properties of the material itself. In most cases the design is more important than the strength of material and instead of regarding the structure as an assembly of components suitable for calculation, one should consider and study it as a global structural entity adapted to experiment.

5.2 House construction: Having this principle in mind, UNIDO planned a housing programme for the developing countries. The construction had to meet the requirements of low cost locally constructed, low energy and material input, high construction speed, use of non-skilled labour, integration of locally available materials.

A series of demonstration projects were carried out in Cyprus, Uruguay, Ecuador, Mexico and Burkina Faso, introducing each time new technical and architectural variables such as sandwich construction, design improvements, mechanical strength of construction, variation in dimensions, use of natural fibre reinforcement, etc.

The performance of fibre reinforced material in a given application depends to a large extent on the method of manufacture. Considering the requirements, an appropriate system of filament winding came out as the most adequate method to construct the insulated space of air needed for the building of dwellings. Among the several building systems designed using composites, the one which is simple in design equipment and utilization of materials is that of the "Patfoort Building System". It allows to obtain a maximum strength of the structure, using a minimum amount of raw material. The shape of a housing module has been found to be perfectly suited to the process of filament winding. Composite construction of the walls can combine strength with high insulating properties. The high technology filament winding process has given the proof of being extremely adaptable to simplification, high quality pieces have been made on a hand driven machine.

The mound shell have been manufactured on a locally made retractable rotational mould supported by an axle driven by hand by means of a crank and a reduction devise. The fibres pass in a resin bath, laterally moving along the rotational mould distributing the wet reinforcement on the mould. The resin bath is a wooden support with a throw-away polyethylene sack containing the resin. The excess of resin is pressed out by the adjustable strips that permit at the same time to adjust tension on the fibres.

5.2.1 Structural behaviour: It is worth to examine the behaviour of the structure in sustaining loads. The structure is strengthened at both ends by two flanges. They have a dual purpose: they are useful in bolting the end walls at one module to the other. Structurally they act as a diaphragm providing rigidity to the cylindrical shape.

Beam action in the longitudinal direction is negligible, because the module does not span between the flanges but is resting and is sustained over its whole length on a bed of sand and stones. In that sense strength and rigidity is only required during transport. On the contrary, the membrane action, typical in shell structures transmit load axially, which is the strongest cross sectional shape in this respect being the circle. The greater the deviation from the circle the lesser is the structural strength which the better space demands. The flanges act in this respect as strengthening elements. Present technology allows to adapt the quantity of strengthening elements and to improve their design and to augment their dimensions. In that way it has been possible to obtain a fantastic increase in rigidity and to eliminate any sagging after removal of the mould. Using this design method it has been possible to obtain even rectangular shapes, using of course more material to obtain the same strength. The cross section can also be considered as an arch; the lateral stresses of the upper arch are taken over by the lower arch working as a flying buttress.

Paper No. 6:

CONCEPTS IN BIOFUELS DEVELOPMENT

1. Agricultural wastes and residues

(a) What they are

- Field residues which remain after harvesting a crop. Examples: cotton stalks, cereal straws, corn cobs.
- Food processing residues which are generated as a by-product at a central location. Examples: coffee husk, bagasse, nutshells, rice husks.
- Organic wastes, usually liquid or high moisture waste streams generated at household, community and industrial levels. Examples: wastes from livestock, canneries, dairies, abattoirs, etc.

(b) How they can be used as fuels

- Domestic sector: Use of domestic stoves capable of burning field residues as a replacement for wood and charcoal. Small "biogas" plants for the conversion of organic wastes to methane fuel gas and fertilizer. Small-scale, decentralized charcoal production from field residues.
- Industrial and agro-industrial sectors: Use of field and food processing residues in solid fuel burning appliances, boilers, kilns, furnaces, etc. for process heat steam and power. Industrial-scale manufacture of charcoal briquettes. Anaerobic digestion of organic wastes producing fertilizer and methane gas for process heat and steam and also power generation. Gasification of field and food processing residues for irrigation pumping and power generation.

(c) Why they should be used as fuels

In many countries wood and charcoal have always been the traditional fuels for domestic cooking and heating. A significant portion of the population of developing countries are hopelessly dependent on these two fuels. Their acquisition and use is characterized by primitive and wasteful techniques of charcoal making and of fuel burning in domestic stoves. In former times regeneration of tree-covered land ensured an adequate, sustained supply of woodfuel, but rapid population growth in recent years has put such pressure on forest resources as to cause uncontrolled deforestation and desertification. The welfare of those people living in regions affeted by this pattern is largely dependent upon the supply of fuel. Provision must be made to ease the burden of collecting fuel and to prevent further destruction of remaining forest lands. Agricultural residues are an alternative to wood and wood charcoal for domestic fuel. Kerosene and bottled gas have replaced traditional fuel in urban areas of the more advanced developing countries but they are too expensive for their use to become widespread.

In net oil importing countries, where the purchase of petroleum-derived fuels leads to a serious drain of capital resources, substitution with indigenous fuels, such as agricultural residues, can result in savings of valuable foreign exchange. The greatest opportunities for effecting a savings of imported fuels are to be found in the industrial use of indigenous new and renewable fuels.

(d) <u>What are the problems?</u>

- Alternative uses for field residues: What, in the first world nations may be waste material, can find uses as livestock feed and, to a lesser extent, as a building material in developing countries. Some residues are simply returned to the land and their use as fuel could result in the loss of a nutrient supply to the soil.
- Acquisition: Field residues can be scattered over wide areas; their collection is expensive and logistically difficult. The seasonal nature of the availability of residues necessitates storage during which organic materials of this type tend to degrade. The stored material is a fire risk and potential cause of pest infestation and disease propagation.
- Development and acceptance of new technologies: When burned on an open fire, residues tend to smoke so new designs of stove are required if wood

and wood charcoal are to be replaced by raw resid· . Some residues can be converted to charcoal; this requires the introduction of new but simple charcoal kilns. For the industrial and agroindustrial sector investment in solid fuel firing capability is expensive since the plant is larger and more complicated than would be required for gas-oil firing of equivalent thermal output. Furthermore, greater control of the combustion process is required to avoid "slagging" - fusion of the ash to form a glass-like material which causes blockage.

- Pollution: Where this is an issue additional problems of cleaning up solid, liquid and gaseous waste streams need to be contended with, particularly in industrial applications.

(e) What about densification?

Frequently put forward as a solution to many of the above problems this involves either pelletizing or briquetting agricultural residues to increase bulk density. Whereas densification can alleviate problems associated with collection, transport and storage, it can substantially increase fuel cost to the user of the briquettes. Although several densification processes are available and equipment manufacturers relatively plentiful, equipment field trials have, to date, met with few successes.

(f) UNIDO's role

Domestic sector

- Support of technical programmes involving the design, fabrication and field testing of efficient stoves capable of burning agricultural residues.
- Support of technical programmes involving the development of hardware for the small-scale conversion of agricultural residues to charcoal fuel.
- Demonstration programmes for proven, new hardware capable of using agricultural residue.
- Surveys to quantify the resource base and to identify the extent to which agricultural residues can replace wood and charcoal as household fuels.

- Assistance with the development of fuel supply mechanisms.
- Strengthening infrastructure required for the fabrication of new hardware.
- Design of appropriate hardware production systems.
- Assistance with the development of a marketing strategy for stoves and charcoal kilns.

Industrial sector

Preparation of technical/economic feasibility studies covering (but not limited to) the following issues:

- Collection systems for field residues;
- Upgrading of existing agricultural residue burning facilities. Examples: cogeneration at sugar mills and other food processing plants, which already burn residues, leading to export of surplus power;
- Conversion of existing gas/oil-fired facilities to solid fuel combustion. Examples: retrofit of boilers and kilns with external combusters and gasifiers capable of burning agricultural residues;
- Installation of a new plant. Examples: continuous kilns for the production of charcoal with waste heat recovery and briquetting the charcoal product. Anaerobic digesters for the conversion of liquid waste steams to organic fertilizer with methane recovery for power and process heat/steam. Gasifiers coupled to engine-generators and engine pumps.

2. Charcoal

(a) Background information and justification

In many countries wood and charcoal have always been the traditional fuels for domestic cooking and heating. A significant portion of the population of developing countries are hopelessly dependent on these two fuels. Their acquisition and use is characterized by primitive and wasteful techniques of charcoal making and of fuel burning in domestic stoves. In former times regeneration of tree-covered land ensured an adequate, sustained supply of woodfuel, but rapid population growth in recent years has put such pressure on forest resources as to cause uncontrolled deforestation and desertification. The welfare of those people living in regions affected by this pattern is largely dependant upon the supply of fuel. Provision must be made to ease the burden of collecting fuel and to prevent further destruction of remaining forest lands.

UNIDO is supporting charcoal projects which encourage the rational and efficient use of forest resources. To achieve this goal UNIDO consultants are assisting Governments to introduce kilns to replace traditional, inefficient earth pits for making wood charcoal, and briquetting techniques to utilize the unavoidable charcoal "fines", which would otherwise be wasted.

(b) Charcoal or wood?

Charcoal has twice the potential energy per unit weight as air-dried wood but 70 to 80 per cent of the energy in the wood is used to produce the charcoal. Charcoal, however, is cheaper to transport and store; it can be used for cooking with greater efficiency and more convenience and does not produce so much smoke.

For small-scale use, whether it is better to use charcoal or wood fuel is an issue which depends on several factors including:

- The combined efficiencies of the charcoal making process and charcoal stoves, compared to the efficiency of the wood stove;
- Whether the fuel is intended for use in rural or urban areas and the transport distance between source of wood and area of use;
- Whether air quality is an issue.

Traditional methods of utilizing wood for fuel either directly or via charcoal have evolved over a long period and what has been developed is usually appropriate to the prevailing cultural and economic conditions. UNIDO's goal is to work within the existing pattern of wood utilization to make available knowledge and improved techniques capable of saving energy and of making fuel available at reasonable cost to the consumer.

Charcoal's convenience make it the preferred fuel for rural industry such as blacksmithing but larger industrial fuel users such as boilers can have the capability of burning wood with adequate efficiency making an intermediate charcoaling step redundant. Where there is a history of charcoal production and use and where the forest resource is both adequate and protected by planned exploitation procedures, the co-production of charcoal and energy may be an attractive option. Several designs of industrial retorts provide for charcoal production combined with waste heat or gas recovery for the generation of process heat or steam and electrical power.

In addition to wood, agricultural residues can be used as feedstocks: coconut shell charcoal is considered superior in quality to wood charcoal.

(c) UNIDO's role in improving charcoal production

- Introduction of improved kilning techniques. Aside from the traditional earth kilns, charcoal-making kilns fall into one of two categories:
  - Brickwork or
  - Steel.

Both can yield up to 20 per cent charcoal (based on dry weight of wood feedstock) which is double the yield achievable with earth kilns. Brick kilns have the advantage of using locally available materials. Steel kilns on the other hand require imported material and the use of a metal fabrication facility, but they offer portability and shorter carbonization time.

- Provision of training and laboratory facilities for charcoal testing and determination of kiln efficiencies.
- Introduction of charcoal briquetting technology.
- Feasibility studies for industrial charcoal producing facilities covering:
  - Investigation of feedstock supply
  - Domestic and export market surveys
  - Site-specific studies for proposed new facilities.

3. Gasification of biofuels

(a) What is gasification?

Gasification is the conversion of a solid fuel to a gaseous fuel. It takes place inside a "gasifier" or "gas producer". The resulting gaseous fuel, known as producer gas or, more frequently now, low-Btugas, can be used as fuel for internal combustion engines or to replace gas or oil fuel in boilers, kilns and furnaces.

Gasification has recently received attention in association with new and renewable fuels since gasifiers can convert charcoal and also wastes and residues from agricultural and forestry activities to a useful fuel gas.

(b) How does gasification work?

Either oxygen or air is introduced into a bed of solid fuel contained in the gasifier. This air supply is controlled so that a partial combustion occurs producing a fuel gas which is a mixture of carbon monoxide, hydrogen, methane and also non-combustible components including nitrogen which, in the case of an air-blown gasifier, is present in concentrations of about 50 per cent. Many different internal configurations of gasifier are available or being experimented with, which determine how the air supply comes into physical contact wih the fuel bed. Fixed bed reactors tend to be used for small systems (50 kw and below), fluid bed reactors have application to larger gas users such as the retrofit of industrial boilers and kilns.

(c) What are the applications?

Composite gasifier-engine-generators and gasifier-engine-pumps can utilize agricultural and forest residues and other "biofuels" in irrigation pumping and remote power generation applications. Such systems are usually mobile with the three units mounted on a common skid or trailer. The gasifier requires periodic refuelling, usually a manual operation which can be accomplished without shutdown, and ash removal, which may require a daily shutdown.

Industrial gas or oil using appliances such as boilers, kilns and furnaces can be converted to solid fuel operation (employing biofuels) by retrofitting with gasifiers. Where the installed plant is relatively new, this offers an economically attractive alternative to the installation of new solid fuel firing plant. Gasifiers for this type of application tend to be larger (ten million Btu/hour minimum) and require automatic, continuous fuel feeding and ash removal.

(d) What are the problems?

Probably the most significant issue currently inhibiting the widespread adoption of gasification is the level to which the technology has been developed. Biofuel gasifiers tend to be troublesome in operation and not always capable of delivering the designed output capacity on a continuous sustained basis.

Satisfactory performance - from both technical and economic standpoints - depends on careful selection of the equipment giving adequate consideration to the following issues:

- Type of fuel for use in the gasifier: wood and charcoal (in lumpform) are ideal fuels but not always available at an acceptable cost. Where the use of these fuels may lead to or accelerate deforestation it is clearly not appropriate. Agricultural and food processing residues such as cotton stalks or rice hulls, particularly where their disposal can incur cost, are more attractive from an economic standpoint, but they are difficult to gasify. Gas exiting the gasifier is contaminated with particulate (ash, soot and tar aerosols) and vapour (steam, hydrocarbon and organic acid vapours). The level of contamination depends on the design of the gasifier (internal configuration), the extent to which it is running at or below design capacity and the type of fuel being gasified. Aside from charcoal, biofuels tend to generate copius quantities or tars (vapours and aerosols) when gasified. Removal of this tar and its subsequent disposal can be major obstacles in the way of satisfactory gasifier performance.
- Intended duty: where the task required of the gasifier system is seasonal or periodic rather than year round, as in the case of irrigation pumping

and crop drying, the proposed installation may not meet conventional criteria for economic feasibility, such as pay-back period or return on investment. Ultimately this will be largely a function of the cost of the conventional - "petroleum-derived" - fuel. Gasifier-engine-generator systems have poor load following characteristics. Slow response times and are rarely able to meet shock loads. For these reasons their use tends to be restricted to a mixed load of lighting and small prime movers where frequency and voltage control - within reasonable limits - is not too critical.

- Operator capability: for guaranteed satisfactory performance, regular maintenance must be undertaken on the gasifier, the gas cleaning system and the engine or other gas using device. This activity can require considerable time and effort on the part of the gasifier operator. Adequate skill levels must be available if these tasks are to be performed satisfactorily.

(e) UNIDO's role in the application of biofuel gasification

1. Assessment of the role which biofuel gasification can play giving consideration to:
   - National pattern of energy production and consumption;
   - Availability of potential gasifier fuels;
   - Availability of suitable applications.
2. Support of programmes which demonstrate the technology to the potential user:
   - Installation of demonstration units;
   - In-country training and overseas study tours.
3. Assessment of the extent to which gasifier equipment can be manufactured locally.

Paper No. 7:

DEVELOPMENT AND MANUFACTURE OF AGRICULTURAL MACHINERY AND IMPLEMENTS

1. Introduction

1.1 The economies of most developing countries are predominantly agricultural, with little industrialization in general and inadequately developed metalworking and engineering industries in particular. The changing agricultural pattern over the past few years has, however, created an increased demand for industrial inputs for agriculture, necessitating the local production of suitable agricultural tools and implements and machinery to meet the demand. The agricultural machinery industry is special, in that it offers a wide choice of technologies appropriate to local circumstances.

1.2 To cope with the projected population growth till the end of this century, increased production of agricultural tools, implements, machinery and allied equipment will help attain more crops and intensified industrial activity, consequently more employment. Although one of the reasons for local manufacture of agricultural machinery is to save foreign exchange, a more important reason in predominantly agricultural countries is to establish a balance between industrial and agricultural development, with the former providing support to the latter where necessary and vice versa. (The recommendations contained in the last chapter will be based on this opinion.)

1.3 What is needed in most developing countries of the world is a full range of appropriate tools, implements, machinery and equipment that takes into account the size of holdings, the farm income, the agricultural technology at the present farming level, etc. The need is for machinery that can be produced locally, i.e., simple agricultural tools, animal-drawn implements, manually operated equipment and low-cost, power-drawn machinery and implements. The following broad-based categories can be defined:

Category I: (simple) Hand tools: hoe, machete, spade, weeder, knife, sickle, axe, pick-axe, shovel, etc.

Manually-operated equipment: pedal thresher, hand sprayer, corn sheller, cassava puller and chopper, hand pump, chaff cutter, storage bins, etc.

Animal-drawn implements: plough, cultivator, leveller, ridger, seeder and fertilizer drill, pump, sugar-cane crusher, reaper, cart, etc.

Category II: (intermediate) Tractor-drawn basic implements: plough, cultivator, harrow, leveller, seed drill, reaper, trailer, etc.

Simple low-cost low-power equipment: power thresher, pump, chaff cutter, corn sheller, peanut decorticator, rice mill, hammer mill, power tiller, low-engine, etc.

The following categories apply to the more developed of the developing countries:.

Category III: (standard) Power-operated equipment: tractor, pump, harvest and post-harvest equipment (may be manufactured in a few developing countries).

Category IV: Specialized machinery: complex high-power tractor, combine harvester, special crop machinery (at present not suitable for manufacturing in most developing countries).

1.4 Requirements for agricultural tools and implements - e.g., hand tools, animal-drawn equipment, hand-operated and intermediate power equipment - will have to be determined, based on a concrete assessment of the actual national situation. Local manufacture of the selected items would be aimed at saving foreign exchange by reducing imports and also at developing local industrialization and the employment potential. However, the following preparatory measures must be taken:

- Identification of the required products including their specifications;
- Evaluation of the expected demand in numbers;

- Design development and testing of the appropriate prototype equipment and machinery; and
- Training in production methods, repair and maintenance of agricultural tools and implements as well as their quality control.

1.5 Handicrafts and small- or medium-scale industries manufacturing agricultural machinery and equipment play a dominant role in programmes for rural development. The promotion of these industries leads to an improvement in social and economic conditions and an overall balance of rural and urban industrial activities which retards migration of labour from rural to urban areas. It, therefore, appears advisable that such decentralized production units be linked to a central urban workshop to form an overall system to carry out efficient production and local maintenance tasks.

2. Design, development, adaptation, testing and quality control

2.1 The design, development and adaptation activities should be developed primarily to suit the manufacturing programme and local conditions and to assist the country to become self-reliant in matters of engineering, design and development, both in respect of improving locally available designs and adaptation of technologies obtained from abroad. Even when a basic design of a machine is available, it requires to be suitably modified and altered to suit the local conditions, the manufacture and trial of prototypes. All these activities do need adequate engineering capabilities. Therefore, these activities should consist of establishing not only the physical facilities, but also programmes for training local personnel in engineering techniques.

2.2 In the beginning, it may be necessary:

(i) To identify items which need manufacture;

(ii) To analyse existing facilities; and

(iii) To formulate projects for implementation.

The design, development and adaptation programme may, therefore, be integrated with a manufacturing plant or treated as an independent activity depending on the needs of a country.

2.3 Quality control and performance evaluation is another essential part of any industrialization programme. It serves both the manufacturer and the customer by ensuring that the product conforms with design specification and performance characteristics. Laboratory and field tests show how the designs should be altered. The quality control activities embrace different aspects of enterprise development as it involves an engineering approach to the problems of design, adaptation and assembly/manufacture.

3. Production units

3.1 Production units in all developing countries can be classified at the following technological levels:

(i) Family type (1-5 persons) - mainly manual operations; products consisting of simple hand tools and hand-operated and animal-drawn implements;

(ii) Small- and medium-scale (30-200) persons - manufacture in urban areas is mechanized, with batch production of animal-drawn implements, handtools, pumps, crop protection equipment, sprayers, etc.;

(iii) Large-scale (more than 200 persons) - machinery and equipment made with conventional, semi-automatic, automatic and special purpose machine tools on a high volume, high-precision and high-investment basis. Products include tractors, tillers, ploughs, power tillers, disc ploughs, pumps, sprayers, storage bins, etc. Plants are mostly in urban areas, rural-urban borders or industrial estates.

3.2 For all practical purposes level (iii), the large-scale unit, should presently not be considered because of the complexity of problems involved. They range from an expected availability of: large sums of money needed for investment and working capital; extensive markets to support large volume production which is frequently based on imports of selected components and special materials; and a substantial number of ancillary industries to supply parts that otherwise cannot be produced economically within the plant.

3.3 For these formerly stated reasons, our study will concentrate on the priority needs, e.g. selected hand tools, hand-operated machinery and animal-drawn equipment. Details on industries operating at the first two technological levels are given in tabulated form below:

Family type production

Product:	Spades, shovels, spading forks, ploughs, digging hooks, hoes, animal-drawn equipment.
Design:	Mostly for local need either by modifying equipment from a national supplier or by manufacturing cheap local replacements for conventional equipment.
Investment:	Very small, sometimes up to US$100, particularly in least-developed countries.
Market:	Depends solely on local need.
Management:	None (family type operation).
Working area:	100 to 300 ft^2.
Facilities:	In many cases limited supply of water and electricity.
Materials:	Mostly mild steel (MS), ENI series; occasional use of MS sheets, round and angle sections.
Machinery:	Small hand tools, e.g. hammer, anvil, chisel, hacksaw, small coal-fired furnaces with hand-operated blowers, pedal-operated grinding wheel, occasional welding, drilling and bending.
Production technique:	Objects and parts produced manually: hand forgings predominant; no application of jig tools or batch production methods.
Quality control:	Very limited.
Employment:	One to five persons; sector provides considerable rural employment.

Small and medium-scale production units

Product:	Animal-drawn implements, e.g., ploughs, tillers, hoes, diggers, pumps, sprayers, etc.; small hand tools on batch production.
Design:	Use of local design, adaptation of well-known products, indigenous design supply from a research and development centre.
Investment:	Varies from US$5,000 to US$80,000 or more.
Market:	There is a greater demand for these products, but little export opportunity except for pumps and sprayers.
Management:	Mostly run on line management; individual ownership or partnership.
Working area:	10,000 to 50,000 ft^2.
Facilities needed:	Adequate power and water supply.
Materials used:	Various shapes of grade 17 castings and various steels, e.g., EN1, EN8, EN16, EN32 and EN42, which are imported or acquired locally, are commonly used. Use of galvanized MS sheet, round, flat, angle and hexagonal sections is common; springs, bearings and hardware axe imported.
Machinery:	Power-operated hammers, presses drilling machines, milling machines, electric and gas welding sets, conventional machine tools and equipment, limited inspection equipment, electrical-, coal- and oil-fired furnaces, pneumatic systems and spray paints usually available; hand-operated flat roller benders and angle benders also commonly used.
Production technique:	Application of welding jigs and fixtures are commonly used in manufacturing; production more on a job shop basis with minimum batch size; assembly and sub-assembly often introduced to increase production, incentive schemes applied.

Material processing: Proper heat treatment facilities available; scientific carburizing and hardening.

Quality control: Inspection system in most firms: micrometers, height gauges, callipers, etc.

Employment: Generally from 30 to 200 persons.

4. Manufacturing profiles

4.1 The following profiles for the manufacture of agricultural handtools at handicraft level (re. 4.2) and of animal-drawn implements at rural small-scale industry level (re. 4.3) cover only a few selected items. A more comprehensive list of products that may be considered for local production and a selection of illustrated sketches are appended to this paper as annex I and II.

4.2 This profile covers selected hand tools, e.g., spade, hoe, fork and sickle. These simple tools for agricultural operation are mostly used by small farmers holding less than 2 ha or by gardeners. The supply of wooden handles, nails and ferrules accounts for a linkage with other industries (woodworking or local carpenters). Material specifications for handtools are SAE 1078, carbon 0.72-0.85 per cent, manganese 0.30-0.60 per cent, making it suitable for forge and heat treatment for which expert advice can improve on product quality.

Table 1

Product specifications (four selected products)

Product	Specification
Spade	Blade and shank size, overall length 20", blade size 8" x 6"; weight 1.5 kg.
Hoe (tined)	Maximum length of tine 10"; width 6"; tine diameter 1/2; weight 1 kg.
Fork	Weeding fork, 3 prongs, length 14"; width 7"; diameter of prong 5/8"; tang bore diameter 1 1/4" (min.) to 2 1/2" (max.); weight 2 kg.
Sickle	Length 9", maximum width 1"; handle 5"; weight 1/2 kg.

Table 2

Production volume (8 hr shift)

	Shop without electricity		Shop with electricity	
Product	Daily production	Annual production	Daily production	Annual production
Spade	4	1,000	12	3,000
Hoe	4	1,000	12	3,000
Fork	4	1,000	12	3,000
Sickle	4	1,000	12	3,000
Total	16	4,000	48	12,000
Manpower requirement	4		9	

The required floor area is 300 ft^2 (20 ft x 15 ft) for a shop without electricity; 1,200 ft^2 (40 ft x 30 ft) for a shop with electricity.

Table 3

Estimated cost of machinery and equipment

Hand-operated machine tools			Electrically-operated machine tools		
Description	Quantity	Estimated cost (US$)	Description	Quantity	Estimated cost (US$)
12" hand shear	1	200	1/4" power shear	1	500
Coal-fired furnace with hand-bellow-type blower 24" x 24" x 18"	1	2 200	Oil-fired or coal-fired furnace, 1/2 hp. 24" x 24" x 18"	1	5 000
Anvil with pedestal, 200 kg	1	200	Mechanical spring forge hammer, 1t, 3/4 hp.	1	4 000
Quenching tank 24" x 24" x 24"	1	300	Quenching tank 36" x 36" x 36"	1	500
Pedal-type grinder 12" wheel	1	100	Anvils with pedestal, 200 kg	2	200
Pedal-type polishing machine	1	100	Double-ended pedestal grinder, 1/2 hp., 12" wheel	1	400
Hand nibbler 1/4	1	200	Double-ended polishing machine, 1/2 hp.	1	400
Blacksmith's and conventional tools	1 set	600	Manual roll bending machine	1	200
Miscellaneous		300	Electric arc welding machine, 120A	1	200
			Blacksmith tools, 1/4" portable drill, paint can and brushes	1 set	600
			Miscellaneous		500
	TOTAL	4 200			12 500

Investment required (US$):	Shop without electricity	Shop with electricity
Total fixed capital	6 100	21 200
Total working capital	2 100	6 500
Total investment (excl. cost of land)	8 200	27 700

4.3 This profile covers the following implements: single-hand wheel hoe, animal-drawn disc harrow, animal-drawn mould board plough. These products are mostly used by farmers with 2-5 ha of land. With the necessary technical know-how, it is possible for the plants producing tools of this size to export their products. The viability of these industries in rural areas depends on the evaluation of demand by the farmers at local and national level, backed by proper feasibility and market studies. Expert assistance may be required for the feasibility study, training, product design and development, marketing and heat treatment. Linkage with other industries: foundry, forge, stockist and hardware industry. Joint venture is recommended because of the high investment requirement.

Table 4

Product specifications (three selected products)

Product	Specification
Single-hand wheel hoe	Weight 12 kg (optional: 3 hoe blades, or 3 cultivator tines, or 3 ploughs
Animal-drawn disc harrow	Weight 50 kg; discs 6-12; working width 36"; working depth 2 1/2-5"; output 0.25 ha/hr.
Animal-drawn mould-board plough	Weight 35 kg; furrow width 5-8"; furrow depth 2 1/2-7"

Table 5

Production volume (8 hour shift)

Product description	Daily production	Annual production
Single-hand wheel hoe	24	6 000
Animal-drawn disc harrow	8	2 000
Animal-drawn plough	8	2 000

Manpower requirements:	Skilled	Semi-skilled	Unskilled	Total
Direct labour (total)	29	14	5	48
Indirect labour (total)	16	2	-	18
Total manpower				66

The required floor area is approximately 40,000 ft^2 for the factory building and 2,000 ft^2 for the administrative block.

Table 6
Estimated cost of machinery and equipment (US$)

Area	Description	Number	Estimated cost
Cutting shop	Power hack saw, round bar, up to maximum diameter of 3"	1	1 000
	Abrasive cutter/grinder 1/2 hp. 8" wheel	1	800
	Hand shear 12" diameter	1	200
Forge and heat treatment shop	Mechanical hammer forge 50t (for hot forge)	1	14 000
	Oil-fired furnace with blower 30" x 30" x 15"	1	5 000
	Water-quenching tank 3 ft x 3 ft x 3 ft	1	500
	Oil-quenching tank 3 ft x 3 ft x 3 ft	1	300
	Anvil	2	200
	Blacksmith's tools	set	400
Machine shop	Pedestal grinder 12" wheel, double-ended	2	800
	Upright drill, MS 1" dia. Radial drilling machine	1	5 000
	Radial drilling machine - 3 ft arm, steel, 1 1/2" dia	1	8 000
	Lathe, max. bore 3" swing 18" max., length 36"	1	6 000
	Capstan lathe with hex turret and attachment swing 6", gap 24"	1	9 000
	Jigs and fixtures for parts		6 000
Toolroom and maintenance shop	Universal milling machine arbour 1" dia., table 3 ft x 1 ft	1	8 000
	Universal cutter grinder up to 12"	1	9 000
	Surface plate	1	800
	Gauges and tools	set	1 500
	Maintenance equipment	set	1 500
Inspection welding and manufacturing shop	Instruments, table, etc.	set	2 000
	Arc welding 250A	2	1 000
	Press brake, 10 ft long, 5t	1	6 000
	Excentric press, 35t, 4" gap	1	8 000
	Welding fixtures and jigs	set	2 000
	Manual roll bending machine, up to 1" rod	1	150
Sub-assembly	Drilling machine upright, MS up to 1" dia.	1	2 500
	Portable grinder 6" dia. wheel	2	300
	Portable drill gun 1/2 hp	2	600
	Sub-assembly fixtures	set	500
Paint room	Pneumatic spray, paint equipment, etc.	set	300
Compressor	Complete motor compressor set 300 ft^3/min: line pressure 80 psi	set	10 000
Stores	Racks, stillage, pallets	set	8 000
Mechanical handling equipment	Fork-lift truck 1t 1/2t. hoist	1	8 000
	Hydraulic pallet truck	2	800
			134 150

Investment required (US$):

Total fixed capital	388 200
Total working capital	127 500
Total investment (excl. cost of land)	515 700

5. Impressions of local situation

5.1 Unfortunately, our short stay in your country did not provide sufficient time to get better acquainted with the prevailing condition in the agricultural machinery manufacturing field and my opinions or suggestions are only based on certain observations and statements made by relevant managing personnel.

5.2 During a visit to the Centre Pilot, a UNIDO-sponsored project, I engaged in long discussions with Mr. Touré, the centre's national director, and Mr. Isekon Kante, the technical director of USOA (Usine d'ontils agricoles) in Mannou. Both of them complained bitterly about the serious shortage of electric power and raw materials needed for efficient operation. Later that evening, I had the opportunity to meet also Mr. Thennissen, the CTA of the centre, who confirmed the views expressed. He is here amongst the audience and I shall ask him to tell you later about the history of the UNIDO project and the shortcomings.

5.3 But, first, I would like to report to you that I was very much impressed by the centre's facilities, i.e., the equipment, and also the work performed in it, which includes prototype machinery (such as a water pump, rice milling machine, brick compression machine, etc.), electrical repair work (rewinding of motors) and other miscellaneous jobs ordered by customers. However, I also noticed that the facilities were underutilized. For those of you who have never seen this centre, I would highly recommend you to pay it a visit in the near future.

5.4 As regards the agricultural machinery plant at Mannou, I ca [illegible]y convey the description given to me: the factory has 7,155 m^2 of floor space, is located on 2 ha of ground and employs, at present, only 50 people though the full capacity would engage 280 workers. They allegedly are producing: hoes, machetes, sickles, ploughs, harrows, chains, hatchets, pick-axes, spades, shovels, rakes and big sickles.

5.5 Due to the aforementioned major problems, both the Centre Pilot and the agricultural machi[illegible]ry factory are operating way under their capacity; yet they are well equipped and would, through additional strengthening, fit the first two of the recommendations that I am going to present later, provided the responsible authorities request relevant assistance.

But, now, I should like to ask Mr. Thennissen to come forward and give us his story about the Centre Pilot.

6. Conclusions and recommendations

6.1 Many countries produce agricultural tools and implements at the artisan or small-scale level, but the quality is often poor because of a lack of common engineering services and basic facilities. Although a few de ng countries are assembling or manufacturing standard tractors, engines and pumps, there is almost a complete gap in the local development and manufacture of equipment in the intermediate category, such as improved agricultural implements and simple low-horse-power machines. Accordingly, UNIDO emphasizes the need to develop self-sufficiency in the local manufacture of agricultural machinery, tools and allied equipment, and renders assistance for establishing small workshops with emphasis being placed on local design and development and maintenance and repair services.

6.2 Over the past years, UNIDO has undertaken a number of technical assistance programmes in the agricultural machinery and implements sector in many developing countries. Special attention is now being paid to this sector's technology, including the development and transfer of appropriate technology, selective importing, testing and evaluation, and the acceleration of the expansion of local production.

6.3 Technical co-operation activities in the agricultural machinery industry during 1983-1984 were concerned with the improvement of national capabilities in product design, production, repair and maintenance. In Africa, assistance was provided to Ethiopia, Somalia, Uganda and the United Republic of Tanzania in the establishment of development centres and pilot plants for national design and production technology. Through the development of national capabilities in product design and production technology as well as the subsequent manufacture of low-cost agricultural machinery and implements, increased output and greater labour productivity could be achieved.

6.4 In this connection, the establishment of such a technological centre and pilot engineering workshop in Guinea could be strongly recommended. The physical facilities for the manufacture of agricultural handtools, sheet-metal products and fabricated items would facilitate training in engineering production techniques and management, and also assist in the development of local entrepreneurship at a later date. The product range is to be limited and volume, initially, on a modest scale. If this concept is supported by the Government, its implementation should take into account:

(i) Possible expansion of existing facilities;

(ii) Utilization of local raw materials including scrap iron; and

(iii) The desirability of establishing a new unit.

6.5 The objectives of such a technological centre are as follows:

- To carry out applied research designed to facilitate the designing, adaptation and development of machinery and equipment suitable for use in agricultural and rural development;
- To develop and manufacture approved prototypes, components and required technologies and evaluate their suitability for local adaptation;
- To adopt foreign designs of agricultural machinery and equipment intended for use in agricultural and rural development in this country and to publish their results;
- To conduct short training courses designed to provide practical training and knowledge to village communities in the use and maintenance of agricultural machinery and other appropriate technology devices;
- To offer consultancy services on the designing, testing and other technical aspects of agricultural mechanization;

- To act as the national link with other national and international institutions engaged in activities related to the functions of the centre.

6.6 As already mentioned in the introduction, the handicrafts, small-scale and medium-scale industries manufacturing agricultural machinery and equipment play a dominant role in programmes for rural development. The promotion of these industries leads to an improvement in social and economic conditions and an overall balance of rural and urban industrial activities which, in turn, retards migration of labour from rural to urban areas. The establishment of manufacturing units throughout the countryside can create new possibilities for employment.

6.7 It, therefore, appears appropriate to recommend the creation of a rural network of production units in areas of this country, where agricultural activities are concentrated. To this end, it is suggested to use the following approach, if so acceptable to the responsible officials:

(i) The number of family-type production units should be as high as possible, preferably one in each village, so that farmers could get minor repairs done and/or purchase new tools within the village;

(ii) Small- and/or medium-scale production units would have to be placed in some strategic location to be easily approachable from the neighbouring villages and have a capacity depending on the demand of the region;

(iii) A central workshop will act as the industrial nucleus, should directly supervise the other production units and have the responsibility of providing raw materials, spare parts, technical know-how and training to medium- and family-type units; in turn, these units may expect to get some fill-in jobs from the central workshop, yet utilizing most of their capacity for repair work and to meet the local demands for new products.

6.8 In concluding, it should be stated that, upon request, UNIDO is always ready to provide assistance to developing countries, either alone or in co-operation with FAO, in expanding existing agricultural machinery plants or in establishing new ones. Emphasis will be given to appropriate product lines;

technology and level of manufacturing; training; and the development of local engineering and technological capabilities. UNIDO is also able to offer assistance in developing appropriate projects, including the preparation of the initial proposal so as to obtain funding. Moreover, with the aim of furthering co-operation and exchange of experience among developing countries and promoting "twinning" of appropriate programmes between developing and industrialized countries, UNIDO is involved in proposals for an international centre for the promotion of the agricultural machinery industry in developing countries. It has prepared a project proposal for such an international centre to be established in Beijing, China, which, if approved and finances are made available, could become one of the most significant projects in this field.

Paper No. 8:

ROLE OF A SHORE FISHERY COMPLEX IN FISHERIES DEVELOPMENT

I. Introduction

Fisheries are understood as a complex of many and various kinds of activities. Basically fisheries' activities can be grouped into the following areas: 1/

1. Production
2. Supply and services
3. Handling and processing
4. Marketing.

In this paper the author presents general remarks on the shore-based fisheries activities, which have significant influence on effectiveness of the main sector of fisheries i.e. production. This topic has also been selected by UNIDO for the First Consultation on Fisheries to be held in Poland in 1987; the Consultation is to be co-organized by Central Union of Work Co-operatives of Poland.

II. Some general remarks on fisheries development

Fishing has been a major source of food for man from the early days of his existence and still plays an important rôle in human diet. Fisheries are an important part of the economy of many countries: contribute significantly to supplies of nutritionally valuable food, to employment of people and to the income of foreign exchange.

The introduction of a new legal regime over marine resources - establishing the 200 mile exclusive economic zones (EEZ) - has increased awareness of the role fisheries may play in the economy of countries which have access to marine fishery resources.

1/ Some authors also include into fisheries activities credit, savings and insurance as well as social and community services (Small-scale Fisheries Co-operatives - some lessons for the future, COPAC Secretariat, 1984).

Fishery products are highly nutritious. Fish protein is supposed to be the most beneficial to humans in terms of its easier digestability and level of utilization. In countries where there are abundant sea-food resources the development of the livestock industry is generally modest for many reasons, the main one being given above. Besides, with the same investment, the total biomass obtainable from the sea-food production far out-weights that of livestock for the same period. The cost of producing of animal protein from the sea is significantly lower than cost on land in terms of energy expenditure.

In 1982 the world fish production was 75.7 million tons. At the same time meat of all kinds amounted to 143 million tons. In terms of protein contribution of fish to the animal intake of humans (direct and indirect human consumption) accounts for 24 per cent (A. Labon).

According to FAO projections (Prospects of World Fisheries to 2000), food fish demand will increase to 100 million tons by the year 2000. Developing countries will require an additional 39 million tons in 2000 and their share in total fish consumption is expected to increase from 48 per cent in 1980 to 64 per cent in 2000. It is estimated that marine catches from conventional resources will not fulfil the projected demand for fish by the year 2000. Only a part of this potential increase in catch may be achieved through increased fishing effort and substantial part will be achieved only if better management of resources takes place.

III. Efforts to increase production through improved utilization of fish

Apart from attempts to increase the total catch through better management of resources, investment programmes in vessels etc. an important matter requiring attention is the improvement in utilization of fish being harvested. It is estimated that about 20 per cent of all fish taken from the sea and fresh waters never reach the consumer. There are thus considerable possibilities for increasing the supply of fish through improved utilization and, it seems, it would also be the least costly method of increasing supplies. There are two main situations where waste can be prevented or reduced, namely in the utilization of by-catches (of fish caught by shrimp trawlers) and by reducing losses of cured fish in tropical countries. Part of the remedy in both cases lies in providing necessary economic incentives, but the most important element in any programme to avoid waste is improvement in the on-shore handling, processing and storage facilities.

Improved facilities on shore including especially harbour services and communications will help to reduce wastage and increase marketing prospects. These considerations apply first of all to small-scale traditional fisheries, an activity that not only produces one-third of the food fish supplies to the world, but also represents the livelihood of more than 30 million people. Very often limited marketing opportunities waste and poor quality result in low returns and give little incentive to artisanal fishermen to increase their catches. The need for improvement of fish handling and marketing generally arises from the fact that mostly fish products are perishable and are produced, in case of shore fisheries, very often in locations far away from the marketing centres. Given above factors, the introduction of improved fish preservation and storage reduces fish losses by limiting spoilage and makes fish available in different parts of the country.

Without such improvements to the shore-based infrastructure, attempts to improve vessels (e.g. through motorization schemes or investment programmes) have often failed since, without better marketing opportunities and consequently higher prices (for better quality of fish products), motorization or investment programmes merely add more to costs than to revenues. Requirements to improve the situation are much the same as for more industrialized fisheries, e.g., facilities to handle and dispose of the catch and also facilities for repair and maintenance of small fishing craft. Summing up the above considerations it must be recognized that: (1) possessing fishery resources alone is not enough; the design of fishing equipment and shore infrastructure is a key factor in fisheries development, (2) the fish production - processing - marketing system represents an integrated and interdependent relationship since no area can be developed in isolation.

IV. General functions and scope of a shore fishery complex

Fishing, as has been mentioned before, is a business encompassing many different aspects and many other groups of people besides the fishermen. Fishermen play the essential role in the production side while other groups of people are involved in handling, processing and marketing of the fish or provide support services such as boat building, engine repair and maintenance, provision and upkeep of ice manufacture and cold stores, fish net and gear supply and repair. Even at the simplest subsistence level, fishing is a complex activity which requires interaction within the whole community and outside.

Production

Production is the fundamental sector in the fishing industry and plays an essential role in fisheries development. The fishery resources within the exclusive economic zones create appreciable potential opportunity to develop sea food production in the coastal states. It is obvious that the fisheries development plans must be firmly based on adequate stocks of commercially valuable species. A necessary fishery resources survey should estimate the marine resource potential in the territorial waters and economic zones. This information is essential to decide on optimum fishing efforts and fleet size, the technique of fishing and adequate fishing vessels to be introduced - trawlers, purse seiners or shrimpers. Finally the adequate fishing gears and boat equipment should be defined. Usually the production sector in fisheries is least effective, basically because of the capital investment to be involved and still the harvesting costs are strongly affected by the price of fuel. One of the ways to increase the efficiency of production and income is to provide required harbour services and improved fish handling, processing and marketing systems. This is an area where the shore fishery complex can provide a useful service, the land based back-up organization.

Supply and services

The shore facilities of the fishery complex brings advantages to the fishermen through the economies of scale realized through fuel, ice and fishing equipment supplies, dockside services, infrastructure for repair and maintenance of vessels. Supply of fuel and ice are the essential activities of the fishery complex since these inputs are required daily. Fuel can be bought in bulk and then distributed at the complex to the fishermen whilst ice may be manufactured on site and supplied to the fishermen as well as to the fish processors and vendors. It is the same with other necessary dock-side services like water and electricity supply or berthing services. The other area in which shore fishery complex can assist fishing efficiency is the provision of boat yards and repair facilities for craft and engines. Other activities which might be considered would be supply of fish nets and gear and fish boxes. The improvement of fish net manufacturing can significantly increase the catch, while introduction of better fish boxes construction can facilitate handling operations and improve quality of fishery products. As with all inputs and services the facilities offered should be appropriate and adequate to the needs of fishermen, both at present and the foreseeable future. Only a detailed survey will provide this information.

Handling and processing

Supply and service activities are examples of horizontal integration of the fishing industry. Fish handling and processing begins the process of vertical integration. Handling is an exercise in maintaining the quality and value of fish. Processing covers up means of adding value to fishery products.

The shore fishery complex can run a variety of handling services providing landing facilities, boxes, scales, water and ice and stores. This is an area often neglected by the fishermen.

Fish processing is no doubt the central link between catching and marketing and since fish is a perishable commodity, facilities for processing are important. In the processing sector a variety of different facilities can be provided depending upon the type of fish, quantity and markets. Traditional methods of fish processing - smoking, salting and drying - may be acceptable to local consumers but it must be recognized that export possibilities for such products will be limited since consumers in the countries which at present provide principle export markets for fishery products increasingly prefer frozen and canned fish. Fish directed for freezing and/or destined for marketing in fresh condition can be processed (gutted, headed, filleted and skinned as required) by hand using traditional equipment or some of the processing operations can be mechanized by introducing specialized machinery like heading and gutting machines and for some filleting and skinning machines. The sort of processing equipment should be designed after the type of fish, quantity and market demand have been carefully recognized. In any case the washing and grading operations are highly recommended both from the quality and marketing point of view. It can be easily done by hand r by special washing and de-icing machine and culling table depending upon the quantity of fish which has to be processed. Freezing requires not only equipment for freezing but also facilities for holding frozen product at uniformly low temperature and has to be operated under carefully controlled conditions to yield good products. In recognition of this fact freezing equipment and cold stores should be provided at the complex.

Fish canning is the best method to obtain a durable food product from fish but circumstances under which canned fish production may be justified are much more limited and thus not recommended at the initial stage of fish processing development. A major obstacle to canning is the cost of the container which in most cases may be more than the value of the contents. Besides the present world market for canned fish is limited to relatively few species and unless such products can be produced uniformly, both in quality and form, the opportunity in fish canning is not promising. In fact considerable technical and economic research need to be carried out before any decision is made to invest in canning facilities.

The utilization of fish offal is the last link in the fish processing activities, and is important from the economical point of view. The use of the fish offal can be made for simple liquid fodder, fish meal for feeding animals as well as for oil (from fish liver), glue for paper and wood and pearl compounds for the chemical and cosmetic industries. These above-mentioned possibilities require different technologies to be applied. However fish meal production or liquid fodder production, depending upon type of fish offal and quantity is recommended. This should be also surveyed and the proper alternative selected accordingly to local conditions and requirements.

Summing up the above remarks it can be concluded that fish has always been a difficult and labour intensive product to process. Improving the fish handling and processing, introducing new technology and equipment make possible to speed up the processing operations with an immense saving of labour and fish wastage. Fast fish handling and processing operations means less time between catching the fish and marketing; better quality and standard of the final products; it means also more hygenic provisions in fish processing plants. Additionally, it makes it possible to process and market small size species that were previously not adequ utilized for human consumption.

These are some examples only, because the marketing activities vary in each country depending upon local traditions, facilities etc. The marketing system then should be adjusted to local conditions and should effectively stimulate fish production and the market.

IV.1. General characteristic of a shore fishery complex of the fisheries co-operative at a fishing village

Swibno in Poland

The co-operative employs about 110 workers of which 65 fishermen, 20 fish processing workers. The remaining are employed in harbour services, transportation and administration.

The co-operative runs two kinds of activities, namely:

1. Fishing
2. Fish processing.

The fishing fleet consist of 26 fishing boats: motor-boats 10 meters long, fitted with slow-speed engines 35-50 HP, and crew of 2-3 fishermen; motor-boats 6-7 meters long, fitted with slow-speed engines 25-30 HP, with crew of 2-3 fishermen; 2 cutters (small trawlers) 17 meters long.

The navigation range of the boats is 6 nautical miles, the fishing activities are carried out in lower course of the Vistula river and in Bay of Gdansk (Baltic Sea area) within 1-2 nautical miles off the coast. Above mentioned boats catch around 250 tons of fish annually.

The following harbour facilities have been provided for the boat operations:

- Quay 180 m long and 4 m wide;
- Basin area 3,000 sqm, draft 2.5-3 m;
- Small dry dock with the area of 150 sqm;
- Mechanical and joinery workshop of about 120 sqm provided with all necessary machines and equipment for maintenance and repair of boats;
- Fuel filling station;
- Water and electrical outlets;
- Ice plant.

The fish handling and processing complex consists of:

- Handling and so called preliminary fish processing area of about 104 sqm provided with simple processing equipment for gutting and heading; fish is processed manually; additionally there is a separate space of about 108 sqm equipped with special tanks used for fish preservation: salting and pickling;
- Smoking plant of about 100 sqm provided with 15 box-type furnaces for smoking fish; the co-operative mainly smokes salmon (15 tons per year), herring and Baltic spratts are smoked successfully as well;
- Defreezing room of about 56 sqm where the frozen fish is being thawed before processing in cases where the frozen raw material is used; the water thawing method is commonly used for this purpose;

- The refrigeration equipment is installed at the complex to preserve and collect the fish during the harvesting season; this section is provided with: chill room (about 0°C) with the capacity of 10-12 tons for short storing of fresh fish to keep the fish in good quality standard and to reduce the temperature in fish before freezing, freezing room with a storing capacity of 10-12 tons at minus 13°C, open air compound for storing boxes, barrels and pallets.

It has to be noted that the fishermen maintain their boats by themselves using the workshop facilities; the fishing equipment is the property of the fishermen and also maintained by themselves. That reduces the time needed for repairing of boats and fishing equipment and keeps the equipment at a high operational readiness ensuring high productivity. The co-operative's final products are of high quality due to efficient shore facilities which results in the effectiveness of the co-operative's outputs. The products are being sold to the State-owned marketing organization.

IV.2. General characteristic of a fish landing complex in Nassau, Bahamas

The Fish Landing Complex in Nassau was constructed in 1983. This complex was established as a centrally located fish marketing and related services infrastructure in New Providence. The wide range of the Fish Landing Complex activities has been designed to provide much needed services to the fishing industry in order to improve the landing, handling and marketing of fish as well as fishing boat operations in Nassau. The Fish Landing Complex is owned by the Bahamas Government.

Layout plan

The total area of the Fish Landing Complex shore facilities of about 2.0 acres is divided into two principal parts: landing and marketing area and public area.

Landing and marketing area

- Landing quay - length 265 feet, draft 15 feet.
- Open fish handling and marketing hall - 4,104 sqft.
- General purpose area - 1,390 sqft.
- Cold storage (freezing and storage facilities, ice making machine room, electrical room, ante-room) - 2,881 sqft.
- Refrigeration machinery room - 450 sqft.
- Office, change and wash-rooms - 972 sqft.
- Packages and pallets holding compounds.
- Parking area.

Public area

- Berthing quay - length 265 feet, draft 12 feet.
- Mechanical workshop - 512 sqft.
- Store room and public facilities (wash-rooms, canteen) - 1,120 sqft.
- Fishing equipment and vessel supply store - 443 sqft.
- Parking area.

The Marine Products Market consists of:

- Marketing area - 4,197 sqft.
- Cold storage and chill-room - 337 sqft.
- Ante-room - 488 sqft.
- Dry-storage - 238 sqft.
- Boiler-room - 132 sqft.
- Laboratory area - 772 sqft.
- Wash-rooms - 192 sqft.

Activities of the Fish Landing Complex

These are as follows:

1. Management, administration and maintenance of the facilities installed at the Fish Landing Complex.

2. Unloading, loading, marketing, freezing and storing operations, transport and other services in the sale of fish delivered to the Fish Landing Complex.
3. Dockage and dockside services - supply fishing vessels with water, electricity, ice, fuel, fishing gear and workshop services.

The administration of the Fish Landing Complex comprises the terminal facilities and the Marine Products Market - retail outlet.

The Fish Landing Complex is designed for landing iced and frozen fishery products from commercial fishing vessels as well as from cargo vessels transporting fishery products. The selling of fishery products through negotiated system takes place between fish owner and buyers on an agreed (negotiated) price. Fish which have not been sold when landed can be stored in ice in a chill-room or frozen in a blast freezer and stored in cold storage until a suitable buyer is found. Fishery products landed and marketed at the Fish Landing Complex are inspected by the inspectors of the Department of Fisheries in respect of size and quality. Products not suitable for human consumption are rejected from marketing operations. For fish handling and internal operations, plastic boxes and pallets are used at the Complex. The boxes and pallets which are the property of the Fish Landing Complex can be used by buyers for transporting the fishery products. All packages and pallets are returnable.

The Fish Landing Complex facilities were designed at a nominal capacity of unloading, handling and marketing 8.0 million pounds of fish a year. The equipment at the Fish Landing Complex provides for the speedy unloading of fish from vessels and for efficient fish handling. The Fish Landing Complex has been provided with chill-room of the capacity of about 5,000 pounds, blast freezer of the capacity of 5,000 pounds a day and cold storage capable of holding of about 150,000 pounds of fishery products.

Dockage and dockside services are provided to the fishing boats through service and supply facilities installed at the Fish Landing Complex. Dockage and dockside services include berthing facilities, electrical receptacles, a mechanical workshop, ice making and supply equipment, fresh water outlets, fueling facilities and a fishermen's supply shop, catering to the specific needs of fishing boats.

To improve the fish landing and fish handling operations, the Government provided also a number of fish holding facilities on some islands of the Archipelagos. Each fish holding facility consists basically of reception (processing room, cold store/freezer, a flake ice marker and 30 kW generator). The reason for constructing the facilities on the islands was to collect catches from local artisanal fishermen, provide freezing and storing facilities which in conjunction with the transport boats could provide a mechanism enabling fish to be delivered to central market in Nassau (also to the Fish Landing Complex) for marketing.

IV.3. Basic equipment of a typical shore fishery complex

(General outline as proposed by METALCOOP for Shore Fisheries Co-operative)

Boats

1.	Boats 6.9 or 12 m length	10 pcs

Means of local transport

1.	Battery-electric truck	1 pc
2.	Fork-lift truck	1 pc
3.	Hand operated pallet-lift truck	4 pcs

Equipment for production hall

1.	Processing tables	3 pcs
2.	Packing tables	3 pcs
3.	Machine for comminution of vegetables	1 pc
4.	Washing machine for production hall	1 pc
5.	Plastic tank for pickling of 5,001 capacity	10 pcs
6.	Metal tank for pickling of 2,501 capacity	10 pcs
7.	Metal tank for pickling of 10,001 capacity	2 pcs
8.	Chamber furnace for smoking	15 pcs
9.	Cutter for fish offals	1 pc
10.	0°C cold store, 10-12 Mg	1 pc
11.	Low temperature refrigerated store, 10-12 Mg	1 pc
12.	Ice generator	1 pc
13.	Scales up to 500 kg	1 pc
14.	Freezer 12 tons a day	1 pc

Workshop equipment

A. Mechanical workshop

1.	Lathe	1 pc
2.	Pillar drill	1 pc
3.	Forge	1 pc
4.	Guillotine	1 pc
5.	Anvil	2 pcs
6.	Rectifier for battery charging	2 pcs

B. Joiners' workshop

1.	Circular saw	1 pc
2.	Band saw	1 pc
3.	Thicknessing machine	1 pc
4.	Surfacer	1 pc

Slip with mechanical or hand operated winch 1 pc

Power requirements

Power consumption:	Processing plant approximately	20,000-30,000 kWh/year
	Workshops approximately	30,000-35,000 kWh/year
	Cold stores approximately	10,000 kWh/year.

V. Conclusions and recommendations

To sum up, it can be concluded that:

1. Fish has always played and will continue to play an important role as a human food.
2. Many countries have a good potential for fisheries development within their exclusive economic zones.
3. The cost of producing fish compares favourably with that of warm-blooded animals.
4. Fish can be better utilized when new post-harvesting technologies are introduced particularly chilling, cold storage and refrigerated transportation of fish as well as processing by salting, smoking and other types of fish preservation according to local conditions and requirements; provision should be made for production of fish meal or other type of fodder.
5. It is fundamental that fish production, processing and marketing be viewed as an integrated and interdependent system.
6. Shore fishery complex plays a significant role in improving boat operations, fish handling, freezing and marketing and in integration of fishery activities.
7. The trend of fisheries development should be towards smaller scale i.e., artisanal and shore fisheries.

VI. References

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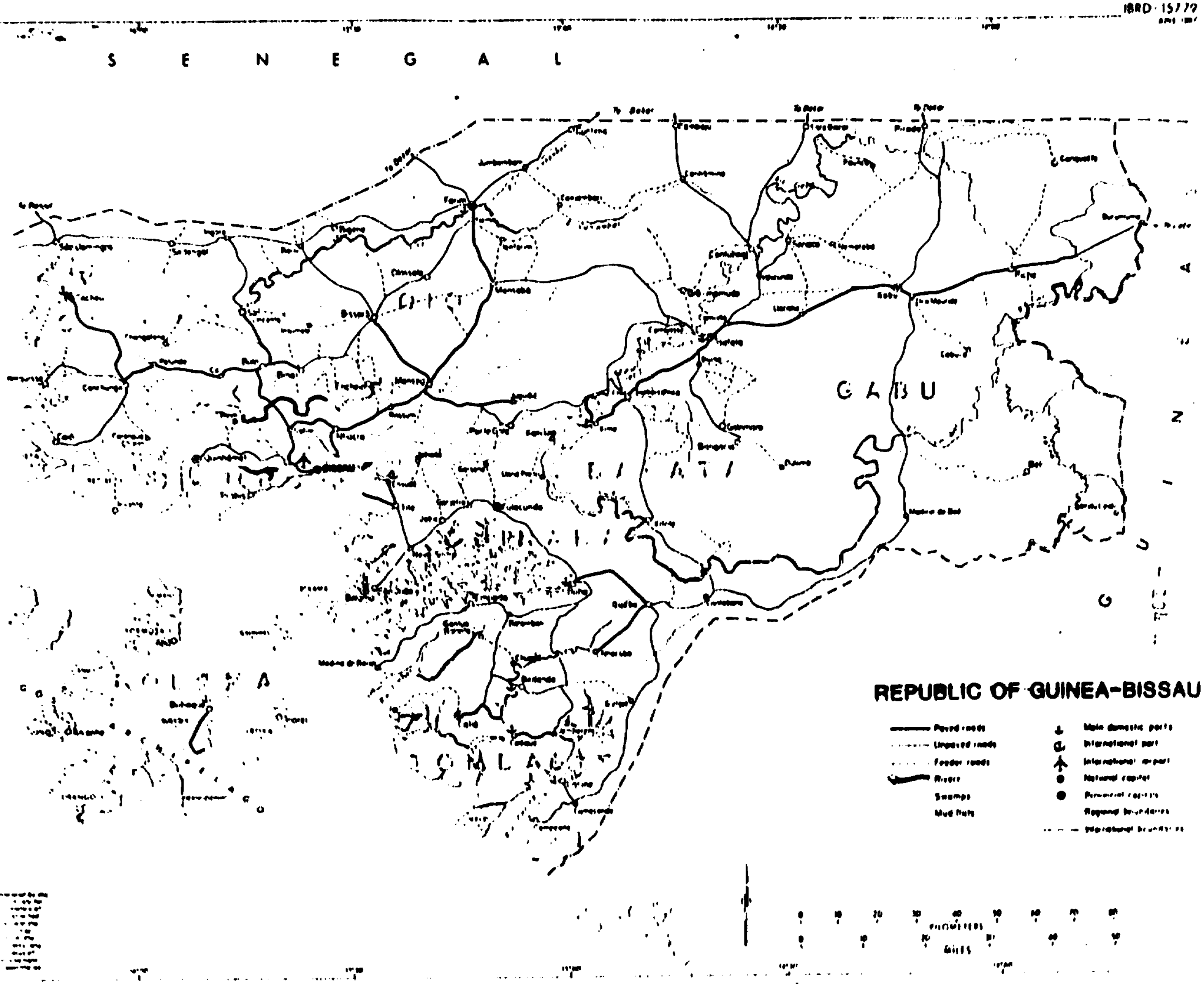
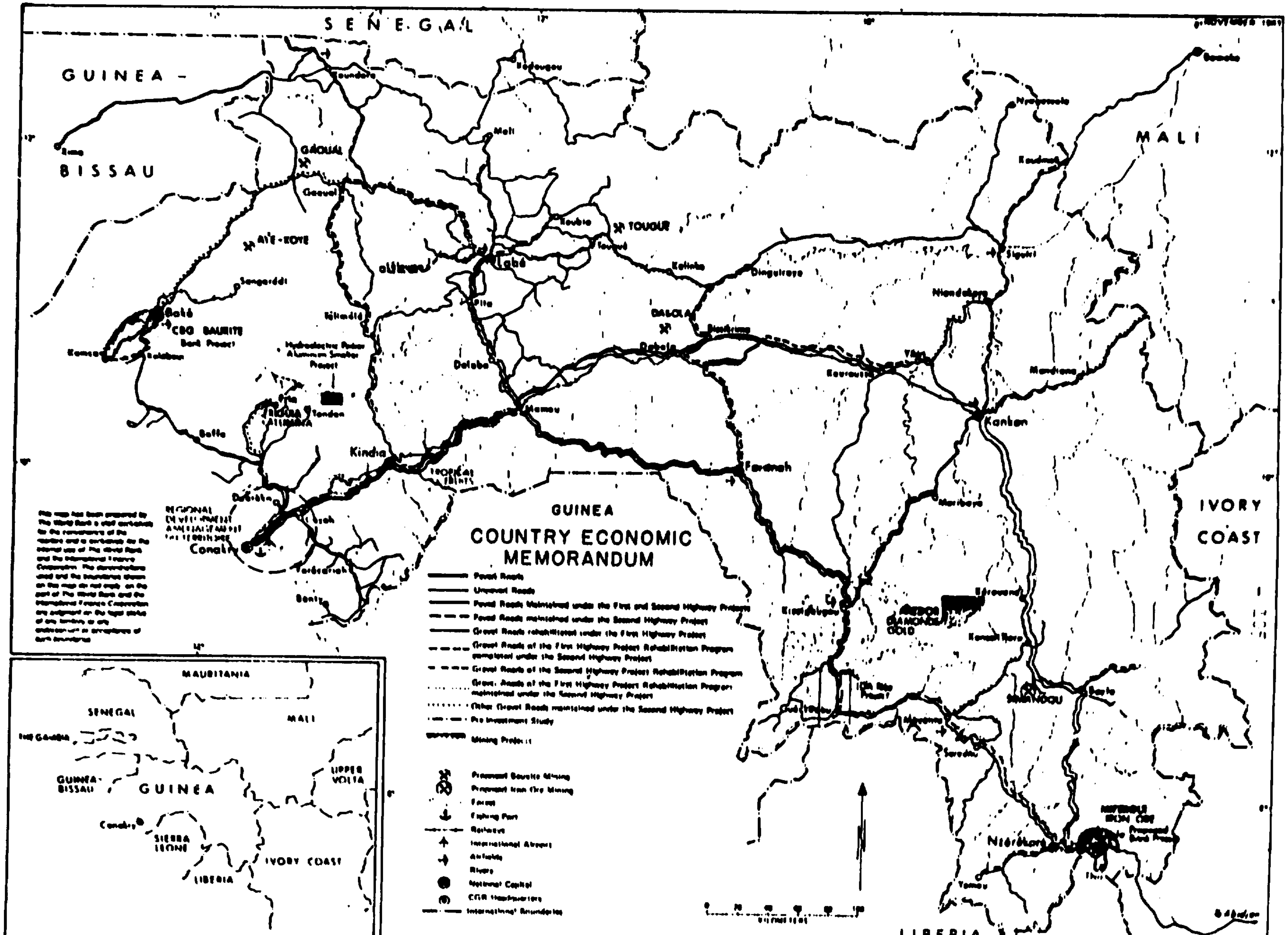
Paper No. 9:

MINI HYDRO-ELECTRIC POWER PLANTS


IBRD 15779
SENEGAL
GABU
REPUBLIC OF GUINEA-BISSAU
Paved roads
Unpaved roads
Feeder roads
Rivers
Swamps
Mud flats
Main domestic ports
International port
International airport
National capital
Provincial capitals
Regional boundaries
International boundaries
KILOMETERS
MILES


GUINEA
COUNTRY ECONOMIC
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Kindia
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Faranah
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Dalaba
Dabola
Siguiri
Kouroussa
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Kérouané
Beyla
Guéckédou
Macenta
Yomou
Forécariah
Dubréka
Boffa
Tondon
Mauritania
Senegal
The Gambia
Guinea-Bissau
Guinea
Sierra Leone
Liberia
Ivory Coast
Upper Volta
Paved Roads
Unpaved Roads
Railways
International Airport
Airfields
Rivers
National Capital
International Boundaries
Fishing Port
Mining Project
Pre-Investment Study

TECHNICAL ADVISORY SERVICES SEMINAR

Guinea Bissau and Gunea

23 October to 1 November 1985

Development and Application

of

Mini Hydro-power plants

Good-Afternoon! Ladies and Gentlemen,

I wish to thank UNIDO for giving me an opportunity to visit you and speak to you on the "Development and Application of Mini Hydro-power Plants". With your permission, what I propose to do in this seminar is to concentrate more on our discussions, solve your technical problems and exchange views than mere lecturing.

The main objects of the discussions are to:

a.) emphasize how to initiate the development of mini hydro-electric power stations and to explain the layout of the plant, technology, technical design, electro-mechanical equipment, installation, protection, measuring and control equipment, application and importance of these equipment, compactness and standardisation;

b.) to encourage you, having hydropower potential, to manufacture indigenously components/electro-mechanical equipment or start producing equipment with an assembly-line workshops with an eye to develop hydro-electric power plants.

To start with, may I request you all to refer to:

Appendix No. 1 -	Major Equipment for a hydro-electric power plant
Appendix No. 2 -	Single-line diagram of a hydro-electric power plant (General)
Appendix No. 3 -	The inside story of "small hydel" sets (An exploded view of a typical Pelton type, hydel set).

Any questions, please!

I have here on the table a prototype 'electric-generator', which we shall see and discuss in detail after this lecture is over.

I think by now, you have a fairly good idea of the major equipment required in a mini/small hydropower stations.

Now, may I show you a few slides to demonstrate further the utilisation and application of the electro-mechanical equipment and protection systems of a hydro power plant:

Slide No. 1 - An installation of a penstock

Slide No. 2 - Francis turbines of various sizes

Slide No. 3 - A Kaplan turbine under inspection

Slide No. 4 - A Pelton turbine under manufacturing process

Slide No. 5 - A Power Plant in Norway showing a Francis turbine with Synchronous generator and turbine regulator 1250 KVA(1000 KW), 400 V, 50 Hz, 750 r.p.m.

Slide No. 6 - Switch and Control room

Slide No. 7 - Machine room showing - different sizes of Francis turbines with Synchronous generators (3 slides)

Slide No. 8 - Cubicle Arrangement, Protection for Generator-Transformer Unit

Slide No. 9 - Transmission lines

Any questions, please!

To summarize, what we have done so far in these 20 minutes are a.) seen the major equipment required and b.) the utilization and application of the electro-mechanical equipment. Now, in order not to waste too much of time in speaking, let us see:

Appendix No. 4 - prices of electric generators

Appendix No. 5 - approximate estimate prices for 100KW, 250KW and 500KW mini hydro power plants

Appendix No. 6 - a sketch showing plant cost breakdown for civil works, mechanical and electrical parts

Appendix No. 7 - "packaged -unit" type, - micro mini hydel set, suitable for power outputs ranging from 5KW to 50KW. This employs a vertical Francis Turbine, self-exciting and self-regulating alternator, oil pressure governor and control panel. It can be used for low heads (approximately between 3 to 12 meters).

Following points may be observed for planning purposes:

I. Production

(see Appendix No. 8 - for Implementation Schedule)

a) Historical development of manufacture in developing countries

1. Stage 1: Assembly and completion of electrical equipment and small control boards for small hydropower stations.

2. Stage 2: Switch-over from assembly and completion to the manufacture of standard material.

3. Stage 3: Stagewise expansion of manufacturing activities - to include gradually more complicated and technically sophisticated electrical products. Limitation of manufacturing activities.

b) Problems in connection with manufacturing activities

1. License matters (collaboration), sanctions and procedures

2. Available production machinery
raw materials, semi-finished products.
sub-supplies (quality)
quality control of incoming and outgoing products

c) Specifications and Standards

1. VDE - BSS - ASA - IEC etc.
Preparation of norms and specifications with reference to local conditions.

2. Required design alterations resulting from availability of local manufactured standard parts like profiles, sheets, nuts and bolts.

II. Project - Planning

a.) Size and type of project - Risks involved

b.) Qualification of project planning personnel

c.) Co-operation and co-ordination between local personnel and specialists delegated from industrialised countries

d.) Training programmes
Problems connected herewith.

III. Service and Maintenance

a.) Selection and training of maintenace personnel

b.) Spare-parts stocking

c.) Operating and maintenance instructions

Shall we take a case study of a mini hydropower project in the Philippines.

Before coming here, I had the opportunity of visiting Agua Grande, a small hydro power station in the Philippines and made some interesting slides and pictures which I will be showing you shortly. I would, therefore, like to take this up as a case study and discuss briefly so that in case you have a similar project in mind, you may clarify any questions you have. I shall give a brief description of the Project and show you some slides after which you may wish to ask me some questions.

Slide No. 1 - shows 5 units of 910KW each
Slide No. 2 - one unit of 910KW with Control Panel
Slide No. 3 - Protection for a generator directly connected with network
Slide No. 4 - Protection for Generator Transformer Unit

Slide No. 5 - Static Generator Protection

Slide No. 6 - Static Generator Protection - Rear side of the cubicle

Slide No. 7 - Signal Flow in Static Generator Protection

Slide No. 8 - Stator Earth Fault Protection with 100% protection range-Principle

Slide No. 9 -

Slide No. 10-

Slide No. 11-

Slide No. 12-

The project, Agua Grande, generates hydro-electric power from the head available between the forebay and the power station. Technical details and financial aspect of the plant are shown in a separate sheet attached with this paper. (see Appendix No. 9).

Appendix No. 10 shows two photographs of the power plant. The first photograph shows a synchronous type generator, a turbine, bearings, flywheel and measuring devices. The second photograph shows control panel with protective relay system.

One can talk for hours on the subject of mini hydro development, but I think it's time I must stop here and throw the subject open for discussion - and answer your questions.

I would like to distribute two separate sheets of demonstration models, namely:

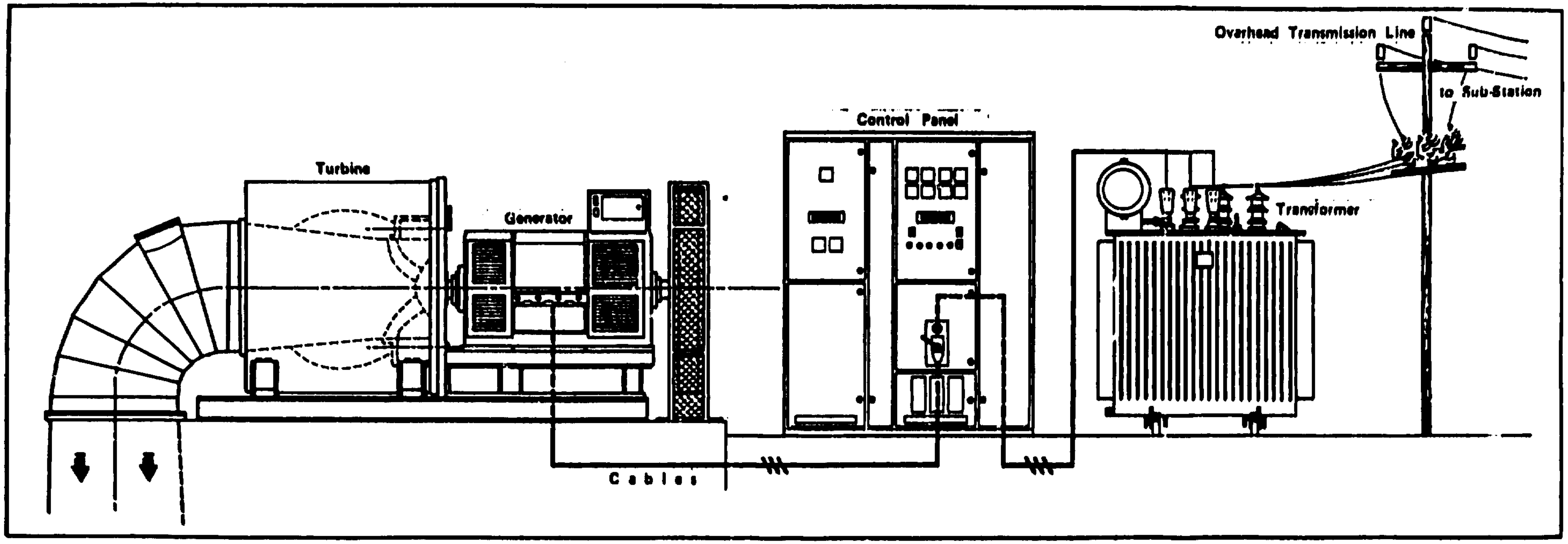
1. Demonstration model for generator protection;
2. Demonstration model for system protection.

These models are designed for training engineers, which can be employed to demonstrate the use of various generator/system protection relays, how they function and their mutual tripping discrimination capacity.

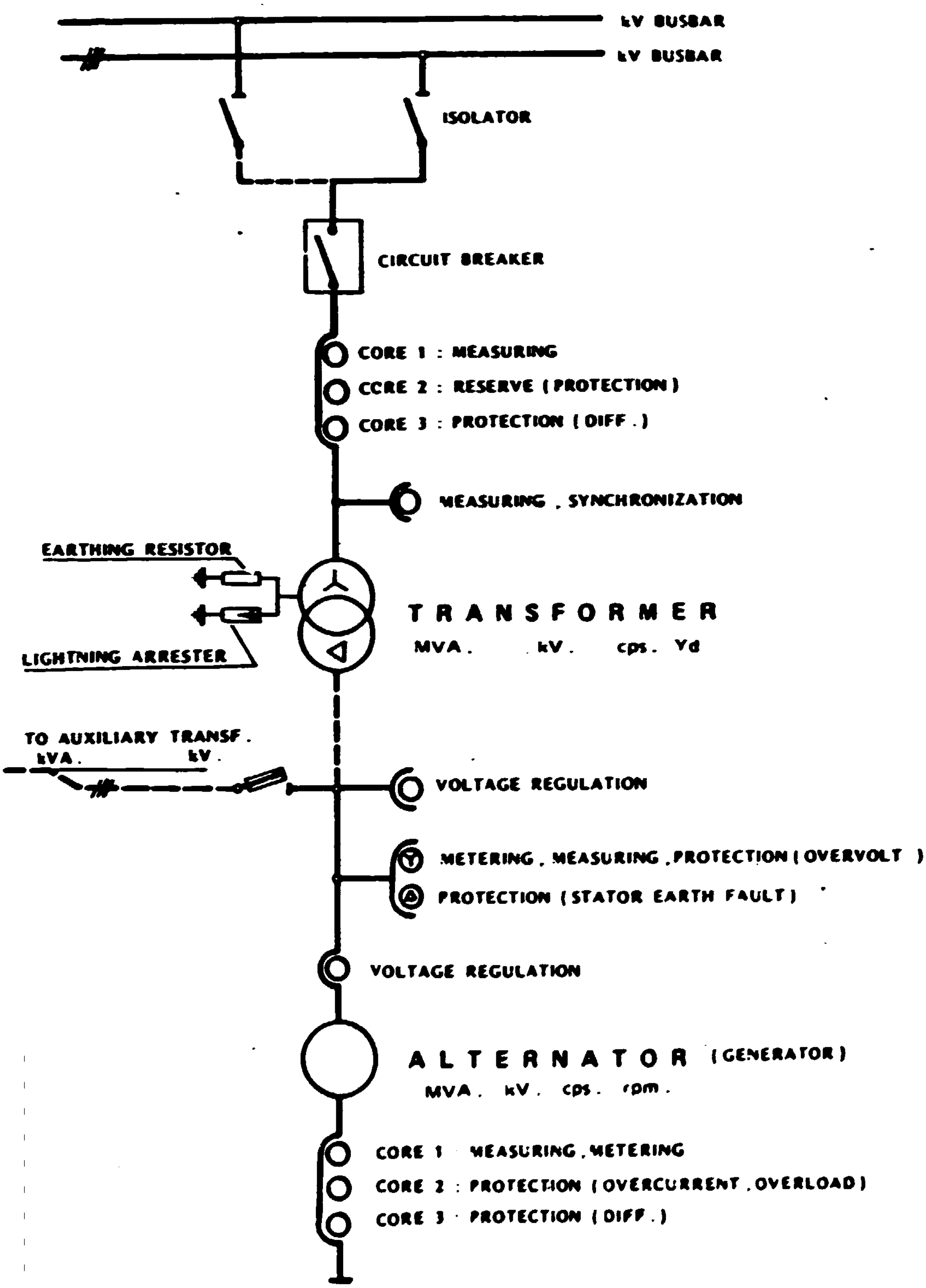
I thank you all - Ladies and Gentlemen! for joining me in this Seminar and I sincerely hope that this has helped you to some extent in building up some ideas as to how a mini hydro-electric power plant can be developed. In case you have any inquiries and if I can be of further assistance, please feel free and do not hesitate to ask any questions.

APPENDIX NO. 1

MAJOR EQUIPMENT FOR A HYDRO-ELECTRIC POWER PLANT

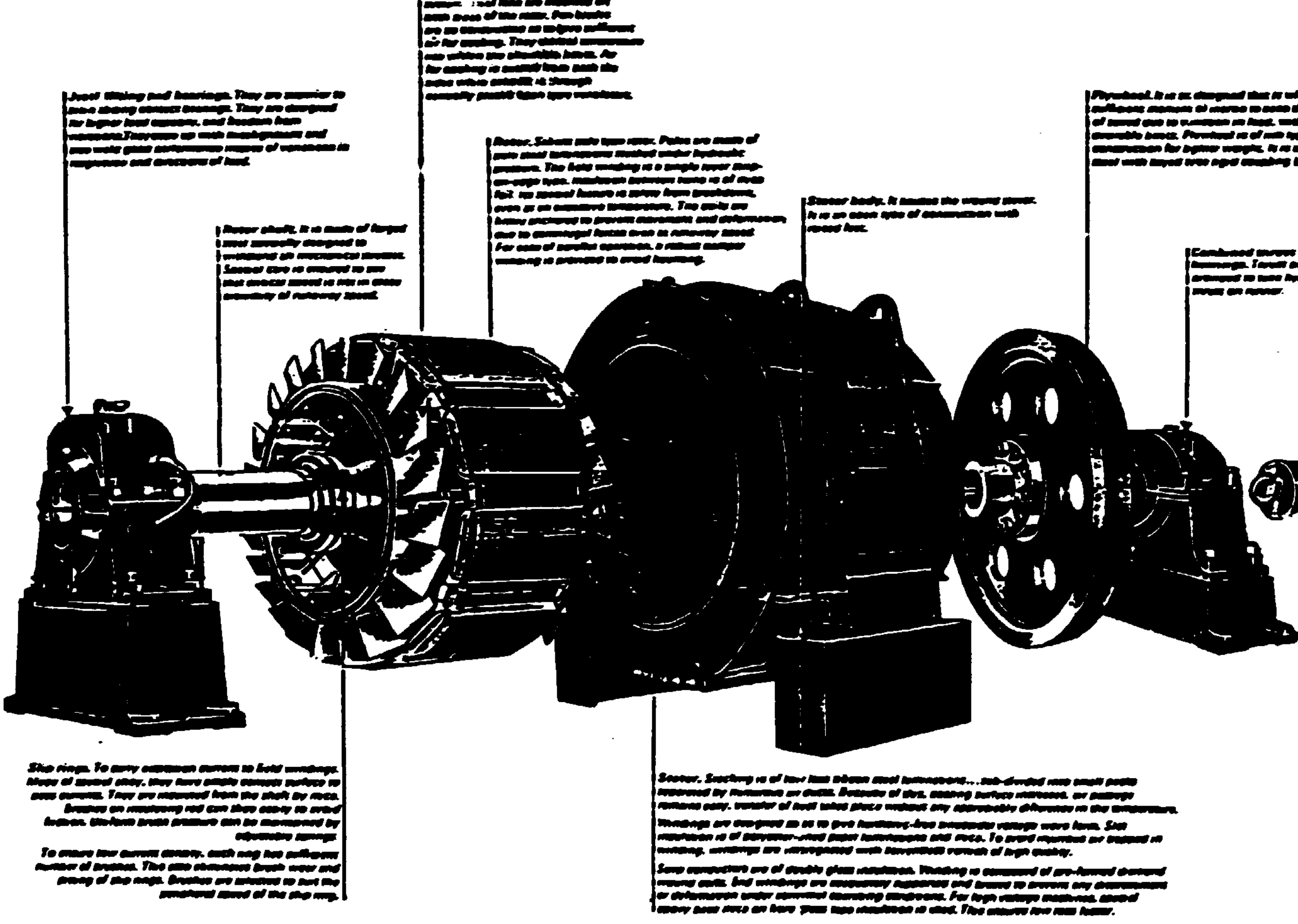


SINGLE-LINE DIAGRAM OF A HYDRO-ELECTRIC POWER STATION
(GENERAL)



The inside story of 'Small' HYDE

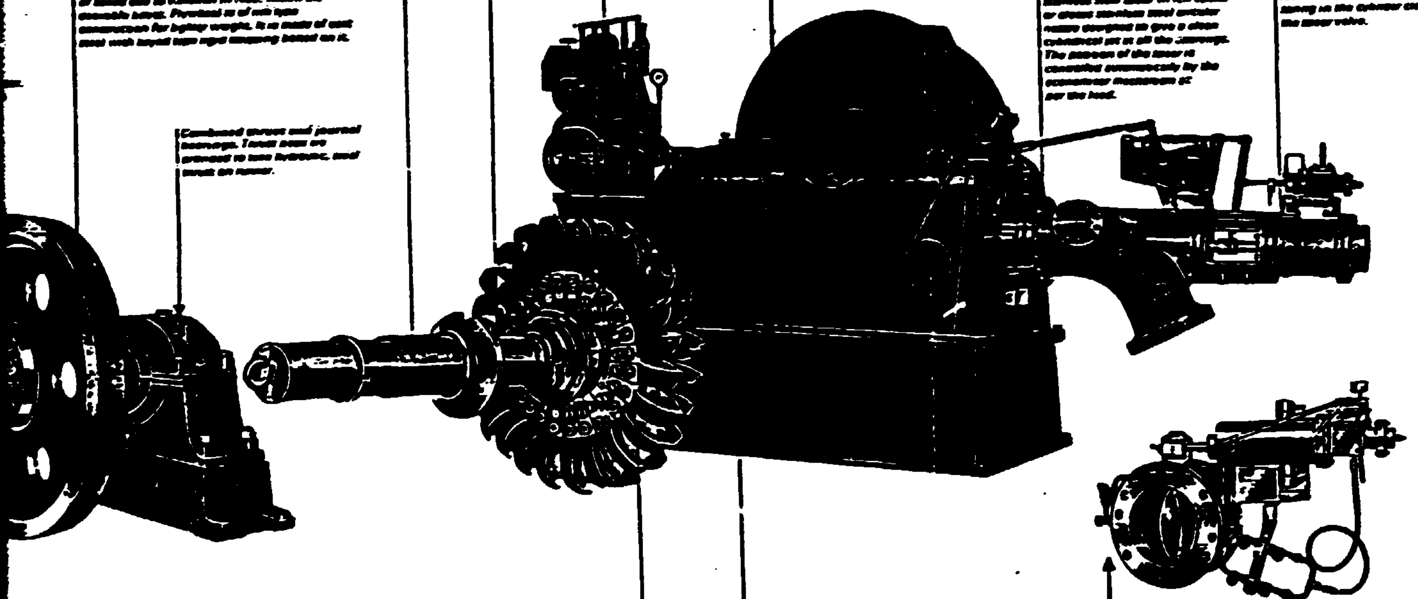
An exploded view of a typical Pelton type, high head Jyoti Hydel S
suitable for generating power from 100 kW to 6000 kW. Dependin
customer needs. Control Panel or Panels (not shown below) with
inserts are invariably supplied with Jyoti Hydel Sets for controlling
output of alternators.



SECTION 1

'HYDEL SETS

...al Pelton type, high head Jyoti Hydel Set
...r from 100 kW to 6000 kW. Depending upon
...el or Panels (not shown below) with standard
...d with Jyoti Hydel Sets for controlling the



SECTION 2

APPENDIX NO. 4

Prices of Electric Generators

For estimation purposes, herebelow are the prices of three phase, electric generators, brushless type, 4 pole(1500 rpm),380-415 Volt,50 c/s.

Item no.	50 c/s,1500 rpm KVA	KW	Prices in US $
1	15	12	2,060.-
2	20	16	2,185.-
3	25	20	2,500.-
4	31.25	25	2,800.-
5	37.50	30	3,350.-
6	40	32	3,800.-
7	50	40	4,185.-
8	65	52	4,500.-
9	75	60	5,025.-
10	90	72	5,385.-
11	100	80	5,800.-
12	125	100	6,500.-
13	150	120	8,200.-
14	175	140	8,800.-
15	200	160	9,500.-
16	250	200	10,900.-
17	300	240	11,850.-
18	330	264	12,500.-
19	400	320	14,450.-
20	450	360	16,500.-
21	515	412	19,350.-
22	550	440	21,000.-
23	600	480	22,485.-
24	630	504	23,235.-

Price of a complete Synchronized Power Plant

" A "

Taking into consideration the availability of the following technical data, a rough price has been calculated to give an idea of a complete synchronized hydro-electric power plant.

Operating Conditions-

H (Height)	=	20	m
Q (Water flow)	=	730	lit/sec.
NT (Turbine capacity)	=	156	HP
NG (Generator output)	=	125	KVA (approx.100 I

Comprises of-

- Suitable turbine to match the above datas
- Fundament base frame
- Pipeline connections - between the turbine and pressure pipe line (pen stock)
- Gear with couplings
- Automatic speed regulation with control drives
- Steel fly-wheel
- Three-phase Generator brushless, self-exciter, with constant voltage regulator and safety switch.
- Control panel with measuring instruments and protection equipment

.......ESTIMATE PRICE.... US $ 90,500.-

The above price does not include, engineering, planning and designing, civil and construction work, penstock, mechanical part, transformer, cables, transmission overheadlines, etc.etc.

Price of a complete Synchronized Power Plant

" B "

Taking into consideration the availability of the following technical data, a rough price has been calculated to give an idea of a complete synchronized hydro-electric power plant.

Operating Conditions-

H (Height)	=	20	m
Q (Water flow)	=	1790	lit/sec.
NT (Turbine capacity)	=	380	HP
NG (Generator output)	=	313	KVA (approx.250 KW)

Comprises of-

- Suitable turbine to match the above datas
- Fundament base frame
- Pipeline connections - between the turbine and pressure pipe line (pen stock)
- Gear with couplings
- Automatic speed regulation with control drives
- Steel fly-wheel
- Three-phase Generator brushless, self-exciter, with constant voltage regulator and safety switch.
- Control panel with measuring instruments and protection equipment

..........ESTIMATE PRICE....US $ 130,500

The above price does not include, engineering, planning and designing, civil and construction work, penstock, mechanical part, transformer, cables, transmission overheadlines, etc.etc.

Price of a complete Synchronized Power Plant
" C "

Taking into consideration the availability of the following technical data, a rough price has been calculated to give an idea of a complete synchronized hydro-electric power plant.

Operating Conditions-

H (Height)	=	20	m
Q (Water flow)	=	3540	lit/sec.
NT (Turbine capacity)	=	750	HP
NG (Generator output)	=	625	KVA (approx.500 KW)

Comprises of-

- Suitable turbine to match the above datas
- Fundament base frame
- Pipeline connections - between the turbine and pressure pipe line (pen stock)
- Gear with couplings.
- Automatic speed regulation with control drives
- Steel fly-wheel
- Three-phase Generator brushless, self-exciter, with constant voltage regulator and safety switch.
- Control panel with measuring instruments and protection equipment

......ESTIMATE PRICE....US $ 248,600.-

The above price does not include, engineering, planning and designing, civil and construction work, penstock, mechanical part, transformer, cables, transmission overheadlines, etc.etc.

Sketches showing plant cost breakdown

Herebelow are the two figures showing typical relation of the plant cost breakdown for low-head and medium-head power stations.

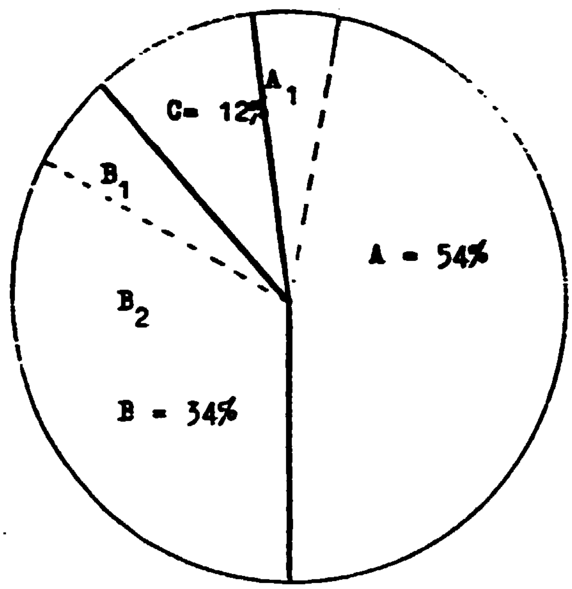


Fig.1 - Low-head power station

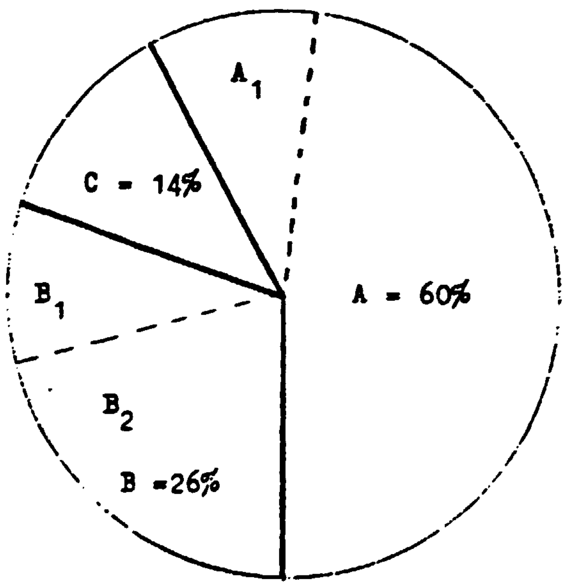


Fig.2 - Medium-head power station

A = Civil construction

A_1 = Civil engineering, planning, design & supervision

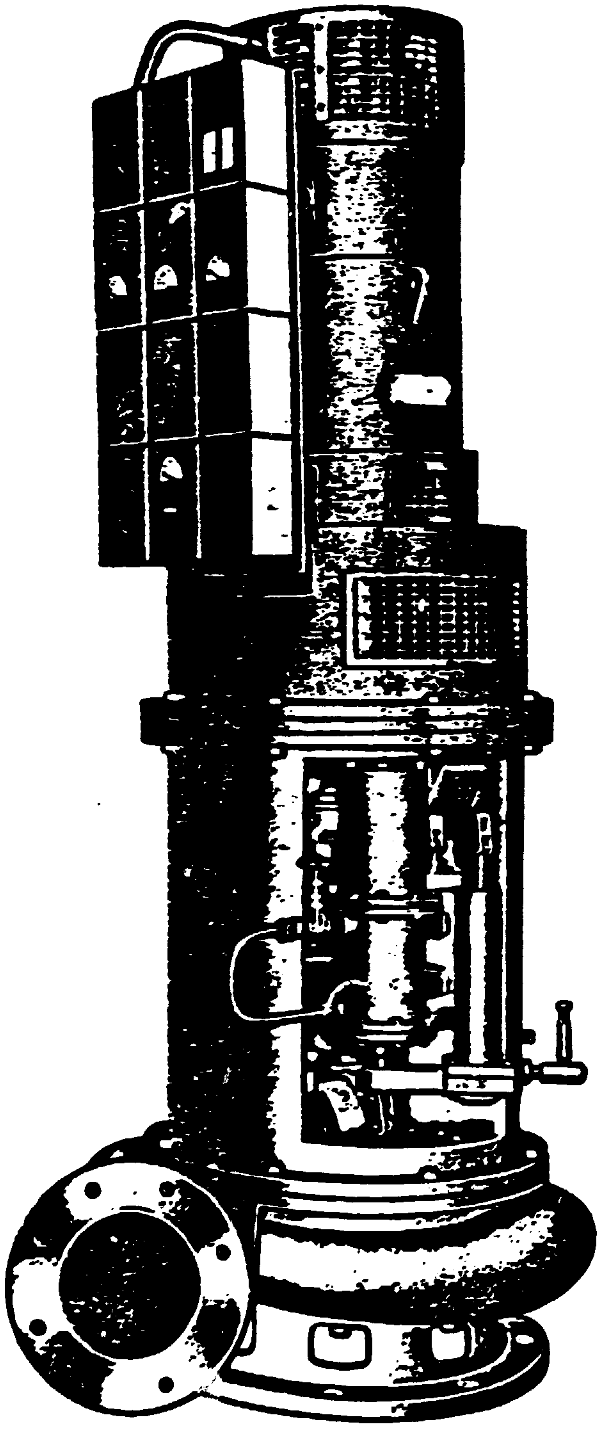
B = Mechanical part

B_1 = Penstock, gates

B_2 = Turbine part, machinery, valves, sheet metal work, and etc. etc.

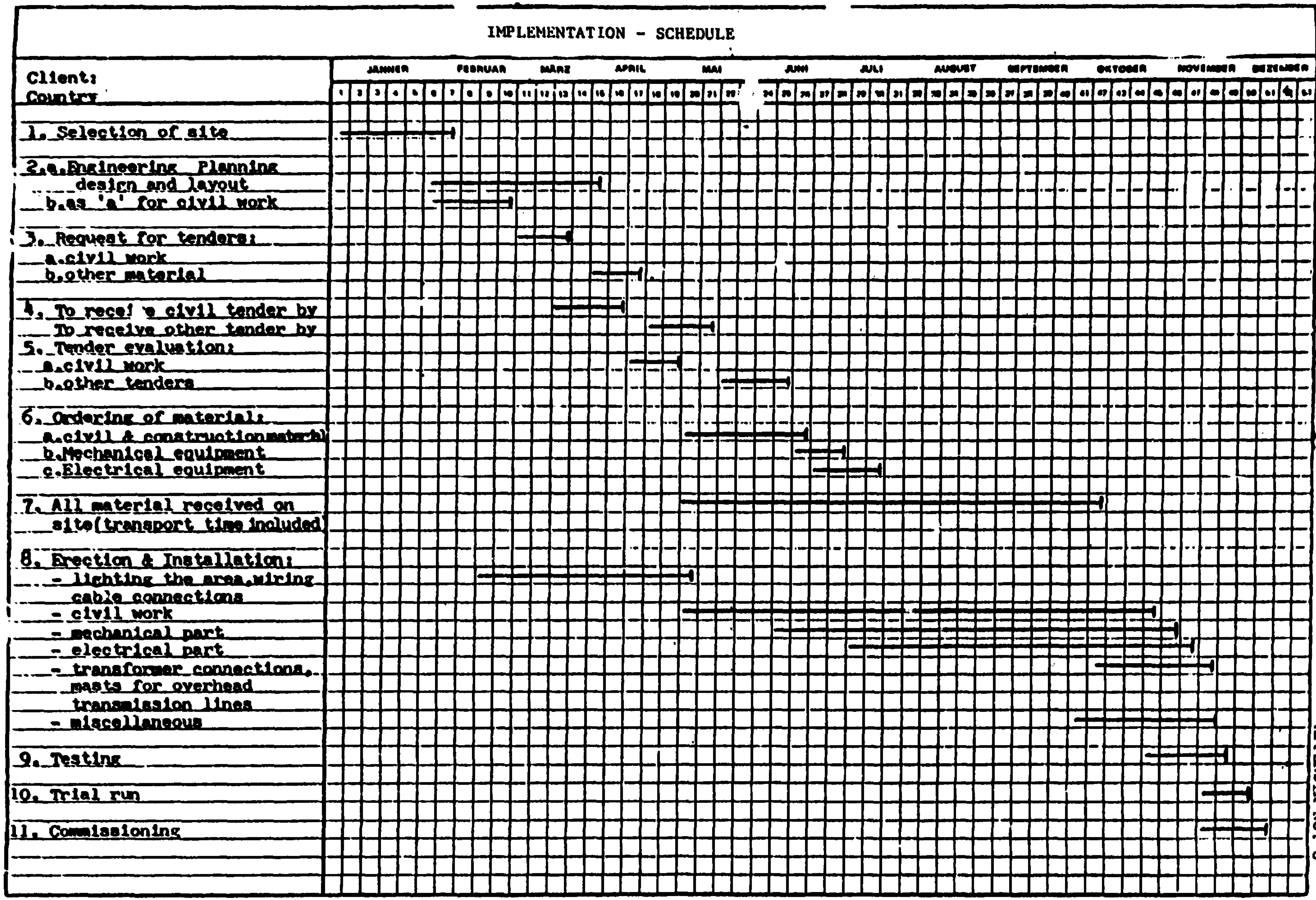
C = Electrical pa
Generator, control panel other electri work involved miscellaneous

PACKAGED-UNIT TYPE HYDEL SET



SUITABLE FOR POWER OUTPUTS RANGING FROM
5 KW to 50 KW

APPENDIX NO. 8



APPENDIX NO. 8

AGUA GRANDE
SMALL HYDRO-POWER PROJECT
ILOCOS NORTE, PHILIPPINES

Agua Grande lies near the northern most tip of the Cordillera mountains of Luzon in the town of Pagudpud, Ilocos Norte, some 120 kilometers north of Laoag City (approximately 500km from Manila).

START OF CONSTRUCTION : November 2, 1981

DATE OF COMMISSIONING : June 1983

Technical Data

Total Capacity	4550 KW 5 units of 910 KW each
Average Annual Energy Generation	19,508,000 KWH
Availability Factor	49%
Net Head	180 M
Designed Flow	3.23 CMS
Drainage Area	5 sq. km.

Turbine

Type	21" Turgo Impulse
Capacity	5 x 1340 HP
Rated Flow Per Unit	0.646 CMS
Speed	900 RPM

Generator

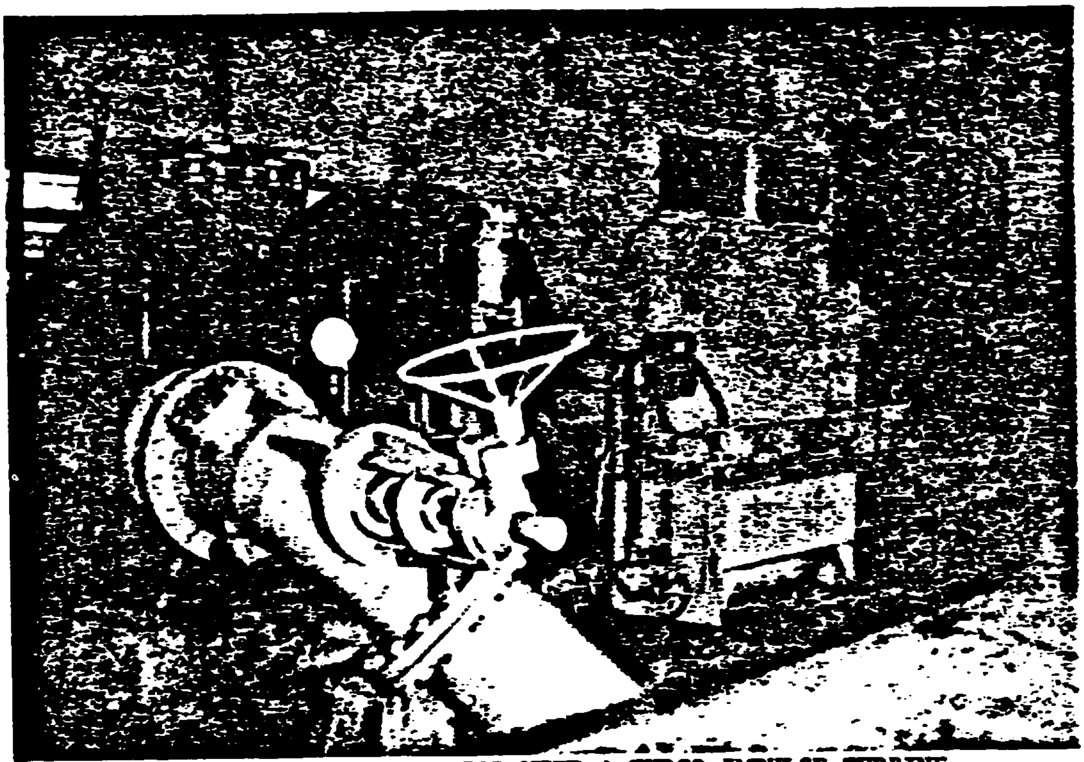
Type	Synchronous Type
Rated Capacity	5 x 910 KW
Voltage	4160 V
Power Factor	0.80
Phase	3Ø
Speed	900 RPM
Frequency	60HZ
Efficiency at Full Load	94.5%

Financial

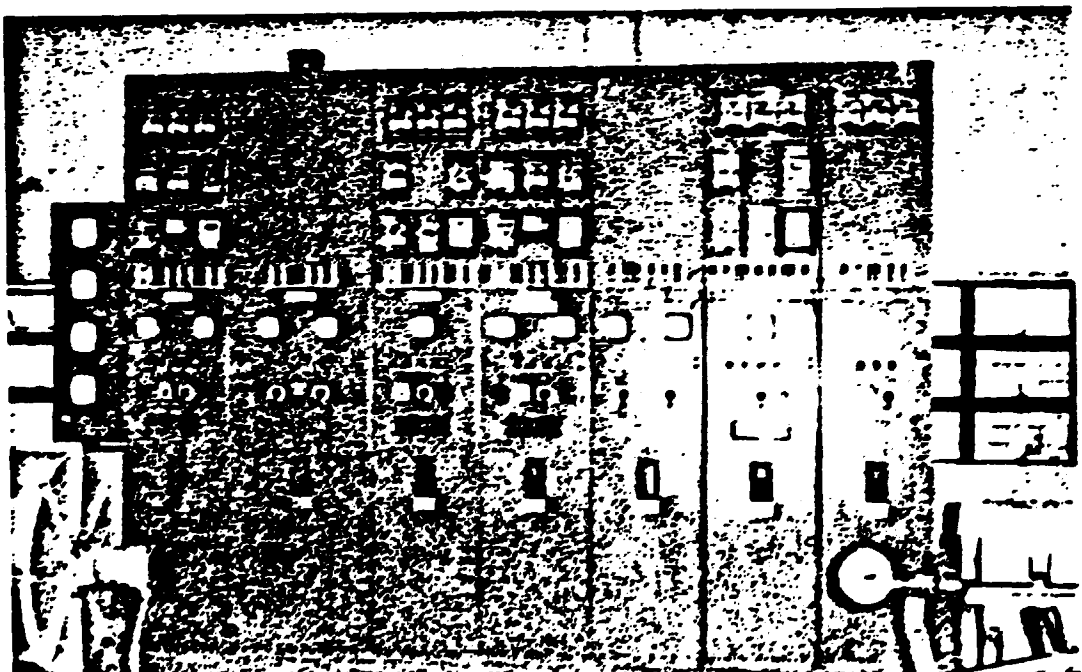
Total Project Cost	Pesos (₱) 80.092 M
Mini-Hydro Equipment Cost	36.89 M
Engineering Services	2.147 M
Civil & Electro-Mechanical Works	41.055 M
Total Investment Cost/KWHR	4.11
Total Investment Cost/KW	17,602.00
Generation Cost/KWH	0.64

ACUA GRANDE
SMALL HYDRO-POWER PROJECT
ILOCOS NORTE, PHILIPPINES

APPENDIX NO. 10



SYNCHRONOUS TYPE GENERATOR WITH A TURGO IMPULSE TURBINE, BEARINGS, FLYWHEEL AND MEASURING DEVICES



CONTROL PANEL WITH PROTECTIVE RELAY SYSTEM

Paper No. 10:

Detailed notes on utilization of bentonites for soil conservation

I. INTRODUCTION

The problem of mankind's nourishment and improvement of living standard call for still more urgent solution. The necessity of reserving basic living means arises mainly in developing and the least developed countries. Some of them are situated on the African continent and it is natural that the United Nations within their Industrial Development Decade for Africa are of the greatest interest to solve these problems using reliable, economically reasonable and prompt technologies.

The agricultural production has been on a low level in many countries of the African continent. The greatest share on this fact has a number of objective conditions, such as climate, lack of irrigating water, humus, soil type, etc. One of the most negative factors is the existence of pure sandy soils in the most of African regions. The structure of these soils as substrates for plant growing is deeply unfavourable - such soils are not able to keep back the irrigating water, they contain a small amount of humus and have a light character and the majority of nutrients is washed out. But there exists a real and many-times approved method of influencing this alarming state to the better one.

Bentonite as an easy accessible and inexpensive raw material is able to improve the soil substrate quality to the fair extent. Being a clay inert rock with high sorptive, ion-exchange and swelling properties, it loads the soil and prevents it from nutrient and water escape.

The active role of bentonite in agriculture has been proved to a great extent by laboratory, pilot-plant and greenhouse experiments and by long-term applications in various soil types resulting into convincing return enhancements of many important agricultural products. The application of bentonites for soil reclamation was performed not only in Czechoslovakia and in other developed countries but also in some developing countries, e.g. Egypt. Czechoslovakia has been experienced in bentonite application for soil reclamation for more than

20 years with demonstrable outstanding results abroad. That is why this technology has been offered by the UNIDO-Czechoslovakia Joint Programme for International Co-operation as an active relief for industrialization and intensification of agriculture in developing countries. The reliability of soil reclamation by bentonites has been appreciated many times and many developing countries express their deep interest in this technology and contact the UNIDO-Czechoslovakia Joint Programme in Pilsen (e.g. China, Argentine, Algeria, Jordan, Ethiopia, India, Tunis, etc.). The application of local bentonites to pure sandy soil reclamation in Egypt has been very successful resulting into a more-than-100 per cent increase of crop yield and reduction of irrigation water by up to 50 per cent. Owing to the fact that there are localities of bentonites with sufficient properties for agriculture exploitation in many African countries, it is possible (through the mediation of UNIDO) to broaden the co-operation in this region as well.

Bentonite itself is a clay rock with a wide spectrum of applications, there are tens of industrial and other branches in which it has successfully been utilized. In addition to the traditional exploitation of bentonite (foundries, geology, ceramics, etc.), it can be utilized in a "non-traditional" way as well. For example, its utilization for environmental protection is one of these important applications in which the UNIDO-Czechoslovakia Joint Programme has reached excellent results. It is to point out that UNIDO Vienna gives attention to bentonites in the complex sense including their agricultural applications. It is able to reserve complex exploitation of bentonites with the outlook of the widest industrial and agricultural applications and evaluation of this mineral raw material.

The UNIDO-Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries is ready to assist the developing and least developed countries in consultations, training programmes and evaluation of selected non-metallic minerals and rocks in order to promote not only the industrial exploitation of local non-metallic natural resources but also the intensification of agricultural production and to contribute to solving environmental problems.

The goal of the following lecture is to make you familiar not only with the industrial exploitation of bentonite but also with applying it in soil reclamation technologies, with results reached in Czechoslovakia and other countries.

Other non-metallic minerals and rocks exploitable in agriculture will be mentioned only briefly. Some economic aspects of bentonite application to agriculture will be introduced as well stressing both the entrepreneurial economy and influence on the national economy.

II. CONCLUSIONS AND RECOMMENDATIONS

1. Non-metallic minerals and rocks play an important role in agricultural as fertilizers, sorbents and carriers of chemical and biological matters.

2. The application of non-metallic sorbents both for plant growing and animal breeding has very favourable results.

3. The most important non-metallic sorbents for agriculture are bentonites, zeolites, perlites, tuffs and tuffites, marls and some others.

4. Some of non-metallic sorbents are represented in the majority of developing and developed countries.

5. Depending on the conditions of application, soil, climate, quality and quantity of dosage, the non-metallic sorbents being applied show the following increase in the yield in comparison with original conditions without sorbent dosing (see the following review below).

6. Aside from the direct economic influence on the agriculture the non-metallic sorbents affect the national economy by decreasing the imports of food and fodder for animals and by increasing the chance of each country to accelerate the production of food for its own population.

7. The exploitation of bentonite in environmental protection (mainly in wastewater treatment) enables to combine advantageous properties of sorbent and manure. This mixture is applied directly in agriculture.

8. In order to exchange experience in the field of non-metallic sorbent application in agriculture, it is recommended to arrange an ad-hoc experts' group meeting for participants both from developing and developed countries.

Sorbents for plant growing

(a) Application under Middle-European conditions

Applied sorbent	Type of soil (% grain 0.01 mm/% humus)	Dosage (t.ha^{-1})	Tested plant	Increase of output (%)
bentonite	9.2/1.3	20	potatoes	18.6
bentonite	9.2/1.3	20	rye	16.7
bentonite	11.1/1.7	20	barley	11.5
bentonite	11.1/1.7	20	maize	8.8
bentonite	6.4/0.4	20	barley & rye	22.2
bentonite	6.4/0.4	20	pulses	39
bentonite	6.4/0.4	20	maize	39.2
bentonite	sandy soil	10	maize	80-90
zeolite 60 1/	N.A. 2/	4	potatoes	30
zeolite 50	N.A.	10	capsicum & tomatoes	16
zeolite 50	N.A	16	capsicum & tomatoes	33
zeolite 80	N.A.	16	paddy	40
tuff	N.A.	20	maize	32.4
tuffites 3/	turf	20	maize	from 7.9-80.6

(b) Application in Egypt

Applied sorbent	Type of soil	Dosage (t.ha^{-1})	Tested plant	Increase of output (%)
bentonite	pure soil	20	maize	90-100
bentonite	- " -	20	barley, vegetables	90-100
bentonite	- " -	18	citrus, orange trees	
bentonite	- " -	18	barley	
bentonite	- " -	18	beans	

Note: 1/ Zeolite index marks the percentage of clinoptilolite.

2/ Not available.

3/ Tuffites of different carbonate content and different sorption capacity.

9. Such experts' group meeting will be the necessary basis for organizing an international seminar as the means of the transfer of technology and evaluation of important questions concerning various territories and countries, such as

(a) evaluation of geological reserves of different non-metallic sorbents,

(b) testing, evaluation and classification of non-metallic sorbents in connection with local conditions in agriculture,

(c) determination of necessary refining and up-grading of existing non-metallics for the application in agriculture,

(d) evaluation of local conditions in agriculture from the point of view of plant growing,

(e) conducting pilot tests on the application of non-metallic sorbents in agriculture of selected developing countries,

(f) preparation of feasibility studies on commercial and economic evaluation of the application of selected non-metallic sorbents in selected countries and evaluation of projects from the point of view of environmental protection.

10. The presented lecture brings forward the information necessary not only for the preparation of experts' group meetings but also for the start on practical applications of non-metallic sorbents in agriculture.

11. The UNIDO-Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries, being experienced in the extraction, up-grading and application of non-metallic sorbents in agriculture, is ready to extend and transfer the wide know-how developed in Czechoslovakia during the past two decades to the developing and least developed countries.

III. DEFINITION AND INTEGRATED APPLICATION OF BENTONITE

1. Bentonite Character

Origin and depositing

Bentonite as a clay rock is characterized by dominating share of mineral montmorillonite which is chemically defined

$(Si_8)^{IV}(Al_{3.33}M^{+}_{0.67})^{VI}\ O_{20}/OH/_4$, where M^{+}s either Mg, Fe^{3+}, Li, etc. * Its origin is linked with the weathering of volcanic rocks, such as basalt and greenstone. However, the principal parental materials are volcanic ashes, namely tuffs and tuffites. It is on the transformation of volcanic materials that the origin of other clay materials also hinges. Bentonite make-up (bentonization is a frequent term) is confined to humid and incontrovertibly alkaline environments which is important for geological prospection programmes.

Accompanying minerals

The process of bentonization of volcanic activity products was irregular as far as time and interaction space are concerned which resulted into a wide scale of by-products and minerals accompanying bentonite in a deposit. The most frequent ones are illie, beidellite, montronite, kaolinite and clastic minerals represented by feldspar, quartz, limestone, gypsum, for instance. Also organic matters and other admixtures, such as coal substances and diatomites, are present in bentonite deposits.

Colour and propensity to disintegrate

The environment of origin and accompanying matters determine all the substantial properties of bentonite as rock. The colours and tints of bentonite are various; light-beige, yellow, red, brown, grey-blue and grey-black colours are frequent which change if bentonite is subject to the open air effect, especially in humid climates. Alterations of cold and warm and deviations of humidity result into disintegration of clay blocks in the deposit or dumping ground. The disintegration follows the original texture which extraction and beneficiation take advantage of. This disintegration is also appreciated in case of soil reclamation by bentonite as it helps ameliorating the soil structure.

* According to Ross C.S. each mineral having ratio between Si and Al 5:2 and this idealized formula can be conceived as "the very montmorillonite".

Texture and appearance

The extracted fresh bentonite is of friable as far as conchoidal fracture which looks greasy. Bentonite is persistent as far as plastic and it swells and blunges if dipped into water. The properties of bentonite cannot be judged from its appearance exactly unless an extraordinary homogenous deposit is in question. Usually, there are considerable differences of the decisive properties among bentonites coming not only from particular deposits but from different parts of the same deposit.

Nomenclature

In accordance with the variability of properties, versatile nomenclatures have come into being both petrographic and commercial ones. Generally, bentonite owing to its properties is read among so called mineral sorbents and dispersive minerals which differentiates it from other materials of sorbent properties that are without the dispersive power, such as zeolite.

Applicability and quality

Whether a certain bentonite is utilizable in practice or not depends on the content of montmorillonite that is a bearer of most of desirable bentonite properties, especially, binding and sorption capacities, dispersion power and others.

Even though other accompanying minerals share in the bentonite overall quality, they have only minor effects on switching particular effects leaving aside the complex efficiency which is a function of montmorillonite. It is most distinct in case of sorption and ion exchange capacities and, therefore, in order to assess the quality of a bentonite it is sufficient to determine total exchange capacity set out in milliequivalents. Approximately one per cent of montmorillonite in the matter corresponds to the 1 mval/100 g of dry matter. (Usual abbreviations of the milliequivalent are "mval" or "meq").

Special uses

In case of some special uses, for instance for catalyses in petrochemistry, other properties are looked for which result from chemical composition and physical structure under conditions of catalysis and the significance of montmorillonite content is rather subdued. Other process, such as bleaching oil, requires also special experiments for the optimal run of the process to be determined. In general, however, it is valid that the less montmorillonite the lower total exchange capacity and the lower quality of bentonite.

2. Bentonite properties

The below properties of bentonite are based on both the content of clay minerals and their structure, especially on the montmorillonite content. It is necessary to mention here that fixing montmorillonite and other clay minerals in bentonite is not an easy work. Their crystals are tiny having dimensions of microns or less and are observable only under electron microscopes with unreliable results as the appearance and behaviour of the observed crystals depend on the preparation of sample, contents and kind of exchangeable cations. Consequently, the determination of bentonite applicability is not easy and infallible without carrying out specialized tests and experiments.

(a) Fundamental structural properties

Owing to its content of clay minerals, bentonite is defined among so called hydrosilicates or aluminium silicates, if need be, that are of the laminated structure of crystals consisting of tetrahedral and octahedral formations of oxygen anions which are tied up with cations inside these spatial formations. The most frequent ones are Si^{4+}, Al^{3+}, Mg^{2+}, Fe^{2+}, Fe^{3+}. The ratio between tetrahedrons and octahedrons is 2:1. There are situated molecular water and ions of alkali or alkaline soils in inter-layer spaces. These spaces, similarly to crystal edges, are source of such properties as the exchange and absorption of ions, sorption of anorganic and organic matters accompanied by swelling in water and other solvents. The lamination of atoms affects also macroscopically the behaviour of thin leaf crystals in the way by which a "card packet" is characterized. The crystals, depending on ions and quantity of bound water, can mutually shift their faces. They are oriented "edge to face" or "edge to edge". It is obvious that this system makes possible to create spatial formations of honeycombed structure which are very solid in suspension and, vice versa, sediments taking up comparatively small room having arrangement "face to face". By the above mechanism, changes of rheological behaviour and binding power are caused. For instance, the viscosity can change substantially without any change of the content of dry matter in the suspension. The area of the inter-layer surface amounts up to 800 sq.m/g and influences principally the sorption of vapour and gases. There are many modifications of the principal properties which affect the industrial applications of bentonite. These modifications have their origin in different structures and arrangements of clay mineral crystals, especially those of montmorillonite which can be influenced in many ways, and in the fact that the evolution of crystals is not uniform throughout a deposit.

(b) Review of applicable bentonite properties

The looked-for properties of bentonite can be broken down into two groups. In the first one, there are properties resulting from crystallography of raw material whereas the second one comprises properties resulting from physical-chemical composition.

Properties resulting from structure of crystals

- Binding power
- Sorption capacity both physical and chemical ones
- Dispersion power
- Filling properties
- Electrostatic properties

Properties resulting from physical-chemical composition

- Ion exchange capacity
- Catalytic properties
- Possibility to produce special chemical matters and building materials
- Capacity to create organo-derivates
- Capacity to create new crystalline phases (for firing in ceramics)

The above properties of bentonite make it very useful material applicable in almost all industries, agriculture and construction industry. The below review lists larger consumers of bentonite:

Review of principal bentonite applications

Sector	Sought-for property	Application instance
Foundries	Binding capacity (bonding agent)	Moulds for casting
Construction industry	Binding capacity (filler, aggregate)	Bonding agent, insulations, grouting and jetting
Building materials	Chemical composition	Cement clinker additive
metallurgy	Binding capacity, creation of new crystalline phases	Pelletization of ore for blast furnaces
Ceramics	Binding capacity, creation of new crystalline phases	Enhancing compression strength of green Bodies, plasticizing
Pharmaceutical and cosmetic industry	Binding capacity, sorption, filler	Drug sorbent and binding agent of ointments and pills
Food industry	Selective sorption	Bleaching edible oils, refining wine and sugar
Geological drilling	Dispersion capacity, filler, sorption	Suspensions for drilling muds
Textile industry	Sorption, filler, Electrostatic properties	Textile thickeners, fuller's earth, antistatic finish
Chemical industries, oil refineries	All properties	Cracking catalysts, refining oil and grease, pesticide carrier, plastics filler, dessication of gases and vapours
Paper industry	Binding power, sorption, filler	Paper for special prints and copying
Waterworks	Sorption and filler	Burdening flocculation clouds, cleaning sewage water
Vegetal production	All properties	Reclaiming arenaceous soils, improving ecological balance
Animal husbandry	Sorption, ion exchange bonding agent	Bonding agent and envelope of granulated feed stuffs, mineral feed stuff additives
Fertilizer preparation	Sorption, chemical composition, dispersion	Additive to composts and liquid fertilizers
Dye industry	Sorption and dispersion	thixotropic varnishes and lutes
Nuclear industry	Sorption	Decontamination of radioactive water and other matters

IV. BENTONITE APPLICATION FOR SOIL RECLAMATION

(a) Classification of non-metallic minerals and rocks applied in agriculture

Non-metallic minerals and rocks owing to their properties are widely applied in agriculture. There are many view points of their classification and they are usually classified according to their fundamental functions and the field of utilization on:

Industrial minerals and rocks as fertilizer minerals

which are the direct condition of farm output. They are divided into:

1. Primary minerals (nitrogen, phosphorus and potassium)
2. Secondary minerals (calcium, magnesium, sulphur)
3. Micro and trace minerals (boron, iron, manganese, copper, zinc, molybdene, chlorine and cobalt)

Industrial minerals and rocks as sorbents

which are not fertilizers but their presence in the soil is indispensable. They are divided according to their activity in the soil and the field of utilization as follows:

1. Sorbents in vegetal production where they are applied for
   - sandy soils (bentonites and marls)
   - argillo-arenaceous soils (tuffs, tuffites, expanded perlite and zeolites)
2. Sorbents in animal husbandry (bentonites and some of zeolites)

Industrial minerals and rocks as carriers

Diatomaceous earth is among others suitable raw material for carrying chemicals to protect plants against insects.

(b) Properties of bentonites important for soil reclamation

Bentonite is a clay rock of high content of montmorillonite. From the point of view of practical industrial application it is (together with zeolites, tuffs, tuffites, marls, etc.) so called non-metallic sorbent. In the line of sorbents, bentonite is of prior economic importance.

Main properties of montmorillonite

1. Large specific surface of particles (about 800 sq.m/g)
2. Particles have electric charge
3. Particles have chip-like shape

The first two properties influence the perfect sorption capacity. It is on the electric charge that the mineral acts as ion-exchanger. The third property influences especially good physical and mechanical properties of suspensions and pastes.

In harmony with montmorillonite contents bentonite displays the above properties. There is soil, bentonite affects especially water retention of soil, soil capacity of reversible change of micro- and macro-nutrients, generation of organic-anorganic sorption complexes and eventually bentonite improves whole the soil profile. This is valid for soils that lack mineral sorbents (clay colloids), i.e. sandy soils.

Dispersion capacity and surface acrivity of particles are those agents that make bentonite be a perfect means of efficient carrier of pesticides to protect plants.

Applying bentonites the objective of fertilization of sandy soils by generating a sorption complex of bound sandy grains and organic colloids is followed which prevents water to percolate quickly. 1 g of bentonite can bind as far as 20 g of water creating so a stable gel which has perfect binding properties, the fact on which, e.g. the application of bentonite to foundry sands is based. The comprehensive quantity of reversibly bound water is a reservoir of humidity of soil utilized by plants. Reversibility of water affects porosity of soil as the drying gel shrinks and generates hair cracks. Hydrophilia of bentonites which is represented by liberating as far as 88 J of hydration heat per 1 g of bentonite receiving water affects positively assimilation processes in plant and controls, to a certain degree, temperature of soil.

The mineral sorbent affects temperatures of sandy soil both direct and through enhanced contents of water in soil. This theoretical hypothesis was proven by exact field tests, bentonite reduced daily alterations of temperatures during the radiation type of climate which is of importance for limitation of detrimentally overheating surface. Bentonite enhances both heat conductivity and heat capacity of soil, organic matters assist jointly.

However, the principal improving effect on soil is attached to volume changes. As a consequence of expansion during water reception the number of capillary pores grows to the detriment of non-capillary ones resulting into considerably enhanced quantity of acceptable water for plants. It results eventually into better water regime and dynamics of microbial processes in soil even at comparatively small dosages of bentonite.

Beneficiation of bentonite for agriculture

The process differs according to the further use of bentonite. The bentonite for fertilization of sandy soils can be used without industrial upgrading, whilst the bentonite for application in animal husbandry and in industrial production of granulated fodder needs the industrial upgrading to reach perfect homogenization.

Mining of bentonite without industrial upgrading

The way and technological process of mining depends on local conditions and on geological situation of strata deposition, i.e. overburden and layer proper of mineral sorbent.

The mining of bentonite for the fertilization of sandy soils must be efficient and simple in order to reach favourable economic relations. The important precondition is a low thickness of overburden. The deposits of bentonite for fertilization of sandy soils are suitable only in cases of easy surface mining. The longwall method is the most suitable, especially in regions with occurrence of sandy soils which need the amelioration by bentonite.

Deeper deposits of agricultural bentonites are acceptable only as interlayers or underlayers of more valuable industrial bentonites, quartzites, etc. and they must be mined out anyhow.

The next sources of agricultural bentonites are so called dumped earths - remainders of bentonites which don't satisfy the standard of industrial bentonites. This material is usually contaminated by carbonates which is favourable for agricultural bentonites. The admixtures of bivalent iron and other toxic elements are undesirable. Indecomposed volcanic admixtures and coal particles are not injurants.

It is necessary to solve the shortest possible transport from mining centres to ameliorations in regions with sandy soils to lower the transport cost.

Opening of a deposit is preceded by geological prospecting and determination of technological process of mining, from which the type of used mining machinery results. Before the stripping starts, the preventive water drainage (drains, sewers, etc.) should have been done.

Mining process

The stripping of overlaying waste rocks is conducted by bulldozers and mobile excavators with direct loading on lorries and transportation to a dump. The mining proper is then conducted by the same machinery.

Technological process of mining must be accordant with regulation for raw material mining in open bearing and is controlled by mining inspection. The extracted bentonite is transported by lorries to a depot, established on the open area with solid subgrade. The lump bentonite can be stored up to the height 0.7-1 m. It is mixed roughly and levelled by the shovel loader and then left to weather effect.

A natural disintegration of a lump bentonite occurs as an effect of the weather - precipitation, frost and sunshine. Considerable homogenization of bentonite is reached by its stratification and mixing on the open-air depot. Thus the fluctuating quality of bentonite from various places of the deposit is eliminated.

The natural disintegration and drying of bentonites can be used in areas of mining with occurrence of sandy soils as well as for the preparation of composts in these areas.

Basic properties of bentonite for fertilization of sandy soils:

1. The most important property of bentonites, used in agriculture, is the swelling, i.e. volume expansion in contact wtih water which must be higher than 10 per cent.

2. Complete sorption capacity should be in the range from 20 milligramequivalents per 100 grams to 40 milligramequivalents per 100 grams.

3. The disintegration of lump bentonite on the open area lasts in average from several months to one year. It can be intensified by mechanical turning upside-down during the period.

Mining and industrial upgrading of bentonite for agriculture

The mining is similar to that of bentonite used without industrial upgrading (points 1 to 6 in Figure 1). The extracted bentonite is transported by lorries to dumping grounds and to homogenization stocks. The raw bentonite is transported from stocks to a feeding hopper (7) which is the beginning of technological line. Raw material is transported by inclined belt conveyor (8) through the feeder (9) and by another conveyor (10) to the pug mill (11) of raw bentonite. At the same time, the precise dosage (1 to 3 per cent) of pulverized soda (Na_2CO_3) is added to the mill by the turnstile from the storage tank of soda (12). The activated mixture from the pug mill enters the worm blender (13) where the next mixing and heating by the steam is carried out. The mixture of bentonite and soda enters by the inclined belt conveyor (14) the parallel-flow rotary drier (15). The parallel flow is used to avoid breaking of material structure by overheating.

Dried bentonite from the drier falls to the set (16), consisting of elevator, crusher and belt conveyor, leading into the fine-grinding mill (17). The mill is equipped with screens, efficient air technique, cyclons, separation filter, magnetic filter of the grist and belt conveyor which transports finally upgraded bentonite to the storage bin (18). The ground and dried bentonite is discharged from the storage bin through the set of belt conveyor + packing machine (19) into bags or through special filling equipment to a tank waggon (20) (See Figure 1).

(d) Results obtained from bentonite application

The practical effectiveness of known theoretical regularities of the effect of artificially introduced sorbents in soil was verified by precise operation experiments in field conditions.

Field experiments with bentonite took their course in 1964-1967 and 1973 in five main areas of light soils in Czechoslovakia and comprised soil sorts ranging from sandy to earthy soils. The precise field experiments were carried out on the surface of more hectares, they were based on and evaluated according to statistical principles and they helped to solve the forthcoming practical problems.

1. Optimal dosage

The information on the dosage is various. The initial attempts used very small quantities of bentonites, e.g. 0.5 ton per ha. Later, the dosage was gradually enhanced and many reports reveal quantities of 10-20, 50, 100 and 900 tons per ha in case of recultivation of dumped waste after coal mining for example. The Czechoslovak long-run experiments with bentonite reclamations are concluded into an assess of production curve which accounts for its maximum at the dosage of 25 tons per ha. Since the maximum of unit increment curve lies in the point marking 9-ton dosage,the economical optimum is assessed to be in the interval between 10 and 20 tons per hectare (Figure 2). Beyond this interval, the law of diminishing return starts performing. The upper limit of the interval was also verified to be a limit of agricultural applications for locally available sorbents in Czechoslovakia from the point of view of costs in transport as far as distances about 100 km were concerned.

For more information on the experiments, the reader is referred to the Joint Programme's publication "Production and Application of Non-metallics in Agriculture", JP/149/83, February 1983.

2. Influence of bentonite on other intensification factors

The following dependences ensued from the interaction of effects of mineral sorbent bentonite with other intensification factors in polyfactorial field experiments:

- The effect of bentonite increases at higher level of fertilization. The sorbent also increases the exploitability of mineral fertilizers and prolongs their subsequent action.

- The simultaneous application of organic manures jointly with bentonite raises the effectiveness of both components. This correlation is direct and is limited (according to the results of model experiments) by the upper limit of the dosage of organic manures amounting to 3 per cent of matter (i.e. about 90 tons per ha) treated soil. A higher dosage of organic manures exceeds the effect of mineral sorbent. Bentonite prolongs the effectiveness and subsequent action of organic manures.
- The reclaiming application of mineral sorbents is demonstrated relatively more expressively without watering than with watering which veils to a certain extent the effect of bentonite on physical properties of soil. If bentonite is applied with watering, its sorption effect is applied to the limitation of leaching of nutrients.

As it is apparent that bentonite effect is enhanced in coincidence with the application of fertilizers, identically, a hypothesis can be drawn that bentonite conserves the fertilizers and irrigation water by their better exploitation.

3. Reaction of different crops on bentonite (Table 1)

The return on bentonite application depends also on price of marketed productions and the actual increase of yield of a crop. It was experienced that the highest increases were reached in case of root crops and that in case of cereals there was a series of best results as follows: (from the best results to the worst ones) maize, rye, wheat, barley, oats (Table 1). However, the yield is very dependent on accompanying circumstances. For example, winter crops reacted more readily than spring crops. The effect of bentonite on the yield of straw was in general lower than on the yield of grain in case of winter crops while in case of spring crops these results were opposite.

This differentiated reaction of crops is very well explainable by theoretical finding of the influence of added sorbent on equilibria in soil and to dynamics of nutrients, especially on the ratios N:P and K:Ca and ecological demands of particular crops in relation to the effect of bentonite on equilibria in soils.

4. Influence of the other accompanying circumstances on the effectiveness of reclamation by bentonite (Table 2)

The most significant remaining circumstances that were followed in relation to the effectiveness of bentonite are the methods of introducing bentonite into soil and the character of vegetation period. The most suitable method of this transfer appeared to be the basic autumn ploughing which spreads the sorbent in the whole layer of arable land and enables the stabilization of equilibria in the period of rest before the beginning of vegetation. The sorbent introduced by basic ploughing is thus made available by current periodical soil treatment and its contingent migration into the lower soils is eliminated.

The character of the vegetation period will contribute to the effectiveness of sorbent or to the reaction of plants under cultivation. A more expressive effect of bentonite was found in dry vegetation period in the application of a higher dosage while in moist vegetation period the effectiveness was lower and it was applied also in the zone of lower dosages. The action of sorbent in wet vegetation period is analogous to the action of sorbent in the participation of an exceeding factor, e.g. the watering. Table 2 demonstrates results of bentonite applications in dependence on humidity.

5. Experiments carried out under desert conditions

The experiments that were carried out in Czechoslovakia with bentonites yielded a conclusion that the efficiency of bentonite application would be very impressive under desert conditions, i.e. on sandy soils and in drought. This has been confirmed by experiments conducted in Egypt recently which have led to the conclusions that mixing sandy soil with local bentonite will improve mechanical, hydrophysical and chemical properties of sandy soil. Consequently, yield and water use efficiency by plants are increased.

(a) The optimal dosage of bentonites was experienced to be 20 tons per ha or 9 per cent rate bentonite in soil.

(b) The reaction of different tested plants was positive, beans yielded twice in comparison with control field.

(c) Bentonite influenced positively the period of germination, growth of stalks, nutrients uptake, water efficiency.

(d) At the optimum dosage the consumption of irrigation water was cut by a half.

The results obtained permit considerations to apply local bentonites economically in a large scale.

Results of bentonite application tests are summed in Table 3.

(e) Application of bentonites to the soil

Bentonite has been verified to be an excellent amelioration means which affects positively fertility of arenaceous-argillaceous soils considerably. Czechoslovakia has put effort in researching the bentonite effects in last 20 years. The results were published in world's literature. Principally, behaviour of bentonite applied to indigent arenaceous soils has been researched and results obtained are very good since bentonite enriches soils by argillaceous components and enhances sorption of water and nutrients. Another sought-for effect is the improvement of soil structure since bentonite swells and its enhanced volume makes soil air so that the soil permeability is higher. The sorption capacity of bentonite brings about even a certain protection of underground water from leached industrial and organic fertilizers, however, this is not without a reservation since it is a question of equilibrium and concentrations of respective matters according to the specific conditions.

For bentonite to be efficient as much as possible, the following principles are to be kept:

(a) Bentonite should be applied to the indigent arenaceous or argillaceous-arenaceous soil containing maximally 2 per cent of humus when the reclaiming effect is optimal. (Figure 3).

(b) The content of clay mineral montmorillonite is important. The minimal ion-exchange of 30-35 mval per 100 g is recommended. Enhanced share of $CaCO_3$ is not detrimental.

(c) Natural crude bentonite is to be applied. Neither acidic nor alkaline activations are needed, suffice it to introduce crushing or coarse grinding, artificial drying is not recommended since it brings about reduced sorption and high costs. The lump bentonite is required to disintegrate spontaneously into smaller pieces.

(d) Bentonite is recommended to be spread as regularly as possible on the field, e.g. by means of manure spreaders, industrial explosives or simply manually. The proper method is to be chosen according to local conditions. The dosage varies between 10 and 50 tons per ha, usually 20 tons per ha. The material is recommended to be applied during autumn fitting as the ploughing is deepest at that time.

(e) To obtain the optimum effect, al' the principles of proper agrotechniques are to be kept, first of all, sufficient fertilizing by both mineral and organic fertilizers.

(f) Service life of the bentonite application is verified to be 7 years, at least, and during this period the output is higher by 20 per cent in average while, in individual cases according to the plant and environment, this number is as far as 100 per cent.

(g) Bentonite applied in this way enhances vegetable crops and affects as an accumulator of nutrients which are kept for further crops.

Among other bentonite effects in soils, the following is worth mentioning: enhanced accumulation of organic matters in the area of application, reduced mineralization of the organic matters preferentially, enhanced occurrence of bulb bacteria including their more intensive activity, better water regime and proper regulation of soil pH. The results obtained by bentonite reclaiming tests in Czechoslovakia in last two decades have been summed up to be presented in Figures 2 - 4.

V. EXPLOITATION OF BENTONITES IN ENVIRONMENTAL PROTECTION

Another area of wide bentonite exploitation is that of environmental protection, mainly in water technologies. The problem of wastewaters is one of the most concerning symptoms at present.

The application of bentonite for wastewater treatment depends on many factors, such as properties of bentonite, its activation, pollution characteristics and content of suspended matter in the treated water. Bentonite is a very suitable agent especially for wastewater polluted with a higher amount of insoluble, suspended or floated substances. On the contrary, when soluble substances are predominating contaminants, sorption and flocculation processes are less effective.

Bentonites are utilized for the wastewater treatment either without other agents or more often in various compositions with other chemical or natural substances. As for bentonite proper, it serves as an excellent sorbent for ammonia and ammonium ion removal particularly after its acid activation by means of hydrochloric or sulphuric acid as well as after heat treatment up to 200 - 300°C. It is suggested that during heating the inner crystalline structure undergoes a change irrespective of the dehydration effect.

Interesting results were obtained by purification of water polluted by polymer flocculants of anionic, cationic and nonionic type (their content being in the range of 1 - 100 ppm). By using various types of bentonite (in Na^+, K^+, Mg^{2+}, Ca^{2+}, Ba^{2+} cycle) all the pollutants were reliably removed with a high efficiency. In this process, the strong selectivity of removing organic substances with regard to the activation conditions was observed.

Bentonite itself has been used as a flocculating and clarifying agent for various types of wastewaters. As a highly colloidal clay it produces readily filtered flocs having an apparent volume greater than that produced with other substances (e.g. alum), and in addition it has good base-exchange properties. The coagulation properties are largely independent of pH-value.

In case of wool industry the optimized amount of added bentonite was 3 g per litre of wastewater; the COD value (chemical oxygen demand) decreased to one third of the original value.

The exploitation of bentonites for wastewater treatment is most familiar in case of compositions with other substances. Thus, wastewater from soya processing industry was treated with bentonite together with $FeCl_3$ and

$Ca(OH)_2$/ratio 750:600:400 ppm/. This mixture is able to remove pollutants from more than 90 per cent. Another composition has been used for purification of dye industry polluted waters. For this purpose, a mixture of bentonite, aluminium sulphate and various organic substances proved to be efficient. Similarly, from experiments concerning removing of turbidity from wastewaters, the exploitation of bentonite and aluminium sulphate resulted as the best clearing agent. The most of these compositions have been used for the purification of waters polluted by crude oil and products of its rafination. Two-step treatment has commonly been used for emulsions removal. In the first step, the emulsion has been broken into the nonstable system using a flocculating mixture (e.g. aluminium sulphate and sodium dedocylbenzensulphonate). Secondly, some adsorbing materials, such as bentonite and/or activated carbon with coagulant (polyacrylamid) are added. By this method, the decrease of COD from 3760 to 5 ppm in clarified water was observed.

Organobentonites are exploited mainly for removal of organic contaminants of oily nature from the water surface. Bentonites impregnated by organosilicon compounds (methyl - and phenylchlorosilanes) are of great use as well. This type of hydrophobization is based on physical sorption of the agent on the surface of bentonite. After impregnation, bentonite is dried in vacuum in order to remove the solvent carrying the active organic substance. Such treated bentonites absorb oily substances very readily and nearly quantitatively.

The treatment of industrial wastewaters from yeast and vinegar production, slaughter houses, meat processing, chemical industry and pig-fattening stations (representing different types of pollutions) by bentonites proved to be very efficient, inexpensive and fast. Results of laboratory and pilot-plant applications showed lowering of chemical and biological contamination down to 10 per cent of the original value.

Sludge originating in the process of wastewater purification by bentonites contains many nutritionally valuable compounds and can successfully be exploited as fertilizing agent.

VI. OTHER NON METALLIC MINERALS AND ROCKS APPLIED IN AGRICULTURE

1. Perlite

Perlite is most suitable for vegetative propagation, for plants cultivated from cuttings, for cultivation and root taking of wine cuttings. It is also used for transport of young seedlings. Experiments were conducted to apply perlite to arable soil for monocotyledonous, dicotolyledonous and hybrid sorts of plants, also for pot plants, for root-taking purposes in nurseries and cultivation of vegetables. The results of laboratory and pilot tests have proved among others for tobacco, that if perlite is applied 15 - 20 cm into the soil layer of the tobacco seedling beds (cultivation area of 25 sq.m and 140 - 200 litres of perlite) the sprouting occurs 4 - 5 days earlier, there are less weeds, root-taking is more active, uprooting plants is not detrimental and after bedding out a larger amount of seedlings develops - 20 - 28 per cent compared to those cultivated in soil without perlite application.

Field tests have shown that the complex effect of the perlite application is best utilized if perlite is applied during the autumn soil fitting. The depth of the ploughed layer is bigger at this time and the soil utilizes winter rains best. Perlite used in any cultivation branch yields better results when its grain sizes are larger (2 - 3 mm diameter). This perlite type should be used for cultivating ornamental plants, horticulture, etc.

2. Zeolites

Zeolite tuffs and tuffites cause neutralization of acid soils and regulate delivering amoniak and other cations from fertilizers. First attempts with clinoptilolite in paddy cultivation were conducted already in 1943. Rice seedlings are cultivated in a blend of soil, clinoptilolite and fertilizer for a certain time. Then they are planted in fields. Five per cent higher crop was a result of attempts with zeolite containing 60 - 90 per cent of clinoptilolite. In case of wheat, zeolite containing 80 per cent of clinoptilolite causes enhancing output by 10 - 15 per cent.

Very successful results were reached with cultivation of potatoes and tomatoes in Sachalin. Two-year tests of zeolite with 50 - 80 per cent of clinoptilolite demonstrated increased output of potatoes by 30 per cent (400 kg/ha added to standard dosage of fertilizer). When dosage of fertilizer was lowered to 50 per cent and the dosage of zeolite remained the same (400 kg/ha), the output of potatoes was 120 per cent. As well, green-house output of tomatoes was higher by 20 per cent when 58 g of zeolite per sq.m were applied.

The results reached in cultivating tomatoes in the USSR prove that zeolites considerably influence yield potential if they are used in optimal dosage with fertilizers according to the specific conditions. When tomatoes had been planted in zeolite only, yield was 33 pieces of tomatoes per 1 bush. When blend 1:1 of zeolite and black soil had been applied, yield was 23 pieces per 1 bush while bushes planted in black soil only bore 18 pieces. Dosage of 5 tons of zeolite per hectare resulted into 190 kg per hectare higher output of wheat, 20 t/ha showed 270 kg higher output. The optimal dosage was 10 t/ha resulting in 440 kg higher output.

3. Tuffs, tuffites

Tuffogenous rocks as tuffs and tuffites of basalt rocks that have become sufficiently clayey have the effectiveness as bentonite. Their montmorillonitic clayey component is very effective. Besides, they contain a higher percentage of carbonates, macronutrients and trace elements.

The tuffaceous structure contributes to better disintegration and consequently to an easier processing and dispersion in soil. These properties make the tuffs and tuffites very suitable as reclaiming matters even for the poorest soils.

4. Marls

The application of marls can be considered for very permeable soils with acidic soil reaction as marls contain a considerable percentage of Ca - Mg component. The effective application of marls will be favourable for sandy soils (terrace sands - average grain size above 0.45 mm) by strengthening the sorption complex with concurrent application of fundamental nutrie[illegible] soil.

VII. ECONOMIC ASPECTS

Utilization of bentonite for light sandy soils reclamation is generally widely spread in many countries with developed agriculture. Bentonite acts as a soil sorbent mainly during the process of humification of sandy soils for originating sorption complex by bonding sand grains and organic colloids and for protection against fast percolation of water through the soil. The research results proved that bentonite reduced wash-out of water, affected as a stimulator of assimilation process, increased fertilizing efficiency and regulated soil temperature to a certain extent.

1. Social benefit - cost analysis of bentonite application in developing countries

During evaluation of any project of soil reclamation by bentonites in developing countries, impacts of such a project realization on social-economic conditions in the country are to be taken into consideration. These impacts may be expected to affect decisions about project realization:

(a) Increase of the food production on existing soil area may influence the market prices of food and thus result into increasing consumption by the poorest.

(b) The area of agricultural land may be expanded by bentonite reclamation and thus a favourable development within the given region can be promoted.

(c) In countries where foods belong to tradables, enhancement of their production will influence favourably their foreign currency exchange.

(d) Reduction of irrigating water consumption (application of bentonite in Egypt proved reduction by 50 per cent) may conserve the capital which would have to be spent on irrigation systems, otherwise. The yield of agriculture is 2 times higher per unit of irrigation water.

(e) Bentonite increases significantly the efficiency of fertilizers (by 30 - 40 pe cent) which may stop their soaring consumption and contingent imports. The reduced wash-out of fertilizers and chemical matters, which means a reduced pollution of environment is the acompanying effect.

2. Financial analysis of bentonite application

(a) Increase of agriculture enterprise's revenues

Reactions of particular plants on bentonite in different climate and soil conditions are listed in Table 1. These results may be summarized into the conclusion that within the Middle-European conditions the average increment yield ranges between 20 - 40 per cent. The arid condition experiments proved higher increments of yields amounting to more than 100 per cent. It has been proved by bentonite application to oranges, lemons, vegetables vine growing under assistance of the UNIDO-Czechoslovakia Joint Programme. The favourable effect of bentonite is evident in case of old and young cultures (bentonite introduction amounting to 7.5 wt per cent into desert soils increases yield of old citrus cultures by 100 per cent, young cultures yielded already 2 years after bentonite application. From Table 2 it is apparent that different plants exhibit different increase of the yield under otherwise identical conditions, the lowest effect being in the case of cereals in the following order: oats, barley, rye, wheat, maize (from the worst to the best). Potatoes, tomatoes, pulse and capsicum showed about two-fold higher effect.

From the revenues point of view the relative increase in per cent is not decisive but the absolute market price realized for the increment (on world markets, wheat and maize have two-fold price roughly than other cereals).

(b) Decrease of production costs

Results of experiments and practical applications showed that bentonite application to soil results in increasing of fertilizing and irrigation efficiency. In Egypt conditions, the need of irrigating water was lowered to one half conclusively. The increase of fertilizing efficiency by 30 - 40 per cent was proved by precision experiments in Czechoslovakia. Although these data cannot be simply economically interpreted (e.g. 40 per cent of costs savings for purchase of fertilizers) they are significant for financial analysis in special cases, e.g. larger areas will be able to be irrigated from one reservoir, etc.

(c) Costs of bentonite application

(1) Optimal dosage

All the field experiments aim at finding bentonite optimal dosage, the criterion being maximum yield. Most of available information sets out the optimal dosage in range between 15 and 25 tons per hectare (1 hectare = 10,000 sq.m = 2,471 acres). In Egypt, the UNIDO-Czechoslovakia Joint Programme proved 20 tons per hectare as optimum (in pure-sands soils). This dosage will be taken into account for economic calculations, the service life of application being 7 years.

(2) Costs of optimal dosage application.

Cost of bentonite - as it is mentioned in part 3B, non-prepared naturally disintegrated bentonite with the exchange capacity from 20 to 40 mval/100 g is used in agriculture. Since this bentonite is supposed to be mined in the open pit mines (the stock piles are considered for one year period only), relatively low price can be expected. Such raw bentonite is cca five times cheaper than the beneficiated one and the average yield per 1 ha is approximately sixty times higher than the price of 1 ton of bentonite (in Czechoslovakia).

Transport costs - manipulation and transport costs may exceed the price of bentonite in some cases. It is recommended to optimize the transport of bentonite since this can be the deciding factor in accomplishing a given project.

Costs of bentonite application into soil - in case of shrub plants or trees bentonite is simply heaped up to the plant. If corn is provided with bentonite homogenous strewing over the whole field surface will do. Distribution by means of various types of distributors or by blasting is also usual. In case of manual work the costs are equivalent approximately to the wages of 1 tractor driver and 2 workers + tractor operation within one day work.

Weathering costs - in this analysis the presumption of existence of the one-year storage dump is taken into consideration. Within this period necessary natural disintegration of bentonite takes place. The costs will correspond to the interest taken from that one year stock (roughly 10 per cent of bentonite price).

(3) Service life of the application

Service life of the bentonite application has been estimated at 7 years. The bentonite effect is decreased after 5 years of application, after 7 years new introduction of bentonite into the soil is necessary.

(4) Simplified model of bentonization economy

$$\sum_{t=1}^{5} R(1 + a)^{-t} = 20\,(P + J + Tx) + N$$

where R ... value of increase in yield per 1 ha after bentonite utilization, depending on the soil type, plant, climatic conditions, it ranges between 20 - 100 per cent

For rough assessment of revenues also prices of cereals as roughly indicated on world markets in July 1985 can serve:

Chicago	wheat	US $ / bushel = 2.99
Chicago	maize	US $ / bushel = 2.80
Winnipeg	rye	Can $ / bushel = 1.19
Chicago	oats	US $ / bushel = 1.41
Winnipeg	barley	Can $ / bushel = 1.237

(Bushel equals approx. to 48 pounds = 21.8 kg)

a ... required rate of return

The dosage of bentonite is considered 20 tons per ha.

P ... price of bentonite (1 ton)

J ... weathering costs per 1 t of bentonite (assessed at 10 per cent of bentonite price)

T_x... transport costs of 1 t of bentonite from the mine to the place of utilization

N ... Costs of application per 1 ha, estimated as the equivalent of 1 day wage of tractor driver and two workers together with 1 day tractor operation

2. Experiments concerning application of bentonite

The model mentioned above can serve for the coarse assessment of economic effect connected with the application of bentonite in an agricultural enterprise or farm without further experiments.

Precise answer with respect to effectiveness of bentonization projects can be made after long term observation tests and investment analysis (erection of mining and preparation equipment, irrigation, etc.).

The first phase of experimental work is aimed at gaining the information about technological data (optimum dosage of bentonite, water consumption, reaction of plants, effectiveness of fertilization, ecological influences, etc.) It can be carried out as a small-scale experiment (ca 1 ha of soil) at a relatively low cost.

The second phase of these experiments ought to be done at real working conditions (20 - 40 ha area) at the basis of mathematical statistical evaluation of experiments. For this phase, representative samples of soils are to be chosen for the relevant area. This phase is to generate data for exact economic evaluations.

3. Conclusions

(1) Experiences show that bentonite reclaiming will be profitable in all probabilities when local deposits of bentonites are exploited.

(2) Applications of bentonite for reclaiming purposes enable erection of economically effective mining and upgrading plants making thus possible the utilization of bentonite also for other purposes (fodder additives, foundry materials, ceramic raw materials, chemical products, etc.).

(3) Utilization of bentonites in case of soil reclaiming belongs to the cheapest technologies in this respect. For comparison, increasing the humus content in the soil by 0.5 per cent requires application of organic sorbents for 15 years period. Bentonite application must be accompanied by other agrotechnical measures and appropriate fertilizing since bentonite does not function as a replacement of other inputs but as the sorbent serves rather as a catalyst of their effects.

(4) Spreading of utilization of non-metallic minerals in agriculture can increase the production of food-stuffs. This task is topical especially in Africa and has significant social and political implications.

(5) The presence of bentonite in the soil substantially decreases the specific water consumption in case of irrigation, which often represents the limiting factor in the development of agriculture within the arid areas.

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APPENDIX

Table 1. Increments of Yield by Sorbent Application

Applied sorbent	Type of soil (% grain 0.01 mm/% humus)	Dosage ($t.ha^{-1}$)	Tested plant	Increase of output (%)	Application in
bentonite	9.2/1.3	20	potatos	18.6	Czecoslovakia
bentonite	9.2/1.3	20	rye	16.7	"
bentonite	11.1/1.7	20	barley	11.5	"
bentonite	11.1/1.7	20	maize	8.8	"
bentonite	6.4/0.4	20	barley & rye	22.2	"
bentonite	6.4/0.4	20	pulses	39	"
bentonite	6.4/0.4	20	maize	39.2	"
zeolite 60[1/]	N.A.[2/]	4	potatoes	30	"
zeolite 50	N.A.	10	capiscum & tomatoes	16	USSR
zeolite 50	N.A.	16	capiscum & tomatoes	33	"
zeolite 80	N.A.	16	paddy	40	Japan
bentonite	sandy soil	20	maize	80 - 90	Hungary
bentonite	desert soil (pure sand)	20	barley	90 - 100	Egypt
bentonite	"	20	vegetables	90 - 100	"
tuff	N.A.	20	maize	32.4	Hungary
tuffites [3/]	turf	20	maize	from 7.9 - 80.6	Hungary

Notes: 1/ Zeolite index marks the percentage of clinoptilolite.

2/ Not available.

3/ Tuffites of different carbonate content and different sorption capacity.

Table 2. Bentonite Effctiveness with Respect to Watering

Experimental year	Character of vegetation period	Index of bentonite effectiveness at the dosage	
		5t/ha	20t/ha
1964	dry	122.6	131.7
1965	moist	126.6	126.2
1966	moist	107.8	113.6
1967	dry	113.1	132.9

Comment:

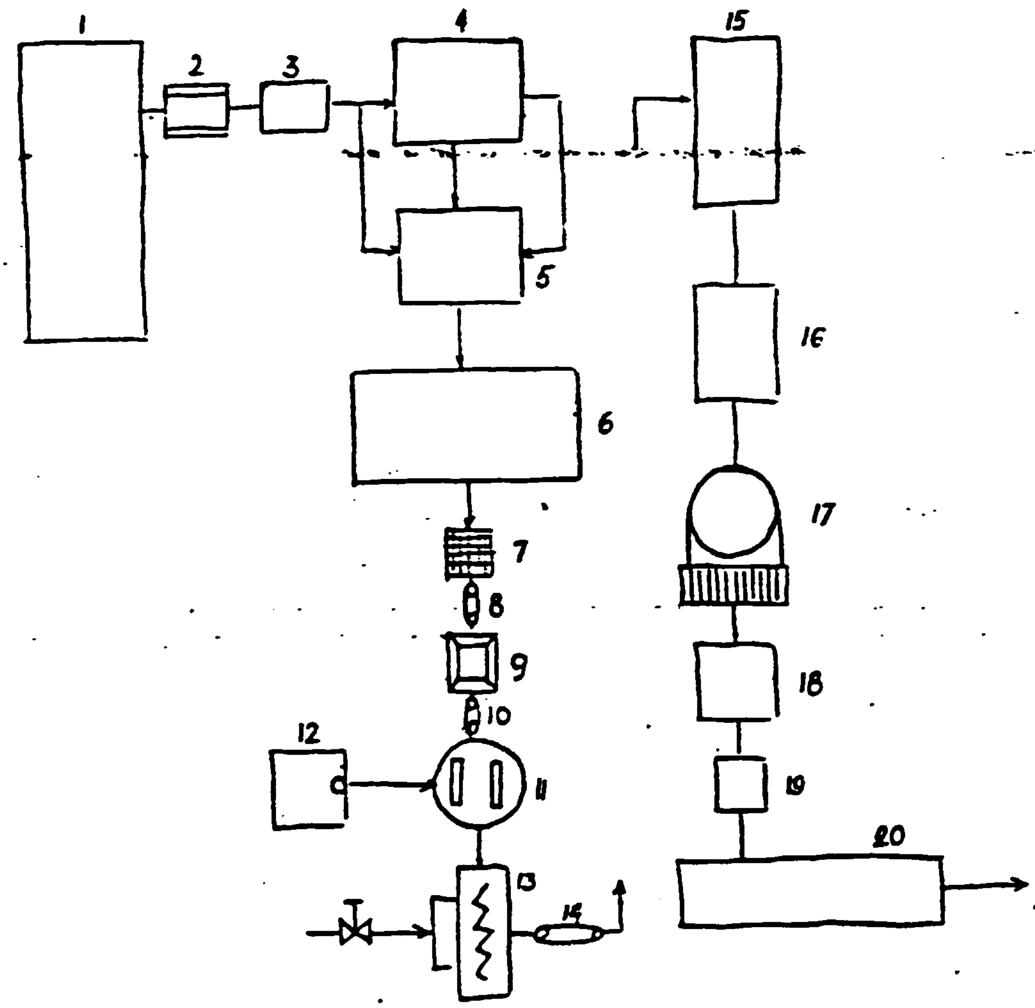
According to the results obtained in Egypt with applicaton of bentonites to citrus and orange trees, barley, beans and grapes field, the water demand has dropped down to 50 per cent of the original value.

Table 3. Desert Bentonite Application Results with Barley

Bentontite content in soil/wt (%)	Germination	Growth of stalks (%)	Relative cont of dry matter		Water use efficiency (%)	
			after 90 days	after 4.5 months	after 90 days	after 4.5 months
0	78.7	100.0	100.0	100.0	100.0	100.0
3	83.3	105.8	114.40	125.58	114.1	129.8
6	86.8	110.3	139.18	127.84	137.9	125.9
9	93.3	118.6	141.24	141.22	139.8	138.6
12	90.7	115.2	104.12	123.26	102.2	120.9
15	87.3	110.9	93.81	118.89	91.9	116.3

Figure 1

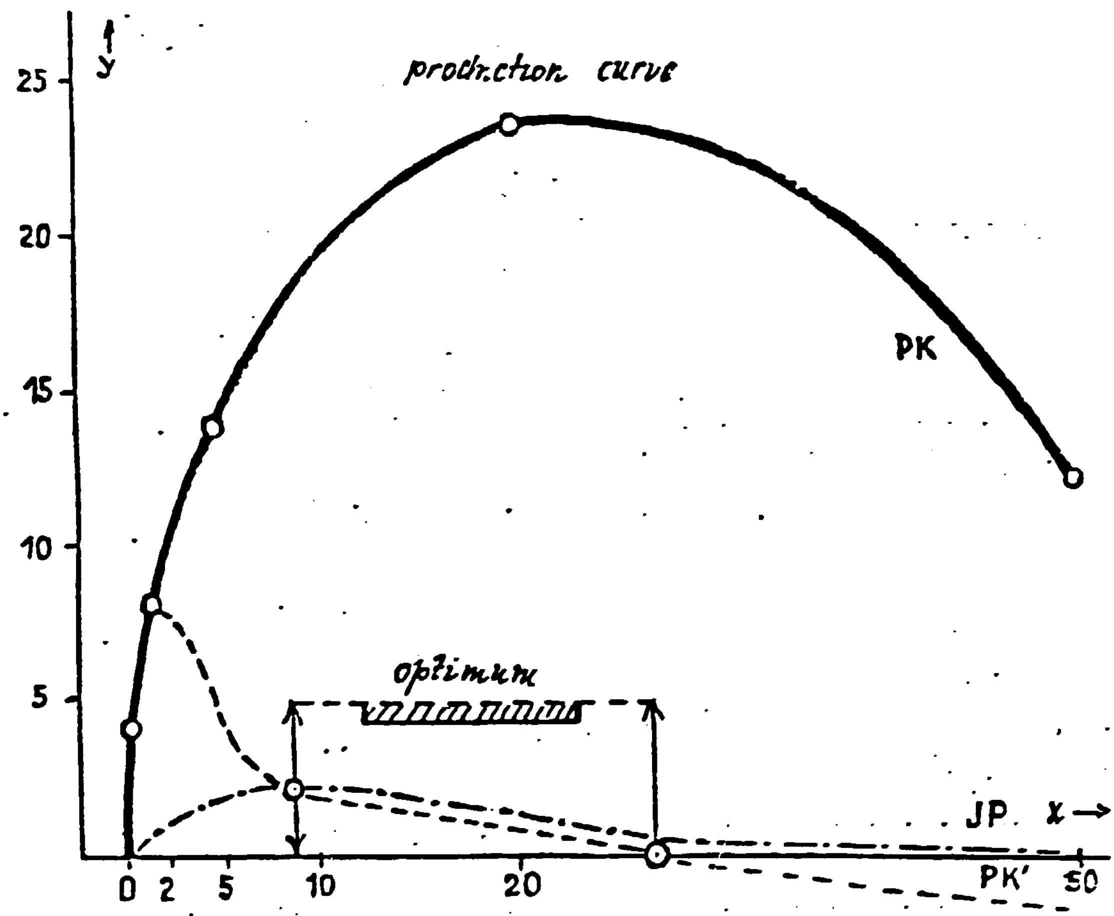
Block diagram of mining and industrial upgrading of bentonite



Legend

1. deposit
2. excavator
3. lorry transport
4. stock in quarry
5. stock in mill
6. weathering stock
7. feeding hopper
8. belt conveyor
9. box feeder
10. belt conveyor
11. pug mill
12. proportioner of Na_2CO_3
13. steampreheated worm blender
14. belt conveyor
15. rotary drier
16. elevator, crusher, belt conveyor
17. fine grinding mill
18. silos
19. special filling device
20. warehouse

Figure 2 Dependance of Yield Increases (sandy and argillo-arenaceous soils) on Bentonite Dosage including Marked Interval of Optimum



Legend: :

x - tons per hectare
y - yield increase
PK - production curve
PK' - first derivative of PK
JP - unit increase of yield

Figure 3 Relation between Reclaiming Efficiency of Bentonite and Type of Soil and Humus Content in Soil

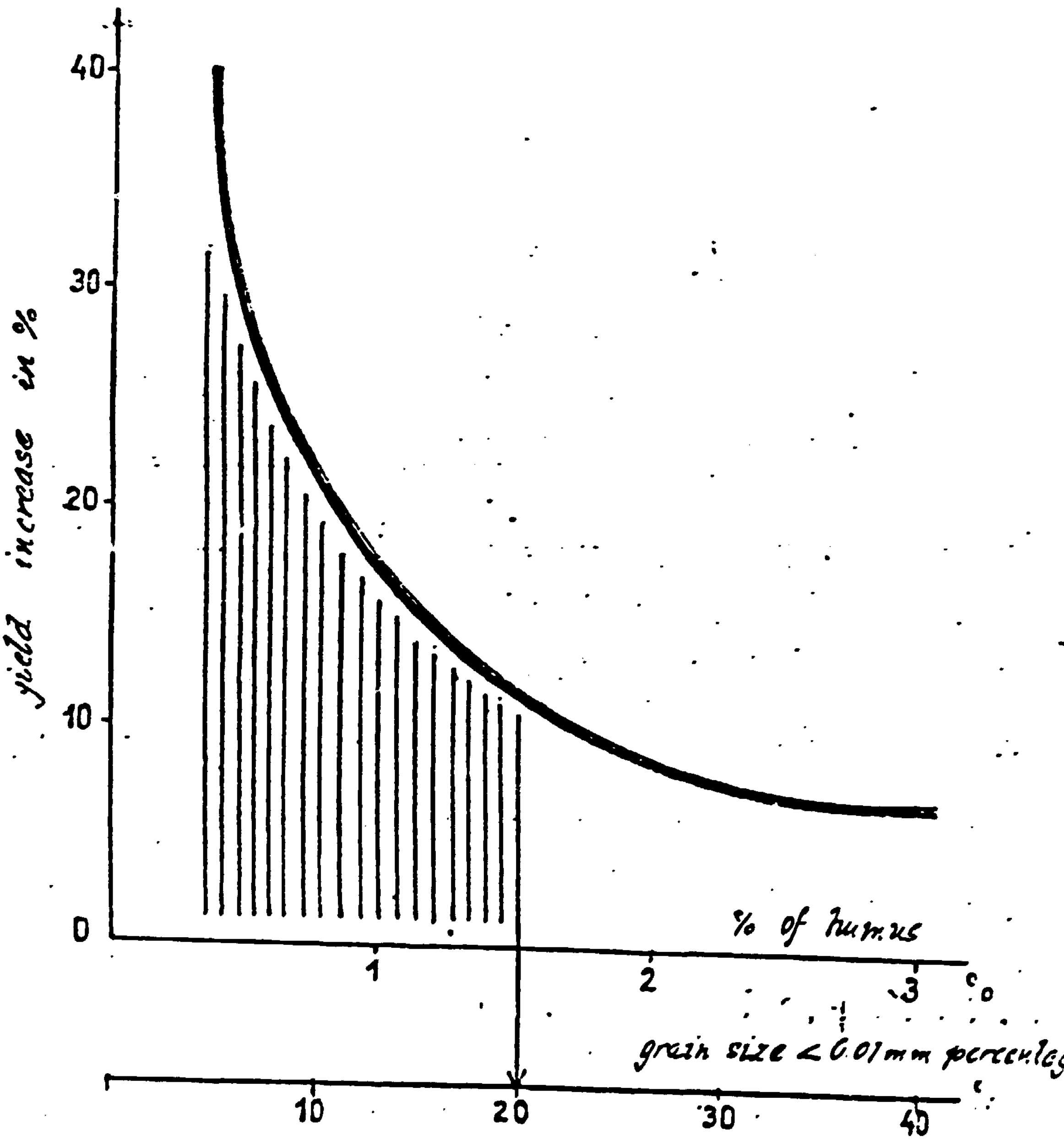


Figure 4 EFFECT OF BENTONITE ON HUMUS RETENTION IN ARENACEOUS SOIL AFTER FOUR YEARS

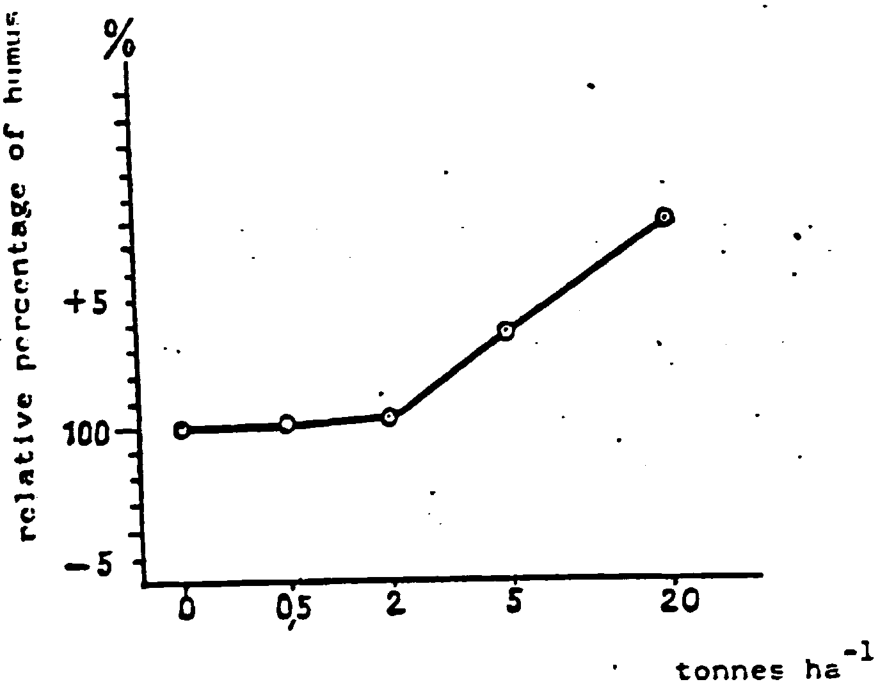
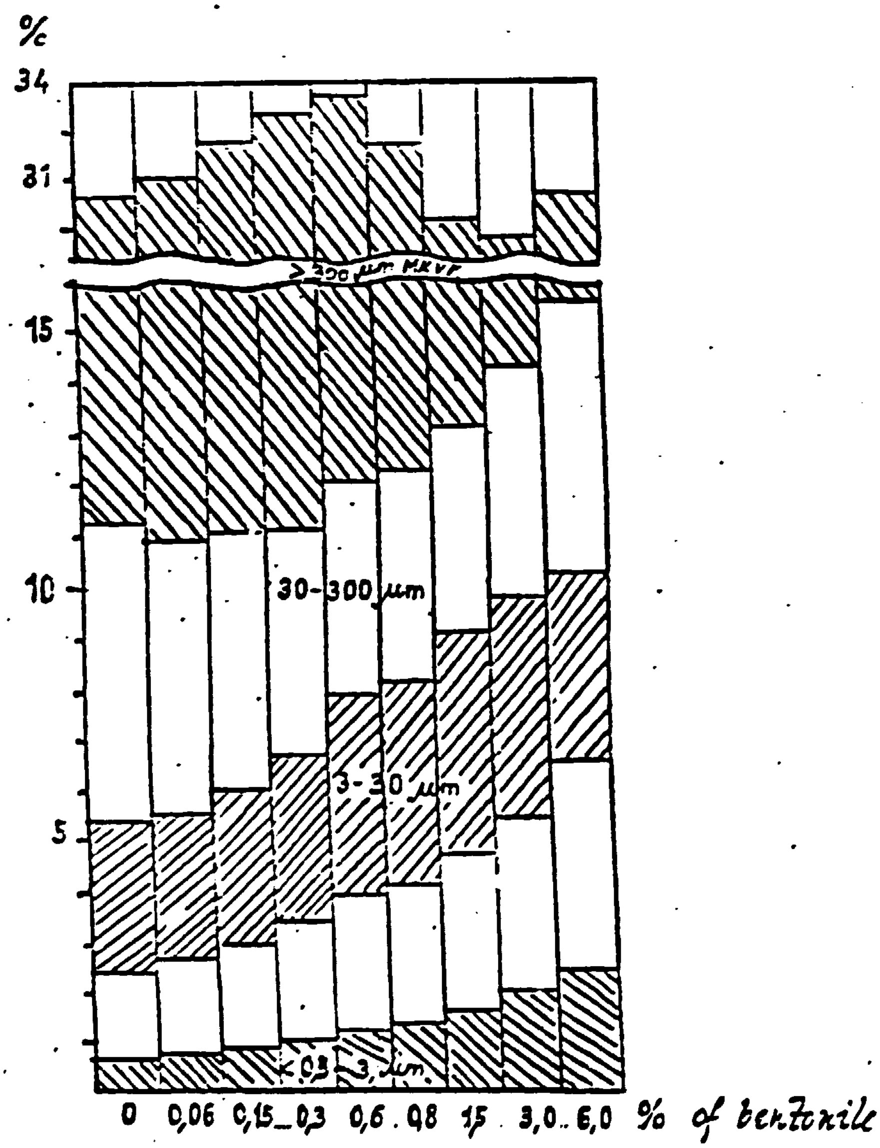


Figure 5 EFFECT OF BENTONITE ON PORE DISTRIBUTION IN ARENACEOUS SOIL



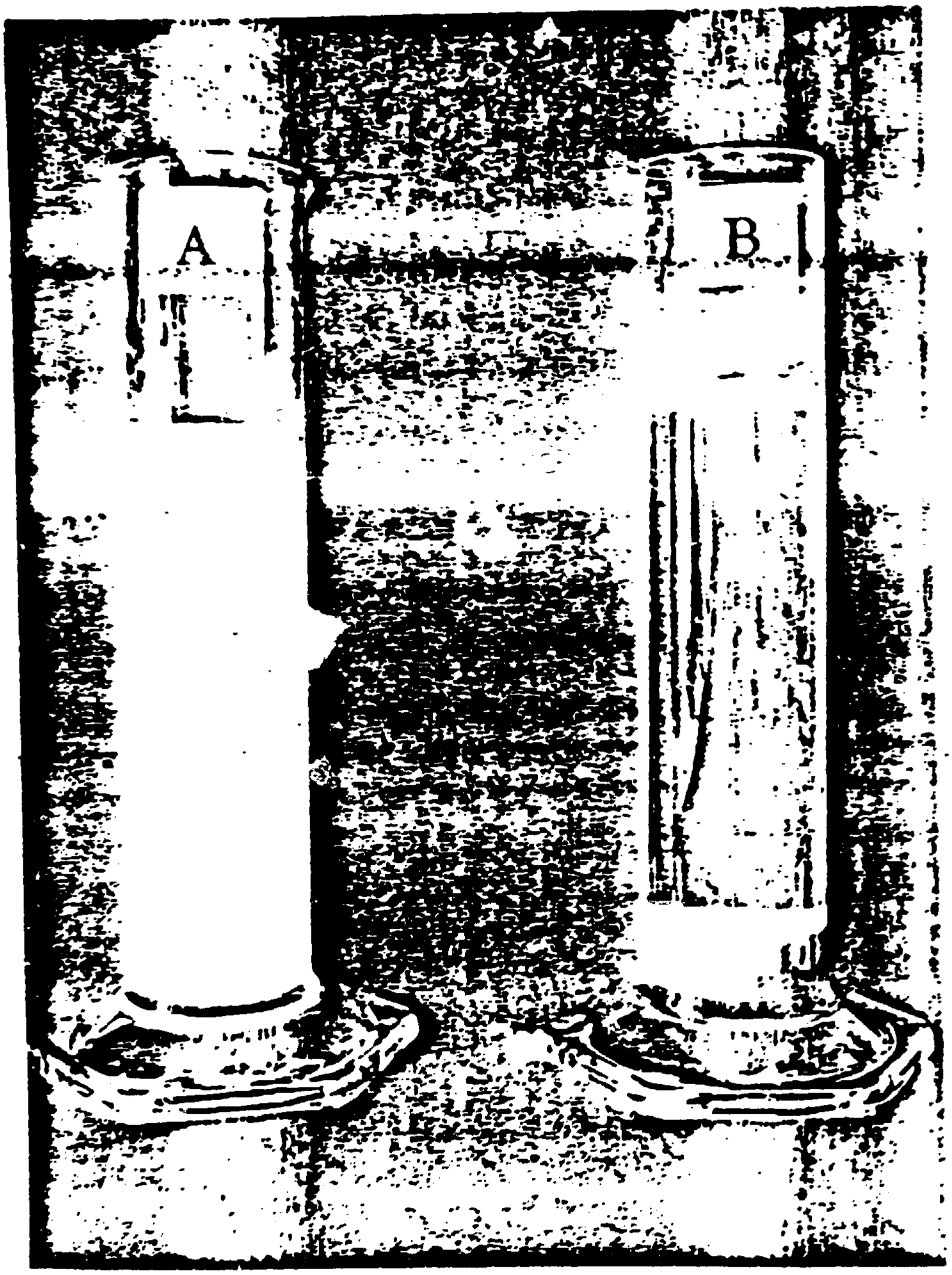


Figure 6 Application of bentonites for wastewater treatment /Pollution by acrylic emulsions/

Note: . A Wastewater from a chemical plant, without bentonite addition

B Waste water from a chemical plant, after 30 minutes of bentonite application

Paper No. 11:

THE IMPORTANCE OF PTT IN DEVELOPING A TELECOMMUNICATIONS MANUFACTURING INDUSTRY. PORTUGUESE EXPERIENCE.

(Presented at a UNIDO Seminar in Harare, Zimbabwe, 6-12 January 1986)

1. INTRODUCTION

When industrializing a country some steps have to be taken, following a consistent plan.

Trying to burn off some intermediate stages may lead to unsuccessfull actions, therefore delaying the process much to the contrary of accelerating it.

On the other hand, PTT policy guidelines will have, in some cases, an important impact in the way the process develops.

Another important issue is related to the typical situation of each individual country.

In trying to illustrate these issues, some experiences in Portugal can be interesting.

Therefore, the most significant were selected in order to help us to situate the problem of industrialization in the field of Telecommunications.

It is however important to say something about the Portuguese Telecommunications so that we understand the kind of enviromment where the experience was developed.

Portugal has today 10 million inhabitants and occupies the Western façade of the Iberian Peninsula, facing the Atlantic Ocean with an area of 100.000 sq km including the Archipelagos of Azores and Madeira.

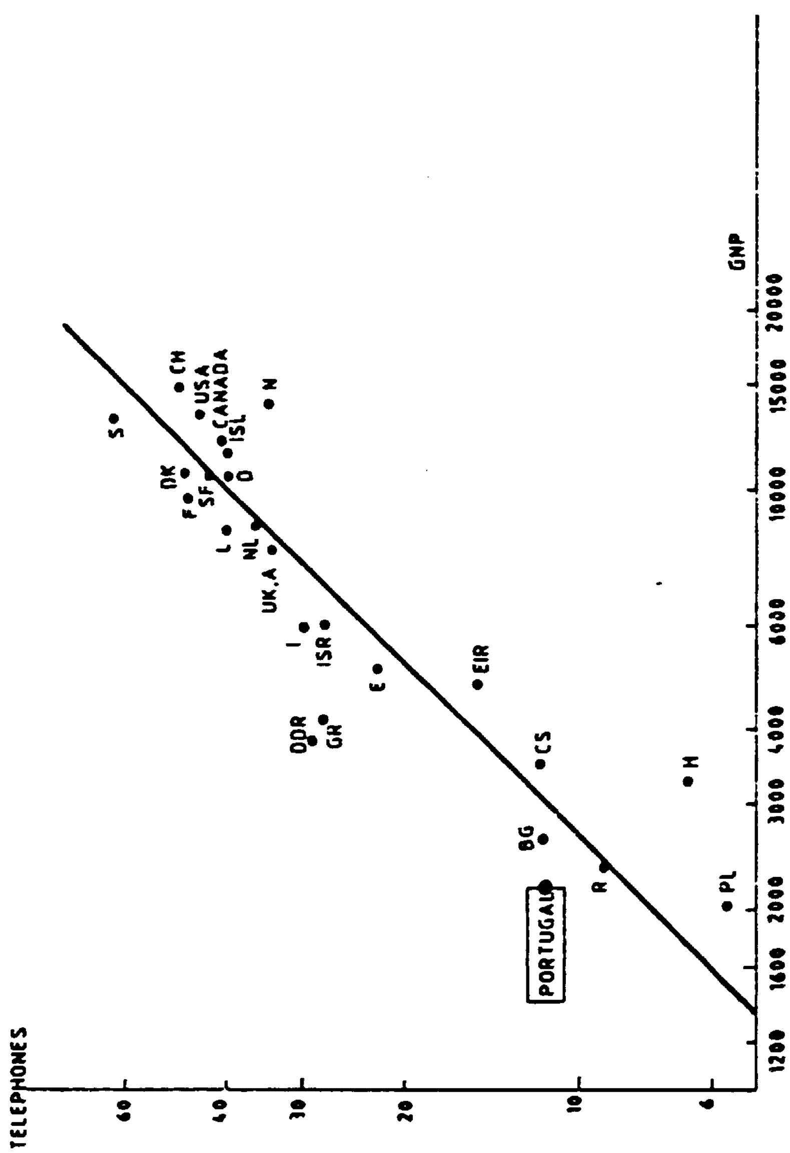
Fig. 1 shows Portugal in European terms, the conclusion being that it has a lower GNP than the other Western European Countries and also less telephones per hundred inhabitants.

Fig. 2 shows how many hours Portuguese subscribers have to work, on average, to pay for the telephone service in various European Countries. Again we see that, when comparing Portugal with other European Countries, a bigger effort is required to the common citizen in order to have access to the telephone service.

Finally Table I shows the differences in the number of telephones in various regions of Portugal. It is to be noted the disproportion of the number of telephones per hundred inhabitants when we compare the main cities with predominantly rural areas. As we see in Table I there are still areas in Portugal with a rate of telephones per hundred inhabitants very far from average European standards.

2. THE INFLUENCE OF POLICY GUIDELINES

Industrializing a country in the field of Telecommunications requires a strong will, namely within the PTT



Correlation between GNP and number of telephone lines per 100 inhabitants

FIG 1

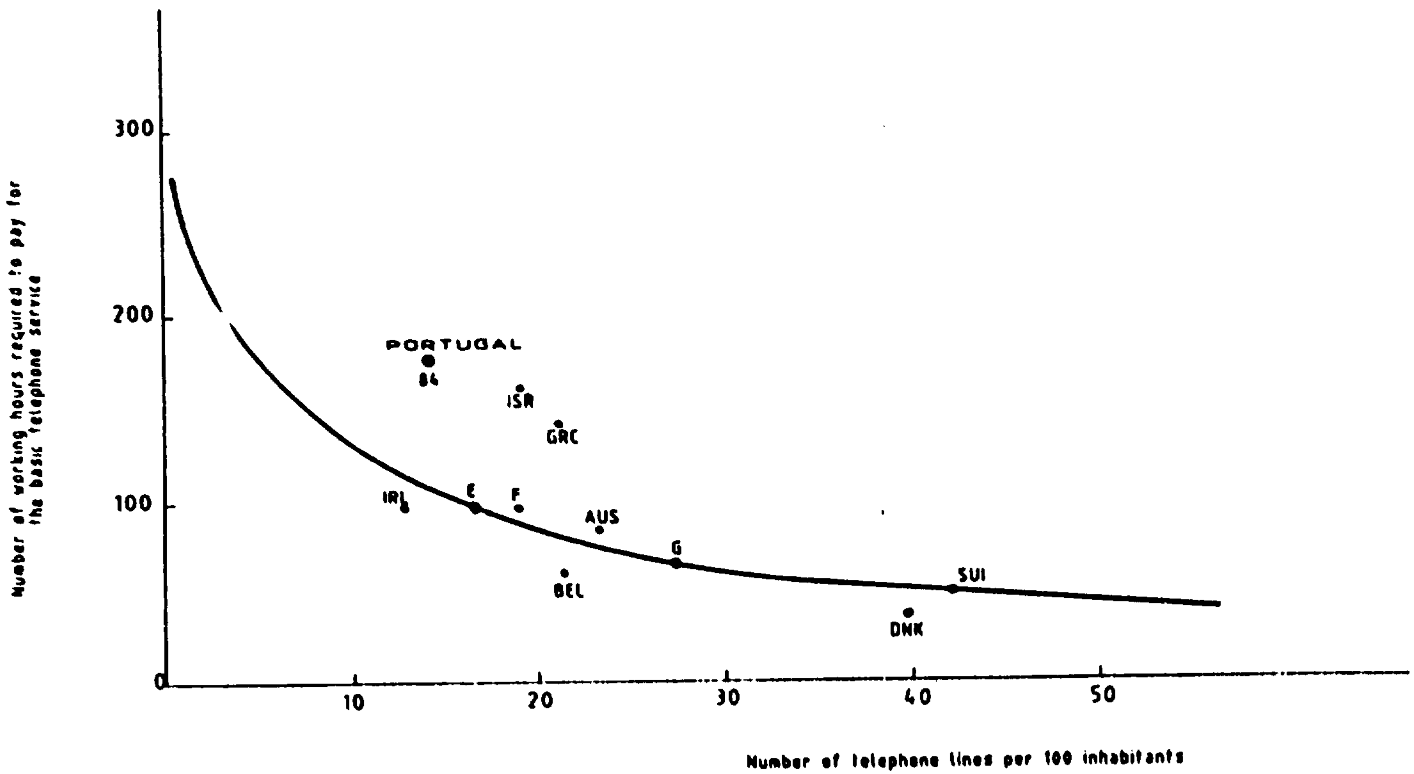

Number of working hours required to pay for the basic telephone service
300
200
100
0
10
20
30
40
50
PORTUGAL
84
ISR
GRC
IRL
E
F
AUS
G
BEL
SUI
DNK
Number of telephone lines per 100 inhabitants

FIG 2

TABLE I

Number of telephone lines per 100 inhabitants in various regions (situation in 1983)

	Population	Telephone line rate per 100 inhab.	Main activities
Lisboa	2 317 189	25.68	Industry, Services, Government
Porto	1 122 344	17.96	Industry, Services
Aveiro	247 434	9.54	Industry
Braga	571 244	5.62	Industry, Agric.
Coimbra	259 469	10.22	Industry, Services
F.Foz	59 948	12.00	Industry
Guarda	121 984	5.35	Agriculture
Setubal	130 283	12.1	Industry
Faro	146 468	12.5	Tourism, Industry
Odemira	29 257	3.90	Agriculture
Portimão	125 107	10.47	Tourism, Industry

organization, sole customer in the area. Particularly when, as today, we are living in a period when technological development, together with economical recession, are creating difficulties to the Telecommunications Manufacturing Industry.

Therefore a fiercy competition, characterizes the present situation in the world. More and more finance resources are required in order to develop new products so that an industry can be kept competitive; less and less people are necessary to operate a plant leading to labour problems not easy to solve in many countries. On the other hand electromechanical systems were characterized by a high percentage of personnel devoted to manufacturing whereas about 10% were designing new equipment; electronic industry also reverts the equation leading to about 80% of staff composed by highly skilled people devoted to designing including software engineering.

As a consequence, a new manufacturing industry has to be based upon a well known and controlled market, the large majority being the domestic PTT network.

It is also important to note that a new born manufacturing industry in a developing country will inevitably lead to delays in supplying the equipment, quality problems and probably more expensive equipment, in most cases, at least in an early stage. It will however create new jobs, increasing the independence of the country and allowing for a higher degree of intervention of local technicians.

As a consequence, it is obvious that PTT are an important agent in industrial development.

Therefore, if PTT are not prepared to give up some degree of freedom in selecting equipment there will never be a local manufacturing industry.

Due to the importance of PTT in the process, it is also interesting to say a few words about the present trends in Telecommunications management, and how they can affect the birth of an industry in developping countries.

Very briefly we can say that there are today two important issues in the world of Telecommunications, in terms of the basic philosophy of the service itself.

First of all some countries are adopting a deregulation philosophy, allowing for competition in some areas, and trying to offer tariffs to the public strictly linked to the cost of each single service. Secondly, there is also a certain trend towards the separation of the traditional activities of Posts and Telecommunications.

I will not develop the analysis of these two issues as not directly related to the subject of this conference. It is however important to comment briefly on their possible results.

As we know, the concept of cross-subsidization is part of Telecommunications tariffs in the large majority of countries. Particularly in developing countries cross-subsidization is a fundamental principle, as to maintain the service in faraway places. Tariffs in straight accordance with costs will inevitably lead to difficulties in developing countries.

Let us analyse the problem a bit more in deep.

Normaly there are two important subsidizing flows:

- Within telephony, mainly from international but also from long-lines towards the local networks

- From telephony, as a total, to other services, namely telegraphy

Deregulation, tends to reduce cross-subsidization effects, therefore leaving less room for strategic decisions towards the industrialization. As a matter of fact, industrialization will be mainly dependent upon the development of local networks as they represent the area where large series of equipment are utilized.

On the other hand, deregulation of international Telecommunications will lead to tariff reductions and increased costs which can only be covered with large quantities of traffic. As a consequence, the Telecommunications revenue of developing countries will be seriously affected, in particular as international Telecommunications represent an important percentage in their total revenue.

Cross-subsidization also occurs from Telecommunications towards the Posts. Therefore it may seem interesting, for the Telecommunications, to have separate organizations for both activities.

The first problem will however be the definition of how the national budget will subsidize the Posts. We may conclude that this will not be a problem of Telecommunications. Nevertheless Telecommunications also take normaly some advantages for being integrated with Posts in the same organization, namely in developing countries:

- first of all, in small villages, Posts and Telecommunications use the same infrastructure, including the staff; separation means that Telecommunications may have increased costs if proper agreements are not concluded

- secondly, Posts have normaly an important financial activity related to money orders which leads to a permanent finance capability without interests, which is beneficial for Telecommunications

As a conclusion, a policy guide-line towards separation of Posts and Telecommunications, has some risks which may affect the industrialization of a developing country in the Telecommunications area.

In short, we can conclude that PTT policy decisions represent a major issue as they can contribute or affect the will that may exist towards an industrialization in the Telecommunications area.

3. THE PORTUGUESE EXPERIENCE IN THE PAST

3.1. The introduction of the telephone service in Portugal

The first telephone communication in Portugal was established in 1877, in the city of Lisbon, using Bell telephone sets. Immediately after another trial was carried out by two telegraph operators (Hermann of the Portuguese Railways and Bramão of the State Telegraph System) who, later in 1879, applied to the Government in order to build the first telephone network.

In 1881, the Portuguese Government decided to open an international request for proposals, in order that the public telephone service should be introduced in the Country.

The Edison Gower Bell Telephone Company of Europe was the only bidder. Therefore, in January 1982 it was granted a franchise authorizing the establishment of a Portuguese subsidiary, The Anglo Portuguese Telephone, that would build and operate the telephone networks of Lisbon and Oporto, the two main cities in the country. The Company still exists as a State owned Corporation named Telefones de Lisboa e Porto (TLP). The first public telephone network was inaugurated in Lisbon, the 26 of April 1882. It consisted of a mannual switching centre and 22 subscribers. During the same year of 1882 the Oporto network was inaugurated.

In 1890 the Company had 2.151 telephones in service; 3.051 in 1990; 6.263 in 1910.

In 1926 the Government also decided to grant a further franchise to another Company, now in order to introduce the new radio technology in Portugal. The objective was to start international service on a world wide basis including also the communications with overseas territories and the Archipelagos of Azores and Madeira. The franchise was granted to Marconi Wireless and Cable Telegraph Company which set up a subsidiary called CPRM - Companhia Portuguesa Rádio Marconi. The Company still exists with the same name and responsibility, the difference being that the stock has been entirely Portuguese for over twenty years.

3.2. The birth of a real telephone network on a national basis

In 1930 Portugal had 6.802.429 inhabitants and a total of 37.334 telephone lines leading to 0.49 telephone lines per 100 inhabitants. A high concentration existed in Lisbon and Oporto with 28.963 telephone lines against 8.412 in the rest of the country.

In 1933 the Government decided to appoint a new Post Master General, Mr. Couto dos Santos, with the main objective of promoting the installation of a national telephone network.

It is very important to analyse what happened in the Portuguese Administration of Posts and Telegraphs from 1933 on, as the basic guidelines set up by the new Post Master General have lead ultimately to a Portuguese Manufacturing Industry in the field of Telecommunications.

It is also very important to analyse the steps taken as most of them still represent today basic issues in the process of industrial development.

When Mr. Couto dos Santos was appointed Post Master General the Administration of Posts and Telegraphs only had five University level technicians:

- one was responsible for the operation of the national telephone network management

- one was responsible for engineering

- one was responsible for buildings and other infrastructures in general

- one was responsible for telegraphy

- one was responsible for various other technical tasks

A few other technicians with minor education background formed the staff, most of them trained by the Admnistration.

The development of a telephone network would require three basic actions:

- A Development Plan

- The reorganization of the service towards a more dynamic philosophy

- Training in order to increase the number and skills of the new staff required to perform the two initial actions

3.2.1. Training

In 1933 Portugal had two Colleges teaching the so called Electrotechnical Engineering:

- Faculdade de Engenharia do Porto, in Oporto

- Instituto Superior Técnico, in Lisbon

Among the best students, three were chosen in each College and hired by the Administration.

When they were hired, their training programme had already been defined.

By then, in Europe there were three countries with significant manufacturing companies in the telephone area:

- England with ATE of Liverpool

- Germany with SIEMENS of Berlin

- Sweden with ERICSON of Stockholm

After a short period in the Portuguese Administration, the six new-hired staff were divided in three groups of two and sent for a training programme of six months in each of the three mentioned countries (England, Germany and Sweden). The training programmes were basicaly carried out in the Administrations of those countries including also some parts in the referred manufacturing companies.

When the six came back to Portugal, they were integrated in various areas of the Administration in order to start the implementation of the three basic actions above referred.

In terms of training, an extensive programme was defined directed to other newhired staff but now including all kinds of technicians.

Later on, in 1939, when ATE was chosen as the supplier of strowger equipment for the new automatic networks of Braga and Coimbra, the Administration was already able to define an on-plant training programme for a team of:

- one six-year College technician (MSc level)

- four three-year College technicians (BSC level)

- ten high-school level electricians

that would spend six months in the ATE plant in Liverpool.

Training was therefore a basic and essential action towards the implementation of a telephone network, and as we will see later on, it ultimately lead to high-skilled technicians at various levels, allowing for the birth of a telephone manufacturing industry in Portugal. In fact the results of the training programmes were such that the above mentioned technicians already participated in the installation of the Coimbra network inaugurated in 1942.

3.2.2. <u>Reorganization of the Administration of Posts and Telegraphs</u>

Careful selection of new staff and their training had created the basic conditions to start the two other actions, namely reorganization.

However, that would not be enough to modernize the Administration of Posts and Telegraphs.

In 1933, management was much easier than today but, nevertheless, a group of young, well trained staff, could not have the experience to reorganize the service.

Therefore, later in 1936 Mr. Couto dos Santos also agreed with the Swiss Administration on a consultancy provided by a Swiss expert who spent two years in Portugal performing the task of Managing Director of Telecommunications. The six newhired staff were their deputies in various areas.

The necessary conditions were so created in order to start the reorganization of the Administration particular care being taken with:

- maintenance standards and procedures

- traffic statistics and forecasts

- acceptance tests of new equipment

- intervention of Portug[illegible] staff [illegible]he installation of new equipment

3.2.3. The Plan

In July 1934 as a consequence of the actions described in 3.2.1 and 3.2.2, the Administration of Post and Telegraph could define the specifications for an international request for proposals concerning the definition of a basic pre-development plan.

As a result a basic development plan was concluded by the end of 1936. It was then completed with some supplemental plans regarding buildings and accessory equipment.

An extensive economical and financial analysis allowed for a final Plan approval by the Government, in August 1937, leading to an over-all development programme to be implemented in fifteen years, from 1938 through 1952.

The Plan was a very important document in the process of industrialization and included the following chapters, which we will analyse very shortly:

a) Basic scheme of the telephone network

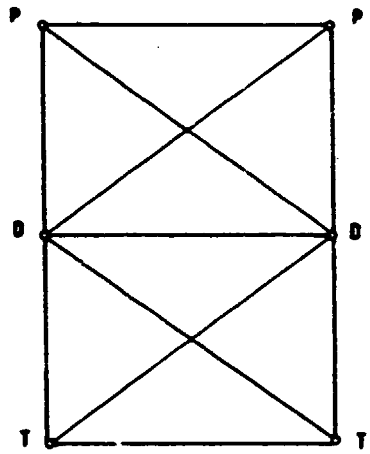
For the first time we could speak of a network as shown in fig. 3, including three types of switching centres:

- (T) for terminal centres

- (D) for distributing centres

- (P) for main transit centres

The concept of 'group of network' was also introduced for the first time as shown in fig. 4, defining a number of small



T - Terminal Centre

D - Distributing

P - Main Transit

Basic Diagram of the long-lines network

Fig. 3

switching centres directly connected to the terminal centres of the long-lines network.

54 groups of networks were defined in order to ensure the total coverage of the country. Automatic service was defined as desirable in order to offer a 24 hour per day service. However due to the costs involved with a fully-automatic network, semi-automatic service was assumed for small and rural areas as an acceptable alternative.

b) Forecasts

Forecasts were established for various years and for every single network.

It is interesting to note that the Plan approved in 1937 referred a forecast of a total of 18.700 telephone lines in 1940 and 41.700 in 1950, not including Lisbon and Oporto areas.

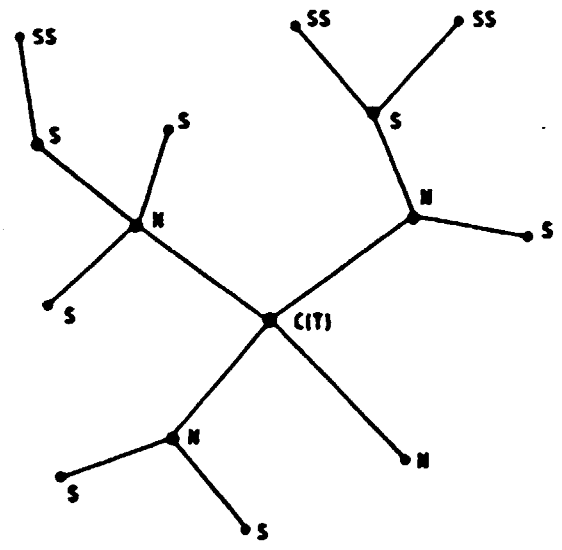
The results of the actions undertaken were very positive as the actual figures were 20.668 telephone lines in 1940 and 52.529 in 1950.

c) Layout of the long lines network

A layout was defined following the international standards set up by the ITU, with international automatic service on a direct dialling philosophy.

d) Modification of the existing network

A number of studies were carried out and their results included in the Plan in order to allow for the integration of the existing network with the one to be developed. Extensive



C - Group Centre (Terminal Centre in the long-lines network

N - Nodal Centre

S - Satellite Centre

SS- Subsatellite Centre

Diagram of a Group of Network

Fig. 4

modifications were also described in order to adapt the existing network to the new standards.

e) New specification in order to improve the quality of the network

New specifications were set up in order to improve the quality of the network.

They regarded electrical and mechanical aspects, burying techniques, new technologies to be introduced, etc.

f) New routes

The Plan included a detailed description of every new route to be implemented in order to offer telephone service in some faraway areas where it did not exist.

g) Circuit forecasts for the international and long-lines networks

The plan included an extensive analysis of a set of parameters trying to forecast circuit requirements for the future in order to make transparent the interconnection between the various groups of networks.

h) Lisbon-Oporto connections

The influence of Lisbon and Oporto, not only by being the two larger cities in the country but also due to their geographical location, lead the planners to pay particular attention to the interconnection between the two cities where a separate organization operated the telephone networks.

Therefore, the interconnection of the two cities represented a separate plan included in the general plan with specific financial and technical analysis.

i) Transmission Plan

Carefull attention was paid to the transmission characteristics of the network in order to allow for the communications between any two points in the country and also the interconnection with other countries through the new-born international network.

j) Type of telephone system to be adopted

An extensive analysis of the service characteristics was carried out.

For rural areas , semi-automatic and automatic service were alternatives analised in the Plan. However no definitive conclusions were presented due to the difficulties in defining the pratical implications of the two alternatives.

It was however assumed that:

- automatic service was desirable in the totality of the network
- manual service would not allow for a 24 hour per day service due to personnel costs
- in a first step, it would be acceptable to offer manual services in some areas with a small number of subscribers, particularly whenever the telephone service could be initiated by using equipment taken from other areas where it was to be replaced by modern fully automatic systems

Capital requirements and tariffs were also extensively analysed in the Plan.

l) Priorities

Priorities were also established in implementing the Plan paying particular attention to the needs of generating the necessary funds to allow for the high annual investment required.

m) Equipment characteristics

Standards were set up in order to allow for harmonizing the various networks to be installed.

Local and trunk switching equipment were carefuly specified as well as transmission equipment.

n) Maintenance

Particular attention was paid to the maintenance procedures including tests and measurements specifications.

o) Reorganization, staff and general specifications

The Plan also described the actions to be undertaken regarding the necessary reorganization of services, personnel requirements and extensive specifications of various types of minor accessories essential for the network.

p) Budget

Budgeting procedures were also defined in order to facilitate the establishment of annual budgets and also its distribution among the various projects to be implemented.

3.2.4. General comments on the actions undertaken in 1933

The Plan was undoubtely the most important document produced in order to allow for the modernization of the Portuguese Telephone Network. For the first time it was possible to have a forecast on the quantities of equipment to be installed during a long term period.

It is however important to stress that:

- on one hand the Plan had been entirely produced by the staff of the Administration, therefore they were intimately linked to its recommendations

- on the other hand it was possible to develop the Plan as a result of an extensive training programme of newly hired carefuly chosen staff

As we will see, shortly after the begining of its implementation, it was then possible to start manufacturing equipment in Portugal as a result of the volume required for the various components, but also as a result of the deep knowledge of the technical characteristics of the equipment. And I think these were the two basic ingredients favouring the birth of a manufacturing industry in Portugal: - training enhancing the capability of knowing well the requirements in their various aspects.

It is also important to note the length of the period of time elapsed since Mr. Couto dos Santos was appointed Post Master General until the first results were shown. He was appointed in August 1933; the request for proposals regarding a pre-plan was issued one year later in July 1934; the final Plan

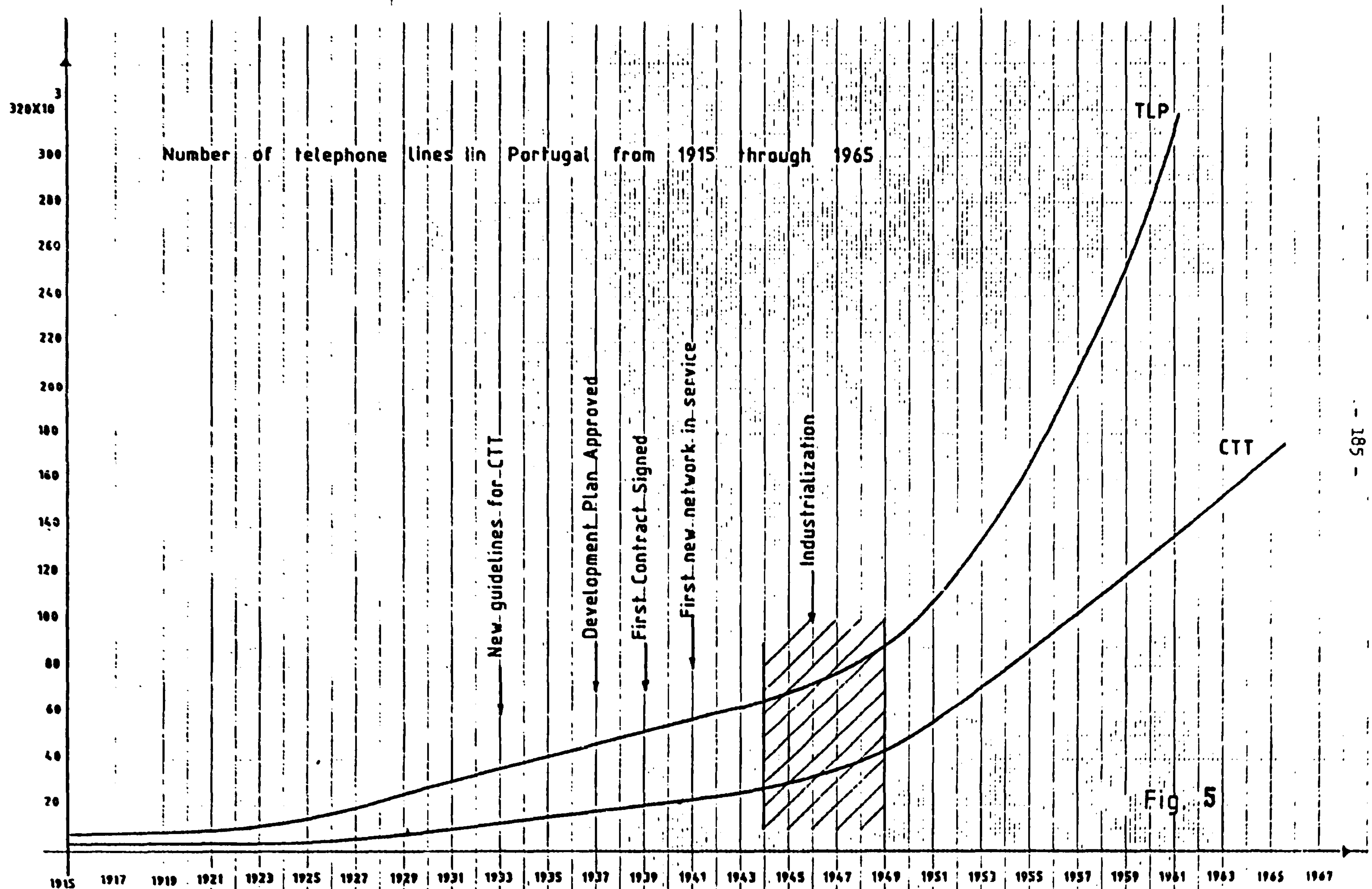

Number of telephone lines in Portugal from 1915 through 1965
320X10^3
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
TLP
CTT
New guidelines for CTT
Development Plan Approved
First Contract Signed
First new network in service
Industrialization
1915
1917
1919
1921
1923
1925
1927
1929
1931
1933
1935
1937
1939
1941
1943
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967

Fig. 5

was approved in August 1937; the first contract was signed in 1939; the first network was opened to the service in Coimbra in October 1942. Nine years in total.

3.3. INDUSTRIAL DEVELOPMENT

3.3.1. First problems in implementing the Plan. Manufacturing some basic items

From 1941 on the big effort has been pointed at the implementation of the Plan.

The Administration was no longer the Administration of Posts and Telegraphs but its name was changed into the Administration of Posts, Telegraphs and Telephones, known as CTT like today.

In Fig. 5 we can show the pratical result of the actions undertaken from 1933 on, by taking a look at the number of telephone lines existing during the various years from 1915 through 1965.

After 1941, when the first strowger equipment was installed, the main concern of the CTT's senior staff was directed at the organization of maintenance. Particular care was therefore taken in setting rules and procedures ensuring the timely trouble shooting, repair and all the necessary preventive maintenance.

These concerns allowed for another step in training also leading to some difficulties with the suppliers due to the care put in the acceptance tests. However, the resolution of those difficulties was another way of training more staff.

During the installation works a relevant fact occurred leading to important troubles in carrying out the completion of new networks: I am referring to World War II.

In fact, most of the raw materials were imported from or through other countries highly disturbed by the war; on the other hand, ATE of Liverpool was the main supplier of switching equipment, obviously going through some difficulties due to the war.

High inflation, also caused by the war, was another factor disturbing the rythm of development.

Finaly, as more telephone lines were offered to the public, a boom of applications for new telephones occurred further difficulting the progress of works.

Obviously, the traffic was also growing very fast creating more difficulties in responding to the demand, particularly in the long lines area where service did not exist in acceptable conditions before 1933.

This situation lead to several decisions:

- a small work-shop was installed by ATE in Lisbon, assembling telephone sets

- there was already a small factory - CEL-CAT, nearby Lisbon, manufacturing electrical wires and cables for building installations; due to the existance of a Plan to be implemented during an important number of years, CTT managed to convince the owner to manufacture various types of telephone wires and cables; later another company - Avila, was set up manufacturing telephone cables

- most of the networks used open-wire lines, particularly in rural areas; it was therefore necessary to draw copper wire, what was done in another factory already drawing copper wire for electrical cables and steel cables - Companhia Nacional de Trefilaria

- ceramic insulators were also manufactured in another existing factory specialized in ceramics and porcelain - Vista Alegre

- a lot of other small acessories were also manufact ed either in CTT workshop or in small factories

Seen from today all these actions may look simple. We m however remember that all this happened roughly fifty ye s ago when the telephone network represented the high techno... of those bygone days.

Fifty years ago the simple manufacturing of a eramic insulator was a problem difficult to solve even using the skills of a wellknown company in the field of ceramics. T: first insulators were rejected as not complying with the CTT specification. And that means that there was a specification and a laboratory capable of testing the insulators!

Therefore those were very difficult decisions requiring a lot of skill and so it is very important to stress the importance of the previous three basic actions undertaken: training, organization, planning.

As a conclusion we can say that the problems arisen from World War II contributed to the birth of a manufacturing industry. However that was possible due to the skills acquired by CTT from 1933 through the begining of the war in 1939.

3.3.2. The manufacturing of switching equipment

In 1944 another important fact occurred.

Due to the traffic growth, the two old long-lines manual switching centres in Lisbon and Oporto were unable to carry all traffic. For various reasons it was not possible to install a completely new long lines network. Therefore the solution should be a new long-lines switching centre in Lisbon interconnected with the existing one. In Oporto the solution was easier as the existing switching centre could yet be enlarged.

The difficulty in operating the same traffic through two different switching centres together with the difficulties due to the war lead jointly to a solution designed and installed by CTT. As a consequence, in 1946 the first switching centre entirely designed by CTT was put in service, using components imported from ATE in England. In 1947 the new switching equipment was also put in service in Oporto using the same design and concept.

Meanwhile, during the period from 1946 through 1948 long discussions took place in order to solve basic issues which were not clearly defined in the plan approved in 1937.

In fact, the Plan approved in 1937 pointed towards the full automatic service as a main guideline. However it had left open the problem of small rural networks assuming that they could be designed as to provide semi-automatic service should a 100% automatic philosophy not be possible due to the lack of funds to cope with the investment needs.

The first choice was to install semi-automatic stations with capacities ranging from ten to fifty subscribers. Mainly because of investment constraints, due to the fact that the suppliers did not manufacture automatic stations smaller than 200 subscribers.

This situation lead CTT to use the experience acquired in order to design smaller and cheaper stations that could offer an adequate response to the demand allowing to develop a 100 % automatic philosophy within the annual budgets approved by the Government.

In January 1950 the first studies were initiated leading to the foundation of CTT's Research and Development Centre in Aveiro, a city in the North of the Country. Later in the 70's this same centre gave birth to a College of Telecommunications that started in the same premises and was later inserted in Aveiro University.

From 1950 through 1955 the Research and Development Centre, Centro de Estudos de Telecomunicações, CET, designed and developed party line equipment and small switchers which were very economical not only by its cost but also due to the fact that they used rooms smaller than the ones required by imported equipment. They also required little maintenance which was an important feature in rural areas. Those were the ATU series, a step-by-step system using uniselectors. Later the following were manufactured, some of them being still in service in the network:

- ATU-52 for 42 subscriber lines

- ATU-54 for 200 subscriber lines expandable to 400 subscriber line

- ATU-61 a revised version of the ATU-54

During the 1960 decade CET was able to design the first long-lines fully automatic switching equipment using four wire switching and multifrequency code signaling. Those were the IUA-57, the first in Europe using four-wire switching.

In 1962 a more elaborate switching equipment to be used in small rural areas was designed using a basic philosophy similar to the strowger system, taking advantage of the experience gained by CTT staff in that kind of technology. It was the SASC-1, replaced by SASC-2 in 1970, this later one using cross-bar technology, prepared for capacities above 1.000 subscribers.

New rural exchanges were developed after 1970 with capacities ranging from 80 to 800 subscribers which are still today the basic equipment installed in rural networks.

It is also important to refer some other important projects carried out at CET during the 70's:

- New numbering plan and design of new long-lines switchers

- International switchers using CCITT signaling systems nr. 4, nr. 5 and R2

- PABX's and line concentrators

As a result, in 1979 the Portuguese Telephone Network used two types of switching equipment:

- imported technology, manufactured in Portugal for the networks of Lisbon and Oporto

- national technology, manufactured in Portugal for the rest of the country

The referred actions taken by CTT from 1946 on lead to setting up a national industry manufacuring switching equipment which was based upon two foreign manufacturers:

- Standard Eléctrica, a subsidiary of ITT

- Automática Eléctrica Portuguesa, a subsidiary of ATE later bought by Plessey

Standard Eléctrica, still today a subsidary of ITT, started manufacturing loading coils and switching equipment using ITT technology. Later on they enlarged these line of products with several electronic components and equipments (HF and VHF equipment, TV sets and VCR's, MUX, etc.). They also manufacture switching equipment designed by CTT according to the SASC concept.

Automática Electrica Portuguesa started as a small ATE workshop assembling telephone sets. It was recently bought by a Portuguese Company, CENTREL. The merge is today known as CENTREL Automática Eléctrica Portuguesa - CAEP. They have a line of products similar to Standard Eléctrica plus an entire plant devoted to manufacturing telephone sets. They also supply coinboxes, automation systems, etc.

It can be seen from this short description the importance of CTT skills in promoting the local manufacturing industries, mainly due to an extensive training programme with a pre-training in another countries but also through the design and maintenance of the Portuguese Network.

On the other hand these guidelines allowed for a 100% automatic philosophy in the network as they have made possible the installation of small capacity switching equipment, cheaper and adequate to the local traffic conditions.

It is also important to note the impact of these industrialization actions in the telephone networks of Lisbon and Oporto as shown in fig. 3 although using imported technology.

Finaly, we cannot forget the birth of University of Aveiro, during the 70's, intimately linked to CET. Actually the College of Telecommunications was born using CET premises and most of its experience.

4. THE MODERNIZATION OF THE PORTUGUESE NETWORK

The decade of 1970 was characterized by the introduction of new technologies mainly in the field of the telephone and telex services.

Generaly speaking we can say that the philosophy adopted during the thirties, was again guiding the basic decisions.

As significant examples, it is therefore important to refer some steps taken in two areas:

- the most important one related with the introduction of digital equipment and computer controlled switchers

- another one is related to building satellite earth stations for domestic and international service

The first shows an example in an area where Portuguese technology exists; the second how to maximize a project with imported technology favouring the participation of local industries.

4.1. Digital equipment and computer controlled switchers

During the decade of 1970 very important actions were taken towards the introduction of digital equipment.

When we deal with digital equipment in a telephone network people tend to think of computer controlled switchers using PCM techniques.

However, we must not forget the importance of the transmission network, not only because it represents roughly 50% of the over-all investment, but also because the efficiency of a digital network is related to its degree of digitalization.

Therefore, during the 70's some important decisions were taken in Portugal:

- the larger capacity systems to be installed in the urban areas of Lisbon and Oporto should use imported technology like in the electromechanical era; the equipment should be manufactured in Portugal in the two existing plants and so Standard Eléctrica and CAEP had to find adequate partners

- some individual decisions should be taken in order that the Portuguese technicians could start dealing with computer controlled switchers, but not interfering with the negotiations towards the selection of adequate partners for Standard Eléctrica and CAEP

- the experience in designing small switchers should be used in order to try to adopt the same philosophy used during the 30's in small rural networks; CET should also develop some digital transmission equipment

- the manufacturing industry could also take some steps towards the fabrication of digital equipment not interfering with the decisions to be taken regarding switching systems

4.1.1. <u>Selection of adequate partners for the existing industries</u>

The process of selection of two partners for CAEP and Standard Eléctrica is not yet finished.

As it is well known, when a telephone industry switches from electromechanical to electronic equipment, there are a number of problems to be solved namely related to the lesser number of people required by the electronic industry.

The negotiations are therefore very difficult as they do not regard only the quality of the technology to be adopted but a large number of other important issues, namely those related to labour problems.

For the time being there has been a predecision, selecting the partner to be associated with CAEP. The partnership for Standard Eléctrica shall be submitted to the Government in six months time.

In any event we may say that the know-how of the Portuguese technicians, acquired during the process described in 3, is largely contributing to the analysis which is being carried out in this field.

4.1.2. <u>Intermediate decisions</u>

Two important decisions were taken during the 70's allowing for the training of Telecommunications staff. TLP installed a computer controlled electromechanical transit switcher in the Lisbon network. The same happened with CPRM for the international service.

These two computer controlled switchers allowed for the training of some technicians without interfering with the adoption of an electronic technology for the switching equipment, as they represented individual equipment that would not be manufactured in large quantities.

The same happened in 1978 with a decision taken by CPRM in order to install a fully digital switcher for the international network.

4.1.3. Design and development of digital equipment

a) Transmission equipment

The manufacturing industry developed digital transmission equipment namely modems for data circuits.

As back in the 30's CET also started the approach to digital technique by designing transmission equipment due to the need of expanding some networks at the lowest possible cost. The first digital equipment designed by CET and manufactured by Standard Eléctrica and CAEP was PCM equipment to be installed in low frequency telephone cables. They started by 30 channel, 2 Mbit/s first hierarchy terminals, immediately followed by the 120 channel, 8 Mbit/s second hierarchy and then the third hierarchy, 34 Mbit/s transmission rate. The first hierarchy equipments are now widely used in Portugal allowing for the expansion of conventional low frequency telephone ca 'es in local networks. In 1990 it is expected to achieve a 50% digitalization in the Portuguese Regional transmission network.

b) Switiching equipment

Due to its important role in CTT, CET is currently taking part in negotiations in order to choose the type of digital technology to be imported and manufactured in the two existing plants.

This task has lead to thorough discussions and visits to plants all over the world and a consequent extensive knowlegde of the various systems manufactured by different Companies. As a result CET was lead to some important conclusions:

- usualy the multinational manufacturers design and develop large switching equipment which can be used efficiently in the very large majority of cases; a maximum capacity ranging from 50.000 to 100.000 subscriber lines and central computers are therefore common characteristics

- the utilization of such large switching equipments in the majority of the Portuguese groups of networks outside Lisbon and Oporto would lead to some inconveniences, namely concentrating all main supervision and control functions in a few long-lines transit centres, due to the small amount of traffic flowing within regional networks

- using the past experience CET came to the conclusion that they could develop small digital transit switchers, using distributed microprocessors for capacities ranging from 1.000 to 15.000 trunks, thus avoiding the concentration of control and network supervision

As we have seen in Fig. 4, the basic lay-out of the Portuguese network uses the group of networks concept, leading to a Group Centre which is also a long-lines Terminal Centre.

In a new fully digital environment, the Group of Networks will be a star network as represented in fig. 6. Nodal satellite and subsatellite centres will therefore disappear.

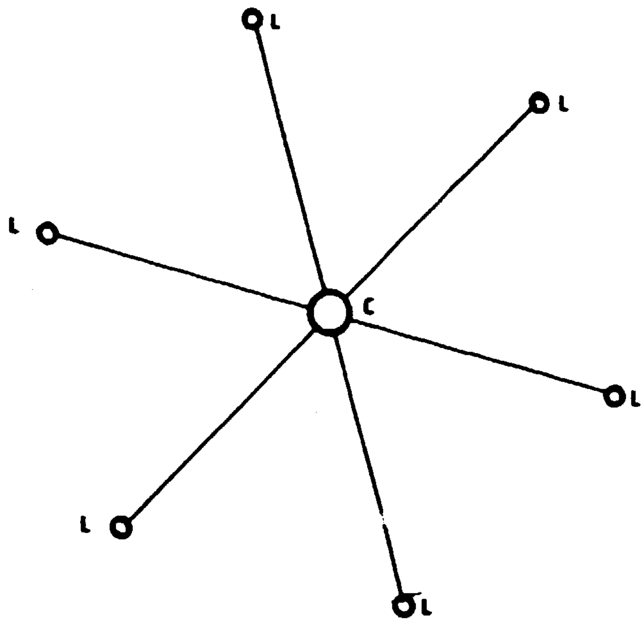
If we now look at typical important Groups of Networks in Portugal, the regional trunk lines requirements are on the order of 1.000 to 3.000. Braga and Viseu, two important Groups of Networks, represent a need of 2.520 regional trunks and 1.440 regional trunks, respectively. As a result CET decided to design and develop digital transit switchers capable of operating a maximum of 12.500 trunk lines. Braga and Viseu were chosen for the first field trials as having some problems due to an expansion of local industries.

The problem then was to develop a switching equipment with a minimum of circuit boards in order to make economical a small series manufacturing. Another problem was to try to use microprocessors easy to find and programme.

Let us see how CET tackled these questions.

Usualy, digital switchers are installed in a mixed analog-digital environment with a large majority of analog inputs at least in a first stage. Therefore, the large manufacturers use digital switchers with analog inputs. Once the environment becomes totaly digital the analog-digital interfaces will be by passed as useless.

In order to reduce the number of circuit boards, CET designed an entirely digital switcher what leads to external interfaces whenever interconnecting with an analog line. This philosophy is normaly more expensive. However it allows for the utilization of PCM equipment already developed and used in regional and local networks.



L - Local switcher

C - Group Centre (Terminal Centre in the long-lines remote)

Diagram of a digital Group of Networks

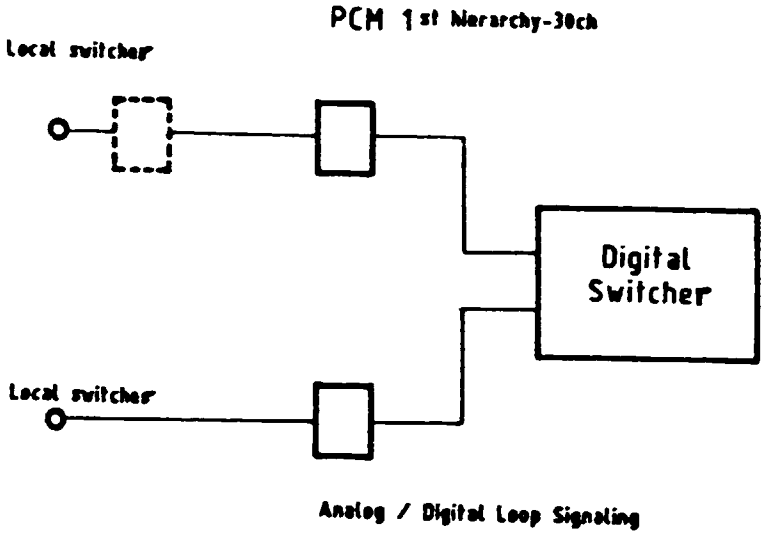
Fig. 6

Fig. 7 shows this concept using two different types of interfaces depending on the signaling system used in the analog switchers. In the case of a PCM interface with E&M signaling it can be used in the same premises where the transit switcher is installed or in the premises where the local switcher is installed, in this case allowing for expanding old cables.

The first prototype of this equipment was alread tested and the first two operating switchers are already being manufactured and are expected to be in service by middle 1986 in the referred above Groups of Networks of Braga and Viseu. It is important to note that the prototype only had 11 different circuit boards and a cost/trunk lower than the one normaly presented by large manufacturers, i.e. approximately 160 $US in a totaly digital environment. Roughly 300 $US shall be considered if analog/digital interfaces are to be added as it is the case in the two regional networks of Braga and Viseu. This later cost is still very low as it refers to a transit switcher including PCM transmission equipment. CET is now developing subscribers switchers using a stand alone philosophy, as opposite to the concentrator philosophy usualy used by the large manufacturers for the size to be used in Portugal's rural networks.

c) Other digital equipment related to network management

Another important digital development in progress is designated as OSCAR and refers to a centralized control system. OSCAR stands for 'Observação de Serviço Centralizado para Apoio à Rede', which can be translated as Centralized Service Control in Support To Network Supervision. OSCAR will also be used as O&M centres for the future digital network although designed for electromechanical technology.



Basic Design of a digital switching centre as developed by CET

Fig. 7

Other acessory equipment has been developed by CET, namely a traffic analyser named REDACO.

4.2. Other relevant experiences in deglobalizing projects

4.2.1. The renewal of CPRM's Concession. Training, Organization and Planning essential for success

In 1967 ended the concession of CPRM, the International Telecommunications operator of Portugal.

By then CPRM was already entirely Portuguese but still a small Company. About 800 people mainly operating services through HF circuits for overseas and European communications.

Telegraphy was an important activity due to difficulties in HF telephony. Telex was a growing activity with the recent design of error correctors.

Satellite communications were a just born technology.

The same happened with telephonic submarine cables.

According to the general trend in the World of Telecommunications,CPRM should be integrated in CTT and therefore CET had already developed the first intercontinental switcher using CCITT nr. 5 signaling system, later installed and used by CPRM.

However, the Government decided to renew the franchise and keep CPRM as a private independent corporation.

As a consequence, all of a sudden, CPRM was involved in a number of international projects using new technologies:

- a submarine cable linking Portugal to the Canary Islands, Cape Verde, Ascension and Cape Town

- a submarine cable to the United Kingdom

- a domestic submarine cable to Madeira

- the participation as a co-owner in new submarine cables in various places namely in North Atlantic, between North America and Europe

- the negotiation of the Intelsat Agreements

- building three earth stations in Angola, Mozambique and Portugal

- installing new modern switchers for the three main services:
    - telephony
    - telex
    - telegraphy

The Company followed exactly the same approach as CTT in the 30's. In CPRM's staff there were a number of teachers in specialized High-Schools and Universities. It was therefore easy to select carefully new highly educated staff. And again, like in the 30's training was a major concern of the management.

Therefore, some newhired staff underewent training programmes in England, in the field of submarine cables, for months. Others went to the United States undergoing a training programme in satellite communications. Others in France followed training programmes in CNET (The Centre Nationale d'Études des Télécommunications of the French PTT).

As a result, in 1972, the first electronic telex switcher in Europe was installed in Lisbon, CPRM's staff having participating in its design and development.

In 1974, the first three satellite earth stations were in service as well as the first computer controlled telegram routing system. In 1976 the first computer controlled telephone switcher was put in service, still using electromechanical technology.

It is interesting to note that the lead time for the first pratical results to appear was roughly the same as during the 30's, i.e., approximately seven years. And the main ingredients for success were again the same:

- A Development Plan

- Reorganization of the service with particular care in maintenance

- New staff and training

In fact, during the referred seven years period the staff was roughly doubled, particular care being paid to hiring highly educated people. As a minimum, high school technical qualifications were required for new staff. On the other hand the percentage of University level staff was largely increased.

However, CPRM's experience in modernizing the access of Portugal to the international telecommunications network is not very relevant in terms of creating a new industry in the country. As a matter of fact, only buying one equipment of each type from time to time, does not allow for developing a local manufacturing philosophy.

The experience in building satellite stations is however very significant to the scope of this contribution as an example of project deglobalization. Therefore it will be used as to illustrate the way of increasing national product in high technology for small series of equipment, helping other by-side simple industries like civil works, air conditioning, small electronic devices used in power systems, etc. .

4.2.2. Building satellite earth stations in Portugal

a) Sintra I, Boane and Cacuaco Stations

In 1972 CPRM decided to build three Intelsat Standard A earth stations in Angola, Mozambique and Angola. Being the first earth stations built by the Company, it was decided to hire a foreign consultant. The stations were bought 'turn-key' although according to the contract signed with the supplier it was compulsory to use Portuguese suppliers for buildings and other infrastructures. It was therefore possible to incorporate 26% of national product in the project, without land plots.

b) Ponta Delgada Station

In 1976 another Standard A Intelsat station should be built in the Azores.

The experience with the three first stations was not considered as a good one. Therefore it was decided to have a higher intervention in designing the station and controlling the works.

As a result the project was divided in three subprojects:

- Telecommunications equipment directly related with satellite communications

- Building including all specialized infrastuctures and telecommunications equipment interconnecting with the terrestrial network

- Antenna structure

(i) Telecommunications equipment directly related with satellite communications

Portugal does not manufacture satellite communications equipment.

As a consequence this equipment was carefuly specified by the Company including the lay-out of the main telecommunications room.

Then, a number of reliable potential suppliers were selected and invited to tender. The offers should include the basic design of the antenna structure and a quotation for a structure built in Portugal as a result of a joint-venture with a Portuguese supplier.

A supplier was therefore selected in order to supply and install the satellite telecommunications equipment including the supervision of the antenna structure manufacturing and mounting.

(ii) Buildings and other infrastructures

In this case CPRM decided to hire a Portuguese Consultant who would plan, coordinate and control the progress of works beginning with the design and finishing with the completion. This to avoid a heavy building department within the Company.

A team of external experts in various areas was formed under supervision of the Consultant who would report to a CPRM Director of Works (See Fig. 8).

First of all the Consultant and the team of experts designed all buildings and infrastructures under CPRM supervision. This work covered the following areas:

- Architecture and civil works
- Lighting and Power installations
- Air Conditioning
- Sewers
- Water piping
- Power generators
- Unbreakable Power Supply Systems
- Fire and smoke detection
- Security systems
- Internal telephones
- Special foundations for the antenna
- etc.

After completion of specifications, various Portuguese companies were invited to tender and then selected as contractors for the various installations. The main contractor would supervise all the others in order to guarantee a firm responsibility in conducting the works. The Consultant with his team of experts would carefully control the progress of works.

(iii) Antenna structure

The antenna structure was built in Portugal, under design and supervision of the Telecommunications contractor, but according to CPRM general specifications. The supervision of the Telecommunications contractor was considered essential as only the steel structure was built in Portugal.

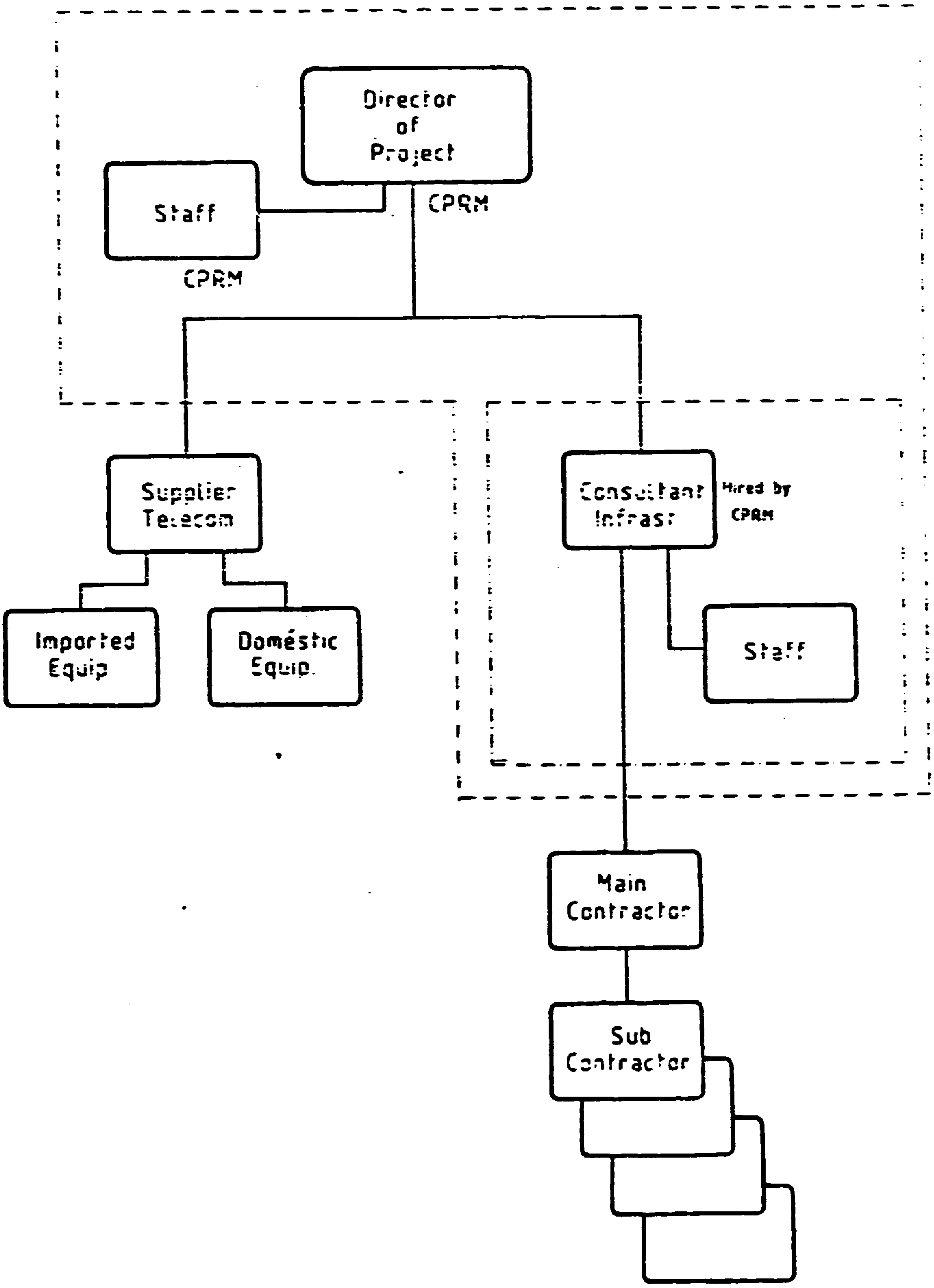

Director
of
Project
Staff
CPRM
CPRM
Supplier
Telecom
Imported
Equip
Doméstic
Equip.
Consultant
Infrast
Hired by
CPRM
Staff
Main
Contractor
Sub
Contractor

Fig 8

As a result of these guide-lines the quality of the earth station was much higher and the national product could be increased to 42%, an important percentage if we take into account that Ponta Delgada is a domestic station. On the other hand it only took 12 months to build the station against 24 months in the first case.

c) <u>Refurbishement of Sintra I</u>

After the experience of Ponta Delgada CPRM decided to correct the defficiencies found in Sintra I particularly regarding the size and layout of the building, power and air conditioning equipment, that would not allow any expansion. All electrical installations including UPS and power generators were also clearly underdesigned.

Following the same philosophy adopted in Ponta Delgada, the corrections cost almost as much as the station itself (2.787.000 USD initial cost for a contract signed in 1972 and RFS in 1974 against 2.494.000 USD for a contract signed in 1977 and RFS in 1978).

As a result we can conclude that the 'turn-key' initial solution was not a good one as the contractor was mainly concerned with the supply of his product not paying careful attention to local and byside works. In fact the national product shall be taken as something in between the initial 26% and 56%, final result after refurbishement. Probably something closer to 50% as a percentage around 40% was later found in all other stations built there on by CRPM which were much smaller in the size of infrastructures (Sintra II, III and IV and Funchal).

d) Extrapolation to local networks

In a local network, buildings and other infrastructures represent a lower percentage of the total investment, the precise value depending on the particular characteristics of each network.

We can however say that in an urban area, ducts represent about 40% of the external network of cables. Taking the overall investment, i.e. including buildings and switching equipment the investment in non telecommunications equipment represents about 15% of total investment.

Therefore the experience described in this section leads to the conclusion that deglobalizing local network's projects can also help developing manufacturing industries not only in telecommunications but also in byside areas. It also helps a higher intervention of local staff therefore representing an important source of training. Finaly it will result in cheaper systems more adequate to local requirements.

5. CONCLUSION

We have briefly analysed the industrialization process in Portugal, in the field of the Telecommunications manufacturing industry, and also how to increase participation of local staff and domestic products, whenever know-how does not exist in high-technology systems.

A few relevant examples that ocurred in Portugal from 1933 through 1985 were shortly described in order to illustrate a basic philosophy adopted in the country. Most of the steps taken are however common to any industrialization process in developing countries. Nevertheless care must be taken in trying to adopt some of the experience described without adequate corrections, due to the fact that each country represents a particular case, and also because the present environment is not the same as it was back in 1933. More sophisticated technology, higher competition and a world-wide Telecommunications network are basic characteristics not existing in the 30's.

In order to summarize the description above done, we will try to list some important conclusions of the Portuguese experience, giving after a few comments on each one. In short we can conclude that the main issues in the Portuguese process were the following:

(i) The most important one was undoubtely the role of PTT in:

- training and selecting new staff

- planning as to define the potential market for a new manufacturing industry

- organizing the service itself taking particular care with maintenance, acceptance tests, technical specifications, etc.

- setting appropriate policy guidelines in order to avoid following trends that can block industrializing initiatives

- using maintenance workshops as to promote industrialization

(ii) A manufacturing industry in the field of Telecommunications can start with simple items.

(iii) In trying to incorporate local products and staff, turn-key projects are not a good solution whenever an organization is willing to acquire the necessary skill to lead future works.

Let us comment on each of them.

5.1. The role of PTT

PTT or similar organizations are usualy the hub of a nation's Telecommunications, namely in what concerns the domestic network. Therefore PTT, as it happened in Portugal during the 30's, will have a very important role in the process of industrialization. PTT role is not easy as industrialization will render Telecommunications management more difficult at all levels of the hierarchy.

PTT are also The Customer of a Telecommnuications industry.

Let us comment briefly on the issues related with PTT's importance:

a) Training and selecting new staff

I would say that training and selecting new staff is the very basic issue in the process. Nothing will happen without skilled staff.

Going through the Portuguese process we also conclude that training is not only sending people to attend courses in schools or training programmes in plants or Administrations. This is only the very begining. Training is also putting people to work in an organized manner, so that they can develop their skills by performing various tasks in the organization:

- installing and maintaining equipment
- specifying new systems
- planning
- organizing services

Therefore, training qualified staff takes some years after they acquire basic knowledge in school or through basic training programmmes.

b) <u>Planning</u>

<u>PTT Planning is another important issue</u> for launching a manufacturing industry. As we have seen, in Portugal, the industrialization process realy started in 1937, with a Plan to be implemented in 15 years allowing for the forecast of equipment quantities to be installed in the network during a long period.

c) <u>Organization</u>

Organization has also been an important ingredient in developing the Portuguese Telecommunications.

In terms of industrialization, organization largely contributed to the process of acquiring the necessary know-how, namely through setting up <u>maintenance procedures, equipment standards, quality control, etc.</u>

d) <u>Setting appropriate policy guidelines</u>

As we have seen, PTT <u>have to be committed to the industrialization process</u> as it interferes with Telecommunications management. It many times cost money, delays and quality. And these parameters are normaly watched carefuly by PTT officers, as responsible for the provision of a Public Service. Therefore PTT have to be fully commited to industrialization no matter what it may cost.

On the other hand some basic policy guidelines regarding deregulation trends, separation of Posts and Telecommunications, new tariffing philosophies, etc. must be carefuly analysed before final approval, as they may have an indirect impact on an industrialization process.

e) Using PTT maintenance workshops as manufacturing premises

Finaly, we cannot forget that PTT can themselves start an industrialization process. It happened in Portugal back in the 30's with small items that could be manufactured using PTT maintenance workshops. It can be done today for small accessories like terminal boxes, connecting bars, etc. Probably even to more sophisticated equipment like assembling telephone sets.

On the other hand, maintenance workshops are easily turned into testing laboratories for acceptance tests. And that will inevitably lead to knowing better the equipment to be installed in the network, so that the skills start growing towards a higher intervention of local staff.

5.2. How to start a manufacturing industry

As we can see by analysing the Portuguese experience during the 30's industrialization started by very simple items:

- installation accessories manufactured in CTT workshops or in small existing factories that could be easily reconverted

- drawing copper wire using an existing plant already drawing other types of cables

- assembling telephone sets in a small workshop that turned into the biggest manufacturing industry in the country; now entirely Portuguese

However, we must not forget that, in a local network, cables, poles and accessories represent roughly 50% of the investment. Therefore, starting manufacturing small items may represent a relevant intervention of local product.

Switching systems were only manufactured in Portugal much later as they represent highly sophisticated equipment requiring large fabrication series.

It is also important to draw your attention to the fact that whenever new technology was introduced in Portugal, there has been a deep concern in integrating it with existing one. We can see that concern in the Plan approved in 1937 and again when developing digital switchers for rural networks.

This means that old systems will continue to operate as long as it is economicaly and technicaly acceptable. Therefore industrialization can also start by some parts of simple existing equipment in order to maintain the stocks of spares.

5.3. Increasing local participation in high technology projects

Beyond the experience related with a new manufacturing industry we have also analysed how to manage system's implementation in higher technology areas where local market does not allow for local fabrication.

CPRM's experience in building satellite communications earth stations can be also applied to other areas. As a matter of fact, a local network is normaly composed of several items, going from very simple to very sophisticated ones.

Therefore, in implementing a local network projects can be deglobalized, thus avoiding turn-key solutions which are not always the most appropriate ones.

It may look simpler and cheaper to use a Telecommunications contractor to look after all infrastructures, supplying a turn-key system.

There is however another solution which is the one briefly described in 4.2, namely 4.2.2 b) dealing separately with Telecommunications equipment and the list of items in pag. 35 in 4.2.2 b) (ii). I could tell you about other similar experiences I have gone through even in another areas like installing linear accelerators in hospitals. Or as simple as installing elevators in Government Department Headquarters.

My experience tells me that a turn-key project, looked on a long-term basis leads to more expensive solutions (if not in investment in running costs), less quality and most of the times less adequate to the objectives.

Deglobalizing a project requires, however, a very accurate planning of projects and works. In particular, works shall never start before every single detail has been carefully analysed by the contractors, agreed upon and integrated in a plan. Most of the times it is preferable to have a delay in starting the works, than starting them on schedule before a carefull plan has been worked out and agreed among all intervenors.

This is also the case in deglobalizing the implementation of a local network. Many times the switching equipment is there in its wooden box covered with a canvas and the building is not ready; other times the trunk cables were buried, everything is ready, and a small piece of interconnecting cable is missing for months. Planning is therefore a major issue in deglobalizing a project.

Nevertheless as we can see from what is described in 4.2 it is however preferable to deglobalize a project hiring external consultants and different contractors, rather than adopting a turn-key project philosophy.

In fact, a deglobalized project allows for:

- higher integration of domestic products, therefore helping manufacturing industry in other areas (wood treatment for poles; civil works for buildings; steel works for towers, structures, etc.)

- higher participation of local staff, therefore representing an important contribution for training

- systems closer to local requirements

- cheaper solutions if looked on a long-term basis

As a final comment I would say that training is a major issue in Telecommunications development; PTT have a fundamental role in launching a Telecommunications manufacturing industry; turn-key projects do not favour the development of local industries in developing countries.

Aknowledgements

The author would like to thank Mr. Mário Santos Silva, one the most relevant staff hired by Mr. Couto dos Santos during the 30's later be coming the Managing Director of Telecommunications. His contribution was essential to describe the Portuguese experience in developing a Telecommunications industry.

Mr. Egas Pinto Basto present Director of CET and Mrs. Leonor Bivar were also unexceendingly cooperative in helping the author to collect data and editing this paper in the extreme short period available.

Paper No. 12:

DEGLOBALISTION OR SELF RELIANCE IN TELECOMMUNICATIONS WITH A VIEW TO DEVELOPING THE LOCAL MANUFACTURE OF CERTAIN SUB-SYSTEMS, COMPONENTS ETC.

1. INTRODUCTION

Self sufficiency and self-reliance have different connotations in different circumstances and for different countries. For an economically strong country whether developed or developing, this would mean capability to procure material requirements for itself from anywhere in the world at reasonable rates. For an economically weaker country, it would mean ability to produce/manufacture certain amount of equipment and materials within the country or within the region so as to muster strength to negotiate reasonable rates for the materials required by it. Even if it is not possible to manufacture the equipment to become self reliant, the country should have the capacity and capability not to become dependent on any other country for the essential items of its infrastructure. One of the essential items is Telecommunications.

2. DIFFERENT COMPONENTS OF TELEPHONE NETWORK/TELEPHONE PROJECT

Before, deglobalisation or self reliance is discussed, it would be useful to study the different aspects of a telecommunication project. These are,

- Demand assessment and formulation of requirements,
- Survey, planning, feasibility study engineering and drawing up of specifications,
- Procurement of materials and equipments (indigenously manufactured or imported),
- Installation, testing and commissioning
- Operation and maintenance.
- Training

For self reliance in a telecommunication project, not only the indigenous manuufacture of telecommunication equipments is necessary, but also the capability to instal and commission the equipments as well as operate and maintain them is important, because some of these project components takes a large percentage of the investments.

3. BASIC COMPONENTS

There are four basic sub-systems in a telecommunication network as are shown in figure - 1.

The different items in each of these sub-systens are as follows:-

SWITCHING SYSTEM

- Exchange Terminations
- Fuses heat coils
- Switching equipments
- Power plant

EXTERNAL PLANT

- Primary cables
- Ducts
- Cabinets
- Distribution points
- Secondary cables

iii) TRANSMISSION SYSTEMS

Multiplexing

i) Multiplexing equipment (FDM or Digital) including frequency generation.

Line Systems

ii) Overhead Lines

Poles and accessories

Overhead wires and cables

iii) - Coaxial Cable

- Line equipments

iv) Radio Systems

- VHF/UHF equipments
- Microwave Equipments
- Tower, Antennae, Feeder cable

Optical Fibre Systems

v) - Optical Fibre Cables

- Optical Fibre system equipments

vi) Satellite Communication Systems

- Satellite Ground station equipment
- Ground station Antennae & Towers

vii) Power Plant

SUBSCRIBERS PLANT

- Drop-wire
- Window terminal
- Subscriber house wiring

- Subscribers plug and socket
- Telephone instruments, non-voice service terminals such as facsimile & data modem.

4. PERCENTAGE INVESTMENTS IN MAJOR COMPONENTS OF A TELEPHONE PROJECT

The precentage investment in each of the major component of a telephone project in an urban network is given in Table - 1.

TABLE - 1

S.NO.	ITEM	PERCENTAGE
1.	Switching System	30-33%
2.	External Plant including subscribers plant	30-40%
3.	Transmission systems including long distance switching	30-33%
	TOTAL	100%

The approximate percentage break up of these three major components in material and installation costs is as given in Table - 2.

TABLE - 2

	100%				
ITEM	EQUIPMENT/MATERIAL			INSTALLATION, TESTING AND COMMISSIONING	
SWITCHING	80%			20%	
EXTERNAL PLANT	(Cables and jointing Material 40%			60%	
				ducts material	Installallation & commissioning
				20%	40%
TRANSMISSION (TERRESTRIAL) RADIO	MUX	Tower Antennae & Power plant	Radio		
	20% (50% equipped)	40%	17%	23%	
COAXIAL	MUX	Power plant	LINE		
	25%	20%	25%	30%	

These are broad percentages which may vary from country to country depending upon several factors such as initial equipped capacity, space and frequency diversity for radio systems etc. However, it would be noticed from these percentages that in switching and transmission projects the material and equipment costs are high, but in external plant the installation costs which include the cost of duct material are higher than the cable costs. This is an important aspect which each country may like to consider in its persuit to become self-reliant.

5. EXISTING NUMBER OF TELEPHONES IN THE CONTINENT OF AFRICA

The number of total telephones in 33 countries of the continent of Africa are given in Table - 3. (1982 figures)

TABLE - 3

TOTAL TELEPHONES IN A FEW AFRICAN COUUNTRIES

S.NO.	COUNTRIES	GDP US $	TOTAL TELEPHONE IN THOUSAND	POPULATION IN MILLION
1.	Chad	80	6.5	4.0
2.	Ethopia	140	100.8	32.8
3.	Mali	180	8.5	7.2
4.	Zaire	190	31.2	29.2
5.	Malavi	210	29.0	5.9
6.	Upper Volta	210	8.6	5.9
7.	Uganda	230	61.6	13.4
8.	Rivanda	260	4.6	4.9
9.	Burundi	280	5.6	4.0
10.	Tanzania	280	96.5	19.2

S.NO.	COUNTRIES	GDP US $	TOTAL TELEPHONE IN THOUSAND	POPULATION IN MILLION
11.	Benin	310	16.2	3.5
12.	Central Africa Republic	310	5.0	2.5
13.	Guiena	310	9.5	5.1
14.	Niger	310	9.8	5.8
15A.	Togo	340	9.8	2.5
16.	Ghana	360	70.7	11.5
17.	Kenya	390	216.7	17.4
18.	Sierra Leone	390	11.5	3.1
19.	Mozambique	-	57.4	12.9
20.	Sudan	440	68.5	19.4
21.	Senegal	490	20.0	5.9
22.	Zambia	640	67.2	5.6
23.	Egypt	690	477.4	43.7
24.	Zimbabwe	850	236.2	7.5
25.	Nigeria	860	708.4	100.0
26.	Morocco	870	265.7	20.7
27.	Ivory Coast	950	87.7	8.0
28.	Guatamala	1130	97.7	7.1
29.	Congo	1180	17.3	1.6
30.	Costa Rica	1430	282.8	2.4
31.	Tunisia	1390	218.8	6.8
32.	Angola	-	36.7	5.7
33.	Algeria	2350	408.2	19.5
		TOTAL	3752.1	444.7

6. LOCAL PARTICIPATION IN TELECOMMUNICATION PROJECTS

To become self-reliant or even to increase local participation in telecommunication projects will depend upon the following aspects,

- Capability to choose the appropriate technology,
- Capability to design, develop and manufacture,
- Financial resources,
- Capability for installation, testing and commissioning,
- Capability for operation and maintenance,
- Capability to train the staff in new technologies.

Several of these aspects are essentially same as the different components of a project given in para 2.

7. CHOICE OF APPROPRIATE TECHNOLOGY

In the electronics and telecommunication field, the obsolescence is very fast. Technology now changes almost every five years. This was not so earlier as we could see about the switching technology:

-	Step by step systems	50 years
-	Common control systems	20 years
-	SPC Analogue systems	10 years
-	SPC Digital systems	5 years

The telecommunication administration, therefore, in each developing country has to make a decision about the technology for their network. The decision has far reaching effect and the consequences of such a decision will be felt for many years. The new technologies now utilise very large scale Integrated Techniques having computer controlled exchanges with time divisions switching and the transmission of information in digital form makes it possible to transmit voice, text and huge quantities of visual information. It is also possible to connect telephone subscribers to large data banks through videotex service and display economic, financial and scientific information as text or grapics on a television screen. Video Conferencing and electronic mail service is also spreading in some of the developed countries. Technology has advanced to the extent that it is possible to provide them services over a single network known as Integrated Services Digital Network (ISDN) and comprising of digital switching, computer control and large capacity optical fibres and Sattelite channels. Keeping in view the above trends, existing systems and capacity to absorb new technologies, a country's administration has to choose a proven technology. It should also be capable to sustain the new technology especially to operate and maintain the systems. It may also be useful to share experiences and seek advice in choosing the technology before final decision is made.

8. DESIGN, DEVELOPMENT AND MANUFACTURE

At present only a few advanced developing countries have design capabilities of their own and a majority of developing countries are dependent on the designs undertaken in the industrialised countries. This inhibits equipments designed and developed in industralised countries to always meet the full requirement of the developing countries. There is also no incentive to develop equipment to suit the markets of developing countries due to limited requirements. For developing countries, the pressing need is to provide service to a widely scattered population as the existing means are costly. It is, therefore, beneficial to set up design and development institutes either individually or in groups or on regional basis. This has been beautifully summed up in the Maitland Report.

"The first objective of the R&D establishment in the developing world should, therefore, be to develop equipment which is not available elsewhere. An example would be equipment capable of providing service at more reasonable cost in remote areas which would be suitable for manufacture either on local or on regional basis. There is also a wide range of devices, tools and aids that are not pure telecommunications equipment but whose development & manufacture locally would reduce construction and operation costs. These establishments could adapt designs from the industrialised world to the needs of the countries they serve. In other words, we do not envisage the institutes developing major new telecommunication systems but rather modifying available systems to their own requirements using modules and components available in the world market."

These institutes could cooperate with each other and with other institutes in the developing countries. They could take up subsequently technical and operational problems and develop installation and maintenance needs of the telecommunication administrations in the region.

This would mean that initially the design and development strategies in developing countries either individually or collectively should be to adapt the equipments of the industrialised countries to suit their requirements. An example of developmental efforts required to develop switching and transmission systems in India is given in Table - 4.

TABLE - 4

	SYSTEMS	MAN MONTHS	DURATION	INVESTMENTS
A.	Indigenous Digital Switching System	9000 25% experienced Rest qualified engineers (250 engineers)	3 years	36 Million $
B.	7 GHz 34 MBit/s M/W system	240 50% experienced 50% qualified engineers (10 engineers)	2 years	0.75 Million $
C.	Second Generation FDM MUX CTE to 12 MHz MUX (including Frequency generation)	750 mostly qualified personnel (14 qualified engineers + two techs.	4 years	1 Million $

The Indian digital switching system would be capable of working in rural environment existing in developing countries.

9. STAGES IN LOCAL DESIGN AND DEVELOPMENT

The local design and development cycle of a telecommuunication equipment broadly consists of eight stages as shown in Figure-2.

- Assessment of the needs and project formulation,
- Feasibility, system engineering and preparation of developmental specifications,

- Development of units and sub-systems,
- Integration of sub-systems, system testing, reliability and environmental testing,
- Preparation of factory prototypes and intensive testing,
- Trial production for field trial systems,
- Field trial, analysis of feed back information,
- Freezing of drawings and regular production and.

The design and development cycle takes 3-5 years depending upon the complexity of the project and the time spent in field trials and environmental testing.

10. MANUFACTURE

Manufacture of the required telecommunication equipment by a developing country makes itself self-reliant in that product besides savings in the foreign exchange. However, indigenous manufacture of telecommunication equipment requires three primary inputs,

manpower,
material,
and financial resources.

Developing countries which have a fairly developed industrial infrastructure and skilled manpower and which have large requirements of telecommunications equipment can absorb the indigenously manufactured equipment but the requirements of most of the countries in Africa may be small and as such manufacturing projects may not be economically viable. Such countries will have to set up manufacturing facilities as joint/collective ventures at regional level, sub-regional level and the ancillary units can be set up in the participating countries. Keeping this in view, let us examine the suitable items, sub-systems for manufacture.

11. In para 3 earlier different items comprising of the four sub-systems of telecommunication network have been given. It would be noticed that a large number of components are simple hardware items which can be manufactured in most of the developing countries. A look on Table - 2 which gives approximate percentage investments in different sub-systems and components of a telecommunication network will indicate that there are several other important sub-systems of a telecommunication network which can be manuufactured in a developing country and these are,

- Telephone cables,
- Telephone instruments,
- Multiplexing equipment.

Setting up manufacturing facilities for switching equipments and large capacity radio and line transmission systems is also possible if a large number of countries in the African continent come together otherwise the projects may not be viable for low capacities. As regards Telephone Cables and Telephone Instruments are concerned, there would be a large number of manufacturers who would be willing to pass on the technology for manufacturing these items. The viable plant capacity for a cable plant is about 500,000 ckm and for telephone instruments about 200,000 pieces.

11. The stages involved in establishing manufacturing facilities for the telecommunication cable or telephone instruments consists of the following :-

- Assessment of the needs and requirement projections for 10-15 years,
- Feasibility studies and economic viability,
- Preparation of technical specifications of the product required to be manufactured and finalisation of Product mix,
- Discussions with reputed manufacturers of the product with regard to technical and financial conditions for setting up the manufacturing facilities,
- Calling for bids for foreign collaborator for setting up the manufacturing facilities,

- Contract negotiations and finalisation of the Foreign Collaborator,
- Selection of site keeping in view the availability of water, electricity and land,
- Preparation of technical specifications for the manuufacturing machinery and release of tender papers, evaluation of bids, negotiations and order placement,
- Start of civil construction work,
- Receipt of the machinery, installation, testing and commissioning of the Factory and trial production,
- Testing of the indigenously produced product within the country as well as at the premises of the collaborator, to ensure compliance with the specifications,
- Regular Production.

While establishing a manufacturing factory, two important points would have to be kept in mind, one, that the price of the equipment or material indigenously manufactured should not be higher than the landed price of the imported goods and second, it is useful to have equity participation of the foreign collaborator. It would also be desirable that there should be more than one source of all the raw materials required for the manufacture of a product as well as the machinery should be available from more than once source to get competitive prices.

12. STANDARDISATION

We have seen in the previous paragraphs that for setting up manufacturing industries in the African continent for the telecommunicaion systems it would be necessary that a nuumber of countries come together and use the same systems in their network. This would require standardisation of the specifications of the equipments and cables used in the country. This is one aspect in which lot of work is yet to be done in the developing countries. Standardisation of equipment, materials and cables by a number of countries will enable the equipment suppliers and manufacturers to produce equipment as per the required specifications even if they are not manufactured indigenously by these countries. The Standardisation thus provides strength to the developing countries not only for the indigenous manufacture of the equipment but also in procurement of equipments from abroad. No doubt, there are a number of International agencies such as CCITT, CCIR, CMTT, IEC, ISO etc. which lay down recommendations for different types of telecommunication systems but it is left to individual countries or regions to translate these recommendaions into specifications. Once the specifications are laid down then the methods of measurement and even the list of instrumentation with which the measurements are taken have to be specified. Stand..rdisation, thus, at every stage is essential especially for the developing countries which have limited requirements of equipment and materials. The work of standardisation could be left to the Design and Development Organisation which can also keep standards for calibration of the test instrumentation in the region.

13. TRAINING

One of the first and foremost task for the developing countries is to train their manpower to enable them to take over not only operation and maintenance but to involve themselves in Design, Development, Insttallation, Testing and Commisioning of the Systems. In fact there are numerous instances when equipments in developing countries is not used to its full capacity or remains out of order for long durations due to the staff being not fully trained in the technology. For getting fully trained the technical staff should not only be fully qualified but should have good field and practical experience as well as should get involved in the new technology right from the initial stage. Such Training Institutes like the Design and Development Institutes can be situated on sub-regional/regional basis.

14. CONCLUSION

We have noticed that the existing telephone density is very low in most of the African countries and for setting up manufacturing entities it would be essential that the countries come together through a common organissation such as Pan African Telecommunication Union, SADACC, ECOWAS and set up collective manufacturing and training facilities. This collective effort will give unmatched strength not only in setting up manufacturing entities but even in procurement of equipent and materials.

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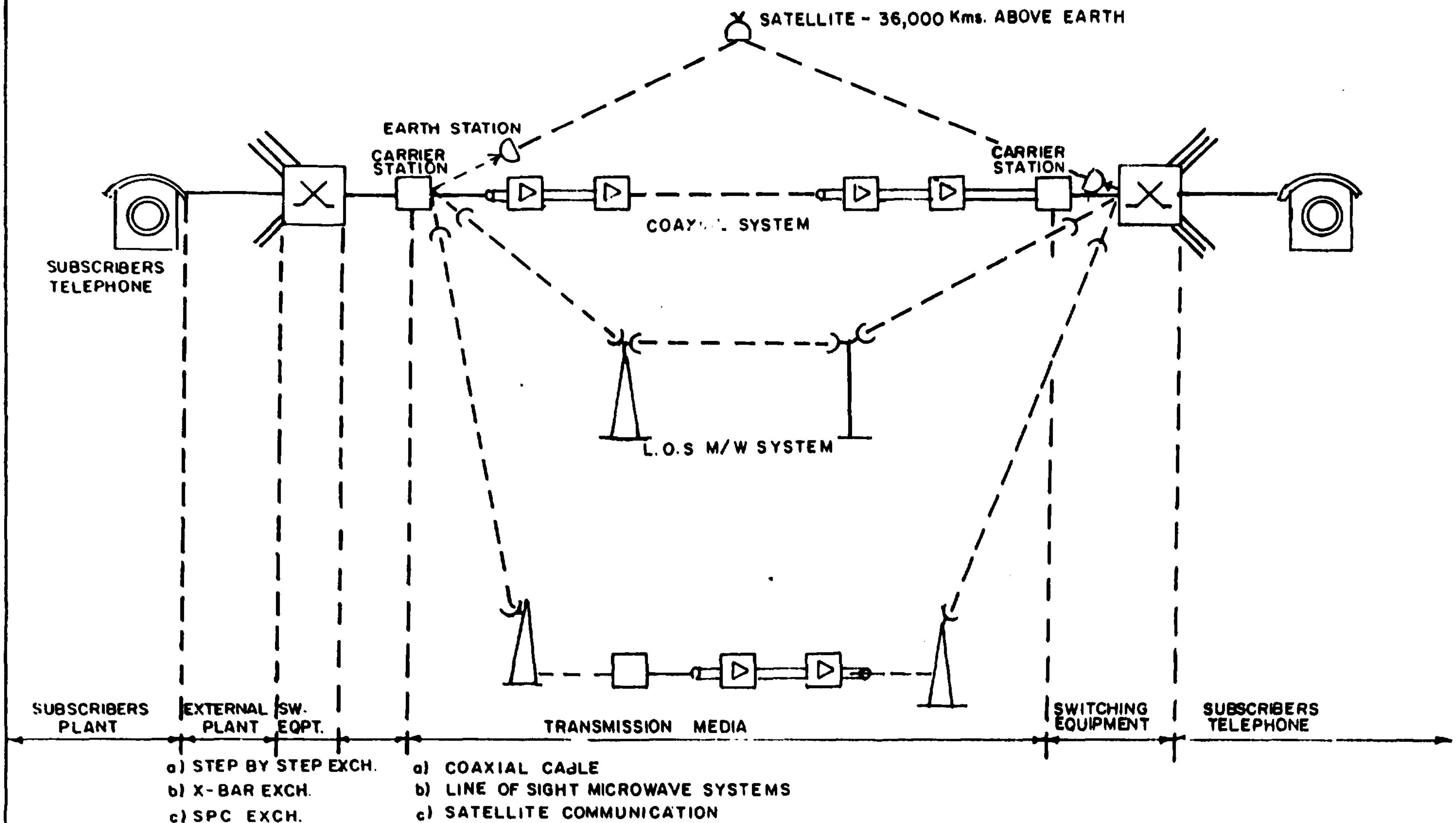


SUB- SYSTEMS OF A TELECOMMUNICATION NETWORK

FIGURE-1

DESIGN AND DEVELOPMENT CYCLE

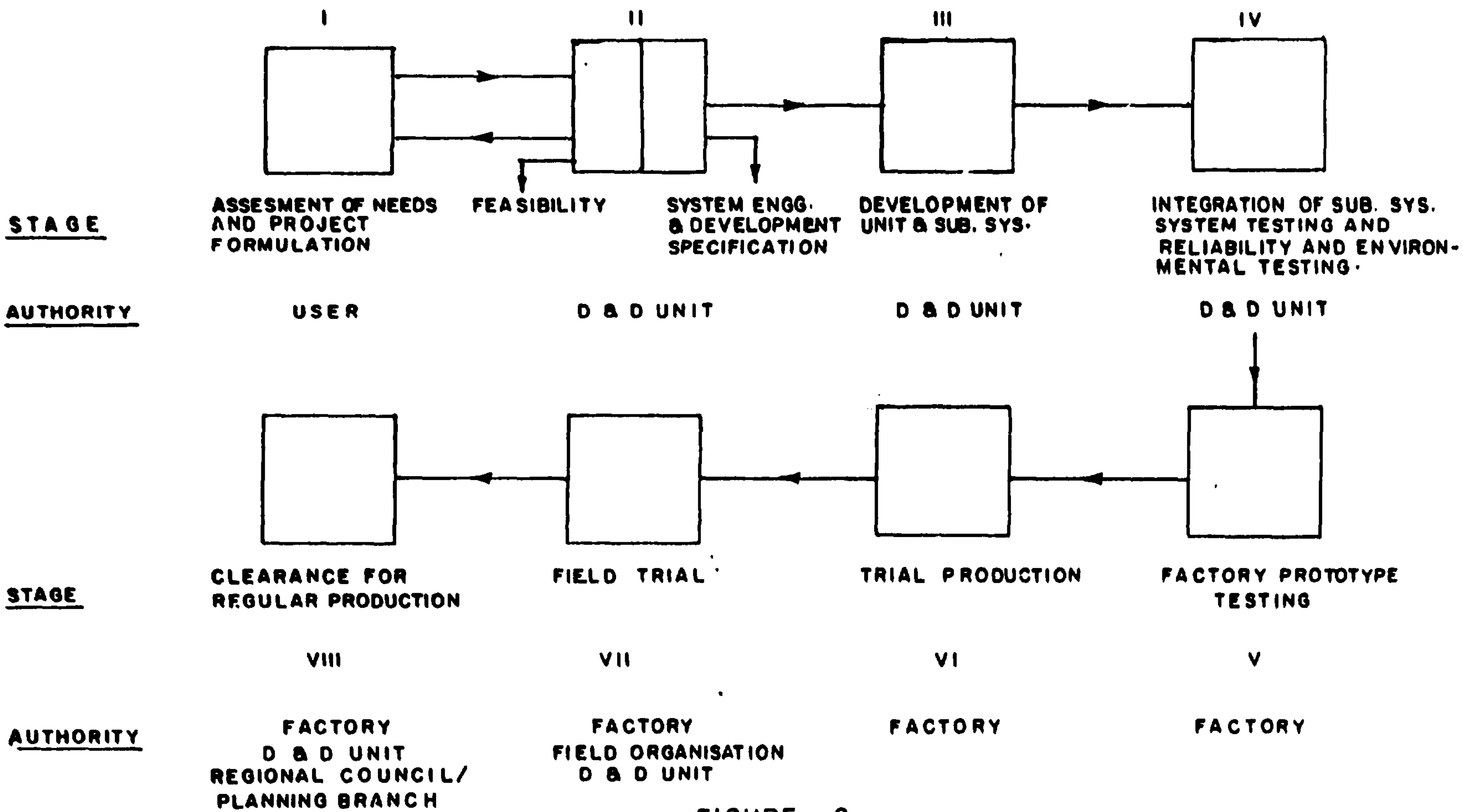


FIGURE - 2

Paper No. 13:

UNIDO/PATU Seminar — Harare, 6 to 11 January 19[illegible]

Subject: **Changing technologies in telecommunications sector - production options in Africa**

Summary: Changes in telecommunications have consequences on the economic and on industrial development.

What are these changes?

What are the consequences?

What are the forecasts and outstanding questions?

What is the choice of technology to be adopted?

What are the conditions for setting up plants for the manufacture telecommunications equipment in Africa?

CONTENTS

1. CHANGING TELECOMMUNICATIONS AND ECONOMIC GROWTH

1.1 Introduction

Life in society and economic exchanges are both impossible without communications. That was the case even at the dawn of human history. It will continue to be so in the future.

History has always been greatly marked by changes in communications techniques and by the systems of communication within society. The process of change first led from verbal communication to the introduction of writing. Gutenberg's invention of the printing press ushered in the modern age, and the bases for the modern mass media (films, radio, televisions) were laid in the nineteenth century. Each step in the development of communications techniques was linked to profound changes in the political and cultural structures of society. And the time between revolutions in communications techniques is becoming shorter and shorter.

Today, we are once again in the midst of one of these processers of change which has its origins in the rapid advances in information and communications techniques as pre-industrial societies become industrial or post-industrial ones.

It must, of course, be admitted that we still know only very little about the future of society, about the way it will evolve. And we know even less about what this society should or should not be like. There is, however, no doubt that it will be a society of information, a society of communication. This means that information, knowledge and communication will become the dominant factors of production and the quality of life. First complementing the traditional factors of production - energy, raw materials, capital and labour, they will gradually reduce their importance. This pattern is valid for all the highly industrialized countries and is increasingly applicable to the developing countries as well.

As a result, the technological and economic battle for the best places in this competition aimed at change is becoming more intense. Therefore, the telecommunications companies in every developing country must make the right decisions about the technology to be used in their systems. The effects of their decisions will be felt over many years and will radically influence operations and their viability.

Telecommunications decision makers must therefore make use of the best possible sources of advice when they make such decisions. The purpose of this contribution is to present to some degree the technological options and their characteristics as seen today.

A fresh surge of growth in communications technology could act as a stimulus for production, exports and consumption, as did the post-war boom in machines, motor cars, construction and electronic entertainment equipment, which culminated in the video recorder. In addition to the euphoria of growth, there is also a degree of scepticism prevailing in Europe. This scepticism derives as much from sociological as from economic sources. Is there a real demand in the home - and, above all, do sufficient financial resources exist - for new items, such as pay TV or Teletext?

Are the new possibilities for office uses not greatly exaggerated:

(a) Because the equipment and programmes are still not perfect;

(b) Because insufficient account has been taken of psychological, social and ergonomic conditions.

What of the speed with which these techniques gain ground, especially when we consider that this depends to a great extent on a combined strategy, on a co-ordinated mobilization of investment and public and private operators? The finest railway carriages are useless if there are no tracks or railway stations or if the gauge is not right. Is it still possible to close the gap in communications technologies which some have opened up on others? And to what extent does the introduction of possible new media uses , which are expected to stimulate economic growth, depend itself on the prospects for growth? Do we not have here a case of the serpent eating its tail? We all seek the soundest possible information on the subject in order allay fears, to find a reason for hope or even to provide the basis for certain decisions. At the moment, no-one can supply a firm long-term analysis of the development and impact of new communication technologies. This does not, however, mean that we know nothing. Therefore, in this paper, we will try only to answer the following questions:-

(a) What economic significance should be attached to communication as a factor of growth and innovation?

(b) What are the prospects of changes in the infrastructure and uses of communications techniques?

(c) What are the bottlenecks impeding the spread of potential applications?

(d) What can be said with some accuracy about the economic effects?

(e) What are the areas in which action is most urgently required?

1.2 THE CHANGING ROLE OF TELECOMMUNICATIONS IN THE ECONOMY

Communication, that is, the exchange of oral information, texts, images and data, is becoming more and more important, in view of the growing number of human beings on our planet and increasing economic interdependence The technical infrastructures for telecommunications have become essential. Indeed:

- in private life, families and friends can contact one another at any time (within a country or across borders);

- communication is provided everywhere in emergencies;

- means of communication account for a large proportion of the available ways of spending leisure-time;

- economic services, the division of labour, and the exchange of goods on a world-wide scale would be unthinkable without telecommunications. Just as economic advances in the past were closely linked first to the transport infrastructure and then to the communications infrastructures (for example, telegraphs and telephones), the importance of telecommunication for international exchanges today cannot be under estimated:

- telecommunication increases the transparency of the market and accelerates economic activity (information is passed on more rapidly and decisions are made somewhat more quickly), leading to a better allocation of resources;

- telecommunication increases the flow of information by providing a large number of forms of communication and thus contributes to a qualitative improvement in decisions;

- by reducing the need for physical materials, telecommunication also saves material resources.

Considering the exponential growth of the volume of knowledge and information which each individual and each enterprise must process, the services offered by telecommunication will become even more important in the future.

Against the background of the problems of flow and adjustment facing national economies, two sets of arguments can be identified in support of the idea of making greater use of new information and communications technologies.

The first concerns the economic use of these technologies in the office and in administration, while the second involves their application in the field of industry, infrastructures and the consumer market.

First set of arguments

1. When a society makes the transition from the pre-industrial to the industrial phase, information, and thus knowledge, gains in importance as a factor of production over other factors, such as raw materials and energy. This means that an even greater amount of human capital must be invested to produce the know-how necessary for the production of technologically advanced goods.

2. With specialization and growing differentiation as a result of the flows division of labour, information thus are going to grow. In the future, the need to exchange information will continue to grow. The need for information and communication on the part of all social entities grows exponentially.

3. In the African domestic economies, the proportion of the labour force employed in the information sector is going to grow, from the current figure of 5 per cent to more than 50 per cent in the future.

4. A growing proportion of the total costs of production in the economy will come from office and administrative costs. In enterprises, office costs already account for almost 50 per cent of the total costs of production. About 70 per cent of office costs consist of personnel costs, which have increased more than the average in recent years.

5. In contrast with the rapidly growing quantities of information and the increased tasks of communication, as well as increased personnel costs, there has far been only a very slight rise in productivity in the office sector, while industrial productivity is increasing more rapidly.

6. These facts alone show the economic importance of information and communication technologies, in that they contribute to a better utilization of resources by enabling information to be collected, transmitted and processed more efficiently, thus reducing its cost.

The second set of arguments concerns the contribution that can be expected of communication technologies in tackling the structural adjustment problems of developing economies.

Second set of arguments:

1. Movement from traditional market structures to a more industrial economic model which requires a rapid co-ordination of information.

2. This situation entails an obligation to innovate in order to cut costs and rationalize production.

3. The application of communication techniques in the business world makes for innovation at the processing level involving a reduction in internal expenditure on production, organization and communication (effects of rationalization, increased productivity).

4. Many innovations are possible with manufactured goods both in their production and in the application of communications techniques, particularly along the following lines:

(a) Reduced prices and for improvements in existing goods or services;

(b) Supply of new goods and services;

(c) New ways of presenting and distributing goods or services.

5. In addition, communications techniques require only a small amount of energy and raw materials and have virtually no harmful effects on the environment. On the contrary, they help save energy and raw materials and reduce pollution.

6. Communications techniques therefore make it possible, through a better use of economic resources, to offer products that are more varied, of a higher quality, technically more modern, and less expensive. They thus help to enhance the capacity of national economies.

Similar problems face all nations, whether industrialized or not. But the hopes placed on new information and communication technologies are also alike. In particular, much is expected of telecommunication as a stimulant of investment and growth.

- The total volume of the world telecommunications market in 1984 was about 300 billion dollars, which corresponds to approximately 2 per cent of the gross global product.

- Since 1980, this market has been growing by approximately 15 per cent a year.

- There is general agreement that a minimum annual growth rate of about 5 per cent can be expected in this area over the next 15 years.

- In the developing countries embarking upon industrialization, the growth will essentially be the result of the establishment and expansion of national telephone systems. A huge potential market therefore exists, and will develop in this area, for communications technology equipment and for the engineering and advisory know-how.

At the moment, in Africa, despite the investment programmes that countries have carried out in the past two decades, the situation has hardly evolved and the annual telephone growth rate in the continent is less than 7 per cent, a level considered to be too low for new networks that are being set up.

In many countries, this sectoral weakness is felt in other sectors which use communications, such as industry, transport and services. According to PATU estimates, the picture is as follows:-

- total installed capacity : 2,814,000 lines
- primary lines connected : 2,610,000
- umber of telephone stations of all types : 4,170,000
- waiting list (demand expressed and satified): 2,168,000, 25 per cent of which, or 542,000, fall into the business category.

According to PATU, 2,000,000 additional lines (pessimistic assumption) will be required, 85 per cent of which will be extensions.

- On the one hand, this situation is expected to give a major impetus to home production in Africa, improved services and economic growth.

- The countries which succeed most quickly in setting up a telecommunications infrastructure at the technical and organizational level will have a significant competitive lead (greater export potential for their products and general reduction of production costs).

Such are the hopes. In view of the study by the International Telecommunicati Union on the relationship between a country's gross national product and the density of telephone stations, these hopes have a good chance of being fulfilled as long as the telecommunications infrastructure is developed according to needs. In all countries with a State telecommunications monopoly, the main responsibility for the fulfilment of these hopes, which are bound up with the development of a modern telecommunications infrastructure, lies with their national osts and elecommunications orporations. Their volume of business, investment and employment makes up an essential part of the economic data in this area.

The development strategy and the investment policy of telecommunications services have major consequences on related areas. Since telecommunications systems are inter-connected there is a need to co-ordinate national and international development strategies and to establish the maximum degree of transparency, in both the supply and utilization of equipment.

1.3 COMPARISON OF INTERNATIONAL TRENDS IN TELECOMMUNICATIONS

Telecommunication may be defined in a very general way as the non-material transfer of information between two or more people (individual telecommunications or among many people (mass communication) over long distances with the aid of acoustic and/or optical signals. In the first case (individual communications), each person in communication can at the same time transmit and receive information.

Thus conceived, telecommunication is suited only to a formalized type of communication limited to the visual and auditory senses. It cannot involve other senses such as taste, touch, radiation, smell, heat, or any mental factor.

Actual telecommunications systems require four elements in order to operate:-

(a) The distribution or transmission network (with or without wires);

(b) Exchanges for switching and transmission;

(c) Terminals;

(d) Services.

Information technology is closely related to the concept of telecommunication. It includes:-

(a) Input/retrieval;

(b) Storage;

(c) Processing;

(d) Transmission of information.

While all transmission systems are, by definition, part of telecommunications technology, information input, retrieval, storage and processing devices are so only in that they can be and are connected to a transmission system, even a local one. In such cases, these devices are also termed peripheral communication devices.

Market estimates may vary according to the category to which the peripherals belong. The basic technologies of micro-electronics, optical electronics (glass fibre techniques) and storage techniques - data processing, viewing procedures and sensors, are the basis for both fields (information and communication). In this connection, the growing importance of software should also be mentioned.

Progress in information and communication technologies is marked by great diversity, as well by the synergic effect of different developments. The frontiers of traditional technical fields are becoming increasingly porous.

The main patterns of change may be summarized as follows:-

(a) Semiconductor techniques, including micro-electronics, computer technology, including storage and transmission, are based to an even greater extent on information and communication techniques;

(b) The basic area of innovation is still micro-electronics. The essential feature remains the gradual improvement of the cost/performance ratio of all components of micro-electronic appliances Semiconductors and microprocessors;

(c) As for storage techniques, the main trend is an improvement of known technologies and the development of new processors offering a large capacity and increasingly short access time with a positive overall cost/performance ratio;

(d) In the software field, the following trends can be seen:

(i) The share of software costs (development and maintenance) is showing a disproportionate increase;

(ii) Constraints on rapid innovation will be increasingly due to the software development staff (programmer productivity);

(iii) These constraints can be eliminated only partially by "software tools" (development of software with the help of computers);

(e) Information (telecommunication) technology is marked by the following trends:

(i) Transition from electromechanical transmission and switching to digital means, which are entirely electronic and controlled by computer;

(ii) Increased appearance on the market of glass fibres, including optical transmission fibres;

(iii) Improved cost/performance of satellite transmission.

These technological developments create a huge potential for applications, including innovations to improve the telecommunications infrastructure. In this respect, the following should be noted:

(a) The introduction of new services on existing networks, for example, teletext, telefax, videotext, etc.

(b) The digitization and intergration of existing narrow-band telecommunications systems (transmission and switching);

(c) The creation of new broadband transmission systems (glass fibres) and the establishment of new broadband dialogue services.

These three stages of innovation are being carried out, or at least contemplated in this or a similar form, by virtually all public services in the world.

The end product of all these efforts and conceivable potential is the creation of a country-wide telecommunications network, with integrated services, first supplied on a narrow band (ISDN), that is both switched services such as telephones, telefax, telex, videotext, telepac, etc. and broadcast services, television, radio programmes, teletext, etc. The transmission lines will be made of optical fibres and supplemented by communications satellites. Digital connection fields will make up the switching centres of this communications system of the next millenium.

The development strategies adopted by various countries to modernize their telecommunications infrastructure are characterized:

(a) By the political and legal environment considered most likely to promote the development of the market. Demonopolization or liberalization, as in the United States, Great Britain and Japan, contrasts with the maintenance of monopolies in all other countries of the world;

(b) By the intensity with which a policy for and the systematic planning of a national telecommunications network is pursued and by the persistence with

with which it is applied and the related measures implemented. As a result, the time taken to introduce these services often varies a great deal from country to country. For example, while in the United States, Great Britain and Japan, the development of telecommunications depends essentially on market forces and the State simply establishes a favourable environment, in other countries suppliers and users wait for their Governments to develop rapidly a modern telecommunications infrastructure and to apply a liberal policy, making limited use of the telecommunications monopoly and to pursue standardization, especially with terminals.

The similarity in the time taken for development in different countries regardless of who they are, depends above all on the fact that the establishment of a country-wide broadband telecommunications network using optical fibres still requires the solution of many technical and standardization problems. That will not be possible before the start of the next decade. Until then, the focus will be on preliminary work (the use of glass fibre in trunk lines, the establishment of an overlay system to meet the most urgent needs for rapid data transmission and video communication in businesses, the implementation of pilot projects, and standardization work within international organizations, etc.).

As a further example, on 21 March 1985, the EEC Commission launched a joint telecommunications research and development project in Europe, the RACE programme (Research and Development in Advance Communications Technologies for Europe). The aims of the programme are as follows:

(a) To introduce into the Community as a whole broadband integrated communication as of 1995, taking account of the ISDN network;

(b) To create a competitive common market in telecommunications equipment and services.

These aims should be achieved primarily through international co-operation in research and development, the solution of outstanding problems, the removal of problems of standardization, and the development of reference models for networks, terminals and applications.

1.4 PROBLEMS REGARDING FUTURE TECHNOLOGICAL DEVELOPMENTS

The EEC RACE programme has shown that planning is not a sure thing, if only because of the technical problems that still have to be solved.

Delays must be taken into account in the same way as changes, either because the technical problems are not solved in time or because the terminal devices are not produced on schedule or are prohibitively priced.

For national telecommunications services, the problem of financing the considerable amount of investment required to establish these networks is, in general, less important than that of guaranteeing the long-term profitability of this investment, it being difficult to estimate the long-term changes in demand.

The economic effects of the various network development strategies depend essentially on the way in which the telecommunications services offered are accepted and demanded by the office and household users.

A number of reasons that could cause demand to develop more slowly than desired have already been mentioned (technical difficulties, standardization problems, inadequate availability of equipment). In addition, there are such factors as a lack of transparency in planning or in the market or the ever decreasing lifespan of goods. These difficulties must be overcome by greater efforts on the supply side.

Other factors might act directly on the demand side. The main causes of a rate of acceptance and demand on the part of business users (enterprises, administrative services, non-profit-making organizations) could be:

(a) Lack of information on the current supply of goods and services and future developments;

(b) Lack of knowledge of the economic utility of new communications techniques, as office and communications costs will be an unknown quantity especially in small and medium-sized businesses;

(c) The 'value' attached to existing organizational structures which are challenged by the introduction of new communications techniques (the need for training and re-organization). These requirements often exceed the ability and willingne s to learn of both managers and workers;

(d) The fears, justified or otherwise, of many managers or persons concerned about the negative impact of telecommunications on the labour market or on the quality of work (skills, reduction of social contacts, increased control over the quality of work, concentration of decision-making power, off-site work);

(e) Finally, the very slow adjustment of the skilled labour market to meet the new demands for skills. In the upcoming sectors, it is very hard, if not impossible, today to find the necessary skilled staff on the labour market (programmers, computer specialists, media experts).

All these factors, regardless of whether or not they are rationally motivated, have an impact and a decisive influence on the process of acceptance and on the development of economic demand.

In the domestic setting, the acceptance of and demand for new information technologies is subject to two variables:

(a) The fact that the buying power of households for the purchase of information equipment and new means of communications is limited and,

(b) The fact that leisure time and the time available for the use of information technologies is also limited.

An estimate of potential household demand carried out in Europe has shown that, even going by an optimistic economic forecast, the money available to households will not be even nearly enough to help ensure the profitability of the developments foreseen on the supply side.

1.5 FORSEEABLE ECONOMIC PROSPECTS

This heading usually covers the impact of telecommunications on economic growth, its effects on the employment rate and the labour market, and its regional economic effects. Growth prospects have already been mentioned in the previous sections. They are based on the theory of cyclical growth of the American economists Simon KUZNET and KONDRATIEFF.

Although it should be said that these theories are fairly speculative and that they can be supported empirically only in a rather unsatisfactory way, it can be said that these phenomena are cyclical by nature, periods of economic growth and decline in growth being intensified by radial innovations, which include the new communications techniques. The cautious optimism towards economic growth in the world in general and in Africa in particular, for this decade and the next, is justified, among other things, by the fact that, though technical co-operation in the African region and throughout the world, national economies will rapidly assimilate the new technologies that emerge.

It can be said that the future economic health of the countries of that region will depend on the rapid and effective application of a number of new information and communications technologies. For that to be achieved, many measures that must be taken. If these measures are taken, particularly in the field of research and development, production, training, and business management and organization, it is possible to count on an upsurge in the annual growth of the gross national product.

As for employment, one of the most controversial questions is how and to what extent do new communications technologies and new information methods influence the labour market.

The introduction of digital techniques into telecommunications means that where four units of manpower have so far been needed per unit of production in the manufacture of electromechanical systems, only one will be required in the the future.

Furthermore, it may be allowed that approximately 25 per cent of all office and administrative jobs can be automated through the use of information and communications technologies, which implies a potential loss of jobs. There are, however, estimates from serious institutions predicting a significant increase in the number of jobs in the very same office sector.

How can this contradiction be explained?

There is no denying that communications techniques do contain a huge potenti for rationalization and the replacement of many occupations, jobs and skills particularly in the office and administrative services, but also in manufacturing.

At the same time, however, telecommunications techniques contain a potential for innovation which, if exploited, will open up many new markets, and new opportunities for jobs and occupational skills. This sort of shift in job opportunities and skills as a result of technical progress is by no means unusual in a dynamic economy and can easily be absorbed when the economy is moving along prosperously (that is, when it is expanding). In this event, the main effect of the new techniques will not be rationalization but the development of production (the development of existing markets or the opening up the new ones).

On the other hand, the present economic situation is marked by two dominant factors: a consistently low rate of growth and a huge rise in population. In view of these two factors, the new information and communications technologies are of but minor importance.

Rather [illegible]est prospects of growth form the back-cloth to the 1980s. It must therefore be reckoned that, in the medium term (up to the year 1990), information and communications technologies will have a rationalizing impact that will exceed its innovative job-generating effects.

Is it possible to identify specific regional effects?

(a) Access to information and the possibilites of communication will be a decisive factor for the competitivity of regions and the competitivity of businesses established there. Decisions on the building of networks are therefore of overriding importance for regional policies and planning;

(b) It is not just the possibility of access to these new technologies but also the costs they generate that will determine the level of industry established. In a communications society, tax and pricing policy will therefore also be important as an tool of regional policy.

On the other hand, there is no denying the fact that decentralized geographical areas will be less disadvantaged in the future, because of available technology. The physical transport of information could be replaced by its electronic transport. The travelling theatre will give way to broadcast televisio That is why the answer to the following two questions is of overriding importance for regional policies and planning:

(a) Should the development of the network infrastructure be viewed first and foremost in terms of current needs at the risk of aggravating regional differences, or should preferential preliminary investment be required in line with a regional or social policy?

(b) Should tax policy be applied to the disadvantaged regions in the same way as to the most well-off, or should the principle behind it be to cover costs or even to accord favourable treatment in order to make up for other disadvantages?

These questions were asked in much the same way when the railways were being built and are still being asked with regard to their fare policy. In connection with the regional effects, it would also be interesting, in the context of another discussion, to address the question of jobs at home made possible through new generation peripherals. To conclude this brief overview of the changes in telecommunications that can be foreseen today, it may be noted that the flood of new telecommunications technologies is going to overwhelm the economic, industrial and social structures in both the industrialized and the industrializing countries. The shock in harsh for everyone, and the task at hand is to negotiate intelligently this new turning point in history.

2. TECHNOLOGY OPTIONS

We have just completed a brief review of the changes in telecommunications and their impact on economic activity.

To echo the report of the independent commission, telecommunications companies in each developing country must make their own decisions on the technology to be applied in their system. The consequences of their decisions will felt for many years and will have a radical influence on the operation of the national telecommunications service.

Bearing in mind the promise and uncertainities that the future holds for them, decision makers must consider the options open to them today, without forgetting that the technology most appropriate for a country is the one which enables its human, material and financial resources to be used to their full extent. This is as true for the industrialized countries as it is for developing ones.

The elements of telecommunications

All public telecommunications systems include:

- subscriber terminals
- subscriber lines
- local exchanges
- trunk transit exchanges
- circuits between exchanges.

Subscriber terminals

Subscriber terminals have come a long way since the simple telephone set providing basic vocal telephony. The current trend favours increased terminal intelligence to allow subscribers to perform different tasks which make the telephone more useful. Terminals connected to such other services as facsimile and data transfer have become both versatile and more refined.

We can already seen the emergence of the concept of a single piece of equipment that can act as a terminal for text transmission, data transfer and other non-vocal services as well as being used as a telephone. An ordinary telephone line can provide a large number of such services and, with this sort of equipment, non-vocal services in rural and isolated areas might be provided more easily and more cheaply.

Subscriber lines (local distribution)

Subscriber terminals are normally connected to local exchanges by a pair of metal conducting wires. These physical connections are cumbersome and on average account for 30 per cent of the total equipment cost in urban areas. However, in highly populated areas, it is possible to plan and set up a local distribution system that may be augmented economically. Local networks use overhead of underground cables of different sizes and connection points with flexible conductors offering enough available capacity for new subscriber terminal connections to be added. There are various electronic ways of concentrating traffic so that several subscribers can share the same pair of physical conductors.

Local distribution is the main problem in setting up telephone services in rural and isolated areas. It can happen that some subscribers are far from the exchange -- distances of 50 kilometres are not uncommon -- while the terrain and the environment may be inhospitable.

The costs of a local network can represent up to 80 per cent of initial equipment costs, while the latter are generally five times greater than urban costs. Connections using physical conductors still dominate with the extendable use of overhead open wiere systems. In some conditions, open-wire lines are suitable, particularly in supplying rural areas without amplification units and can use small carrier systems that supply a number of subscribers from the same pair of physical conductors. However, they are subject to electrical interference and physical damage, which means high repair and maintenance costs.

Instead of physical conductors, especially in rural areas, it is possible to opt for radiotelephones. Microwave systems on 30 to 300 MHz (VHF), 300 to 3,00 MHz (UHF) and 3,000 to 30,000 MHz (SHF) operate along line-of-sight radio paths, the maximum distance from transmitter to receiver being between 60 and 70 kilometres: in practice, environmental and typographical conditions sometimes reduce their range. It is possible to improve the efficiency of the frequency spectrum by making use of the cellular concept and other methods of dynamic frequency assignment.

Decametric wave systems have been used only on a limited scale because there are few frequencies in the HF band and the risks of interference are high. Althoug HF frequencies are being used less for intercontinental services from one country to another, new domestic users have introduced them, with the result that the HF band continues to be crowded. However, with suitable antennae and a proper selection of frequencies, HF systems can be used effectively over long distances.

Satellite systems are already suitable for a large number of circuits and are becoming an attractive solution for rural systems with a low traffic volume, particularly when there are long distances to be covered or in cases where it proves difficult, if not impossible, to install a radio repeater. The cost of satellite communications service includes the investment in a satellite repeater and in earth stations. At the moment, earth stations are expensive but their cost is falling.

Exchange systems (local and transit or trunk)

Manual or operator circuits in which connections are made by means of jacks and plugs are still widely used. As long as staff are available around the clock, these systems can provide a reasonable service with allow level of investment, low energy consumption and moderate maintenance. However, in rural areas, it often happens that they are manned only during the day and that operating costs are high.

In all automatic analog systems, voice frequencies are converted into an electrical signal of variable frequency and amplitude, and the communications are connected by means of a separate switch within the system. The oldest automatic system is the step-by-step system including electromechanical switches. Although it is still widely used, it is now obsolete. Maintenance costs are high, the system has a large number of moving parts, and its capacity is limited, but it can provide a reliable service and a great many maintenance engineers are familiar with it. It is almost no longer possible to buy a new step-by-step switch, but such equipment can be obtained in reconditioned form and perfect working order on the world market. Crossbar systems operate at higher speeds, are less expensive to maintain and have more to offer subscribers. However, these systems are also obsolete and it is expected that their production will continue only for the expansive of existing systems.

The most recent generation of analog systems includes stored programme control (SPC). In these systems, the control functions are performed by a computer and the switching matrix can employ solid-state electronic cross-over points. The advantages include extensive possibilites for remote operation and maintenance, integrated test signal units, and an almost total absence of unprotected contact points, which makes these systems less vulnerable to dust. Normally, SPC exchanges are produced in compact form so that air-conditioning is required, particularly in hot and/or tropical countries. These systems are not yet obsolete, but most manufacturers tend to be concentrating more and more on the production of digital systems.

In a digital switching system, telephone conversations are converted from an analog signal into a code consisting of a high speed go/stop pulse.

The pulses from different conversations are separated from one another by discrete time intervals and are switched in turn by the system (time switching) so that many conversations can be handled by the same switch. Digital exchanges are cheaper to install and maintain than analog exchanges particularly in the larger sizes, and they will probably become even less expensive. The advantages of this type of switching include its computer output compatibility and the potential for savings where it is operated in conjuction with digital transmission systems.

Junctions and trunk circuits

Communications can be transmitted between exchanges along paired symmetrical, star quad, coaxial, or optical fibre cables, or by means of microwave radio system, overland or via satellite. The choice of medium depends on the bandwidth or the volume of traffic to be transmitted, the distance and terrain to be covered, the quality required, the traffic distribution and the cost.

In the past, trunk transmission systems were analog, but they are now being gradually replaced by digital systems.

Technological progress reduces the cost and improve. the quality of service. The optical fibre cable is particularly suited to high capacity routes with longer distances between the signal regeneration points, which reduces costs even more while increasing reliability. Optical fibre systems are going to replace star quad and coaxial systems as the prefered medium. Microwave systems are particularly suitable for medium or high capacity routes in the developing countries and over difficult terrain. Submerine optical fibre or coaxial cables can provide an economic solution in many cases for long distance or international transmission. Satellite systems, particularly low traffic systems, are becoming more and more competitive when there are long distances to be covered or where the topography poses problems.

The Integrated Services Digital Network

The advantages of digital exchanges and transmission systems have already been noted. These systems can been istalled piece by piece as needed within an existing analog network. However, the full potential will not be realized until they are used to create a totally digital network constructed according to a set of integrated standards.

A network of this type transmits data as easily as it does voice signals and may therefore be used for many types of service. This results in economies of scale and an ease of adaptability to traffic flow on special services. Computers installed in the exchanges can monitor and control the behaviour of the network as a whole and offer further possibilities and techniques for operation. The easy adaptability of digital systems also simplifies the physical design of networks -- for example, there are fewer restrictions in supplying large areas from one exchange.

We consider that overall an entirely digital network offers great advantages and that all telecommunications planning decisions should be made with the establishment of this type of network in mind. This argument may be expressed as follows:

"Although the data or even broadband communications are not at the moment as important for the third as the transmission of telephone signals, we feel nevertheless that it is extremely important, when adopting the principle of digitization from the moment a telephone system is stalled, to prepare the ground for expansion in that direction at a future date."

However, when telecommunications networks are expanded in developing countries, in order to install advanced data communications equipment, the companies from the industrialized countries who would normally operate such equipment could derive improper advantages by collecting information on world markets and trade. For this to be avoided, there must be closer co-operation between the industrialized and the developing countries in the field of data communications.

The choice

The increased speed of technological progress has, as we have seen, widened the range of options and complicated the problems facing developing countries when they proceed to a choice. The case of each developing country must be considered individually. Advanced technology has not always been the best solution. However, the introduction of digital systems would be justified in several networks, especially those where the existing infrastructures are not sophisticated. In any event, the shift from an analog to a digital network will take many years in both the developing and the industrialized countries.

There are various considerations that should guide the operating companies when they choose a technology. One major aim should be to cope with current and predicted demand. To do so economically, there is a need for prudent long-term planning in order to select the most appropriate technology. Existing analog equipment should be used up to the end of its economic life rather than being replaced prematurely by digital equipment. It is possible to introduce digital equipment alongside of analog, but the difficulties involved in operating a network comprising too many different systems must be recognized.

Network planners should also take account of the capital available the effects of investment on finances, administration, telecommunications and staffing the space necessary for construction, and other non-technical problems.

The formulation realization and implementation of long-term strategic plans are very difficult processes. In laying down the main lines for the development of the network and providing a basis for financial, personnel and other non-technical decisions, the plans must be sufficiently versatile to be capable of incorporating technological advances.

There are not enough competent network planners, even in the industrialized countries. Special efforts must be made to develop these skills, while using those that already exist.

Although suitable equipment does exist for the provision of service to isolated areas with a scattered the population, equipment and operating costs are high compared to the number of subscribers served. In urban areas, a closer relationship will exist between needs and equipment since the environment a user requirements correspond more closely to those of the industrialized countries where the equipme[illegible]s designed and manufactured. But this is not so in isolated rural areas w[illegible] the distances are long and population density low, where the terrain and the physical surroundings are difficult, and where there is possibly no ele[illegible]y or even roads.

There is a need to develop systems that are specially designed to provide service to the most isolated areas, and at a lower cost. From the point of view of the manufacturers of telecommunications systems, including satellite systems, there is a large potential market here for cost-effective equipment. The developing countries have a role to play by creating a telecommunications centre capable of analysing this need and introducing the necessary changes into standard equipment, in collaboration with the manufacturers.

One example of a study that should immediately undertaken would be the preparation of a schedule for a small capacity public switching exchange

(500 to 1,000 lines) for rural applications, based on a modified version of the standard PABX systems on the market.

Apart from carrying out studies, the telecommunications centre would also have to develop the equipment and installation and maintenance techniques to satisfy the specific needs of the telecommunications services of the region.

Such an approach would allow technology to be transferred in a practical and profitable way, on a scientific and technological basis from which all would benefit.

3. THE TELECOMMUNICATIONS INDUSTRY IN AFRICA

3.1 Necessary conditions

The establishment of local manufacturing centres for telecommunications equipment in developing countries requires at the outset three types of resources: manpower, materials and finance. Some developing countries have a relatively developed industrial infrastructure and a sufficiently skilled work-force, and their telecommunications equipment needs are also considerable as their networks are to extensive. These countries can, and some already do, set up fairly large manufacturing centres. However, for many smaller countries, the creation of enterprises is not justified economically.

Such countries can establish manufacturing centres as joint or collective operating ventures at the regional or subregional level. Secondary centres may be established in different member countries in order to improve gradually their industrial base and to consolidate the collective effort while ensuring a local source of supply for a given piece of equipment and thus its long-term maintenance.

It must be recognized that only the large developing countries can find enough capital to set up or even have sufficient demand to justify, factories on their territory, even if they produce only the simplest types of equipment. It is common knowledge that the viability of an industrial enterprise depends on the production of enough units to offer economies of scale. It is generally considered that the annual minimum output needed to justify the production of telecommunications equipment is approximately as follows:-

250,000 telephones

200 public switching exchanges (500,000lines)

1,000 private switching exchanges (PABX units with an average capacity of 20 lines)

1,000,000 telephone relays (components)

The reason for including relays in the range of products is that both Africa and industrialized countries are finding it more and more difficult to maintain their supply of such components, which are the basic elements of electromechanical switching systems. This is related to the increasing and irreversible introduction of digital technologies, towards which production lines are being increasingly converted. The increase in unit costs caused by these changes in the telecommunications sub-sector in the industrialized countries could promote the Development in countries with a plentiful and inexpensive supply of labour, of production units making competitively priced spares.

This would, moreover, help prolong the operational life of existing electromechanical exchanges in African countries.

African production units would thus become exporters to the technologically more advanced countries.

It is also conceivable that the modification of standard PABX systems to make public exchanges for use in rural areas could be done in special workshops.

It is also possible to imagine an extension of this process with the production of complete or parts for switching centres, in collaboration with the European supplier on the basis of two- or three-year management contracts and a mutually acceptable profit-sharing scheme.

Before going into detailed examples of industrial production in Africa, and taking account of the limited financial resources available to industrialization projects, it should be said that the importance of a high rate of operation cannot be stressed enough if a low level of profitability is to be avoided. The objectives of perfect matching of the product to needs and of high quality standards should be achieved through rational planning, construction, operation and maintenance, which should observe the following conditions:

(a) Selection of a serious partner and a co-operation contract that benefits all parties;

(b) Project studies and a coherent and comprehensive planning programme;

(c) Proper project implementation and experienced management;

(d) Intensive technical training for junior staff.

There are also other criteria that could be mentioned, such as the size of the enterprise, geographical location, originality of the product, etc.

In order to introduce the desired consistency into these sketchy arguments, I would like to refer by way of conclusion to a number of projects carried out in the following countries:

- Turkey
- Egypt
- Iraq
- Algeria
- Nigeria
- Bangladesh
- Saudi Arabia.

All these projects were successfully completed by observing the essential conditions that have just been mentioned.

The common features of all these national projects were:

(a) A management contract of at least two years;

(b) Equitable profit-sharing on the successful completion of the project;

(c) A licence for use of the registered trade-mark.

The introductory programme can be summarized as follows:

- 1973 to 1975: Basic discussions with the Governments concerned, submission of an initial project, revision and changes:

- 1976: Agreement on final project and formal signature;

- 1977: Negotiations on the site and construction of the factory;

- 1978: Amendment of contract to include a new project;

- 1979: Start of construction, arrival of specialists and recruitment of work-force; beginning of training:

- 1980: Training of specialists in Switzerland:

- 1981: Installation of machines and equipment. Start of production of parts and equipment.

- So far, results have exceeded the forecasts for the initial project, and an additional project aimed at increasing production is under review. Here are some facts about these production units:

- Number of employees: 530, for production at 70 per cent of capacity;

- On-site production of components;

- On-site assembly of components;

- On-site final inspection of equipment.

In addition to the film I am going to show you in a moment, I also have some background slides, together with a complete record, of one of these projects, which are at your disposal.

IV CONCLUSION

There have been many studies published on the theory and practice of regional economic integration, and many practical trials have been conducted over the last thirty years.

Some of these have achieved only limited success because not all prerequisities the conditions for the planning of a regional telecommunications industry were fulfilled, at all levels, political, economic and technical. These conditions are:

(a) Favourable socio-economic climate;

(b) Resolution of institutional and organizational questions;

(c) Prudent selection of products;

(d) Choice of factory site;

(e) Guaranteed funding.

It may be noted that the choice of equipment for manufacture is only one of a number of technical factors.

The nature of the political agreement will determine the choice of materials for manufacture and make it easier or more difficult.

Electronic switching

We have shown that according to ITU statistics, it might not be possible to produce electronic switching equipment at a profit for some time yet.

However, the production and modification for public use of small private exchanges seems to me to be reasonable, for capacities of between 100 and 1,000 lines. The purpose of these exchanges would be to satisfy rural public switching needs.

On the other hand, the model adopted should be modular and adaptable so as to satisfy PABX needs and with a capacity of 10 to 50 lines.

Thus, the same model would be suitable for two applications subject to adaptation.

Electromechanical switching

The production of electromechanical equipment, limited mainly to assembly, and requiring the purchase of parts, would be possible but might run counter to the network development objectives set by the countries concerned.

If we assume that electromechanical exchanges will continue to be used for another 30 to 50 years, it would be reasonable to consider the production of electromechanical equipment.

Note should be made of existing production in Algeria and Egypt.

Telephone sets

The manufacture of telephone stations could be profitable at the regional level.

The production in Algeria, Egypt, Sudan, Tunisia and Zambia should be noted.

Multiplex transmission

The limited production of multiplex equipment, preferably combined with the production of single channel radio equipment, is possible at the regional level.

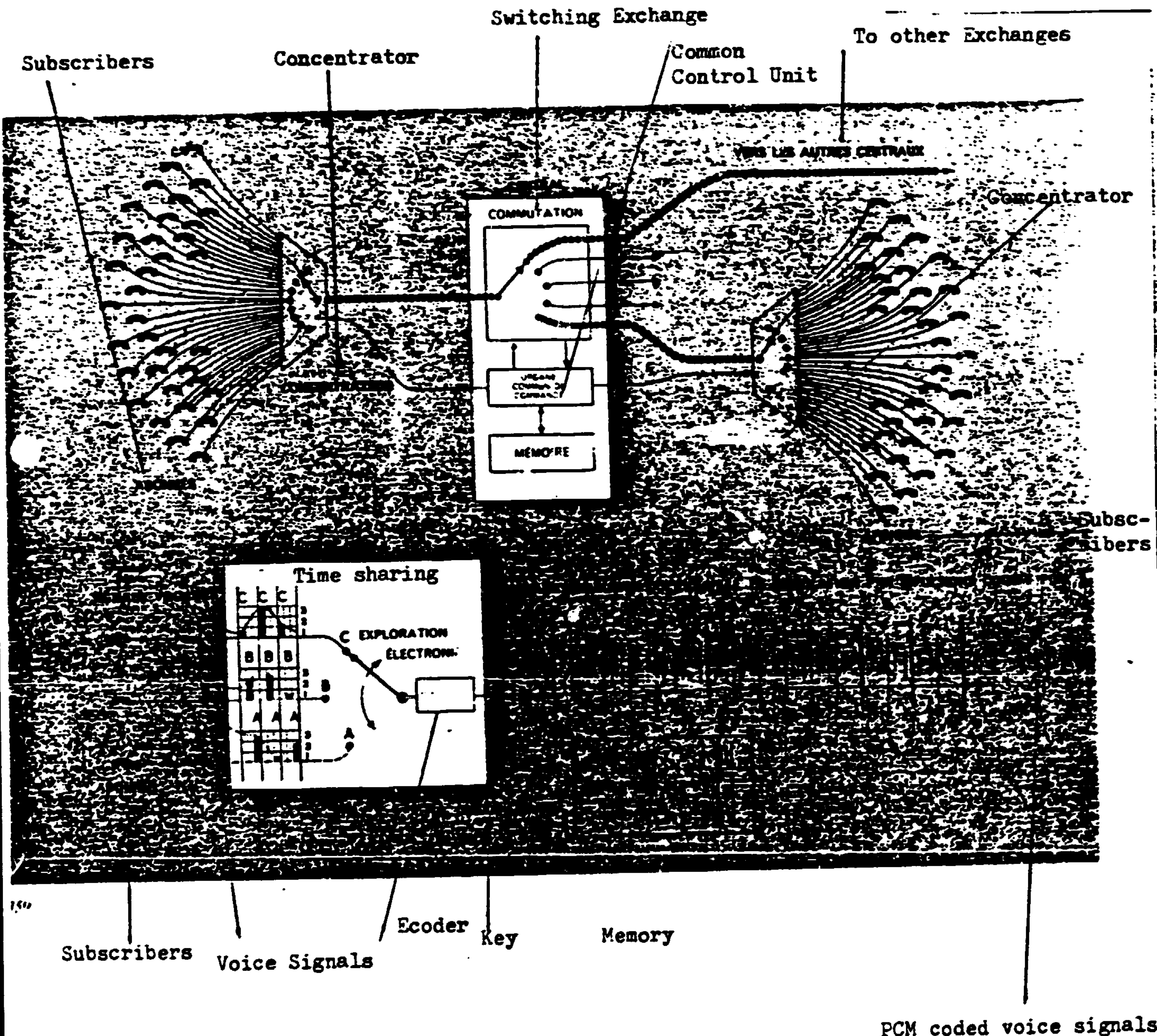
It should be noted that such production does exist in Egypt.

Components

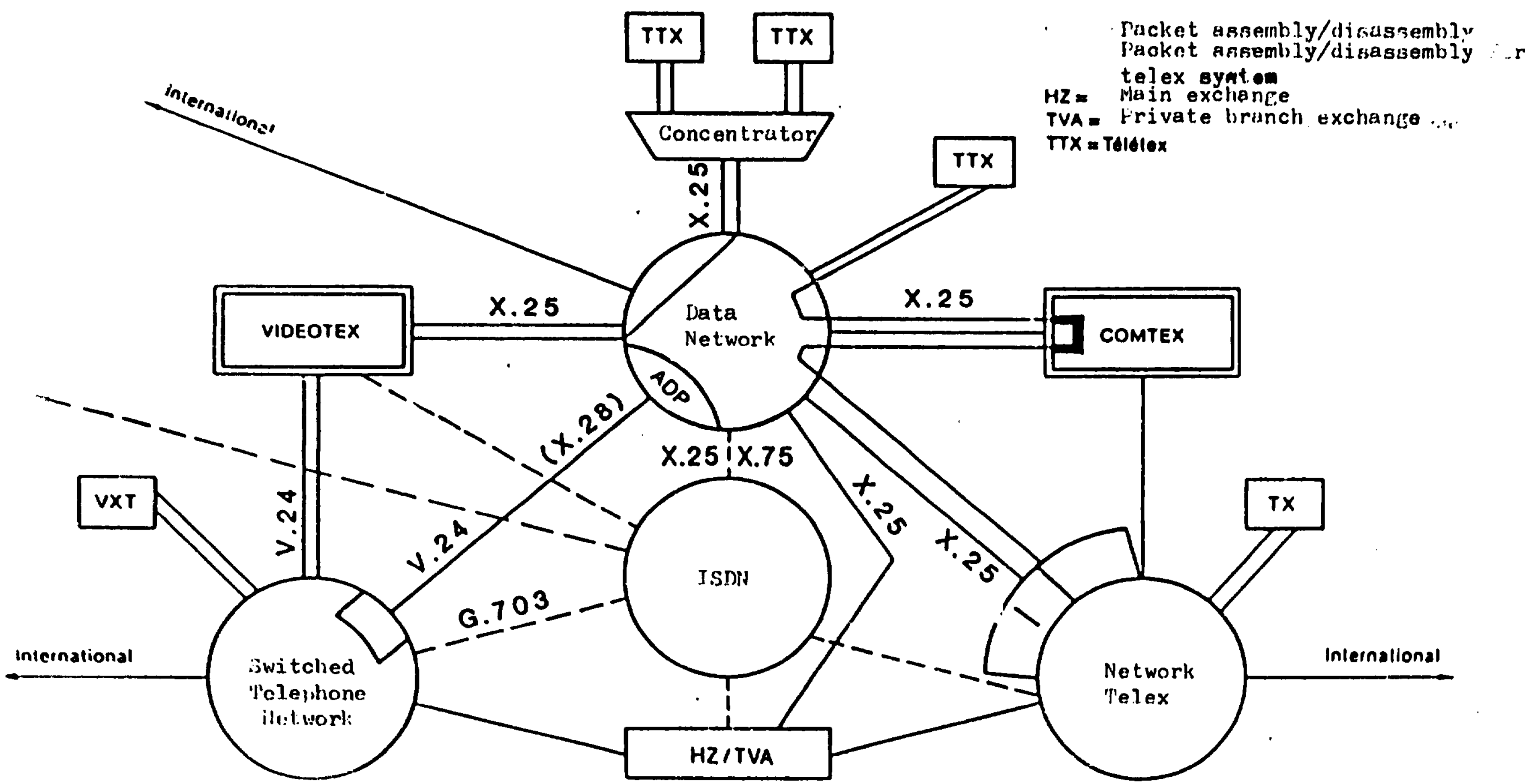
The large quantities involved and the short time factor prevent the production of sophisticated components in the region.

However, basic components, such as relays, could be suitable for production in the region, both for the maintenance of existing equipment and for export, since this type of production requires a large supply of labour and raw materials.

Finally, and given the complexity of my subject, the fact that I am Swiss, ever neutral, obliges me to remind you of the importance of the spirit of mutual compromise for the development of a viable regional industry.


Switching Exchange
To other Exchanges
Subscribers
Concentrator
Common Control Unit
COMMUTATION
MEMOIRE
Concentrator
Subscribers
Time sharing
EXPLORATION
ELECTRONI
Subscribers
Voice Signals
Ecoder
Key
Memory
PCM coded voice signals

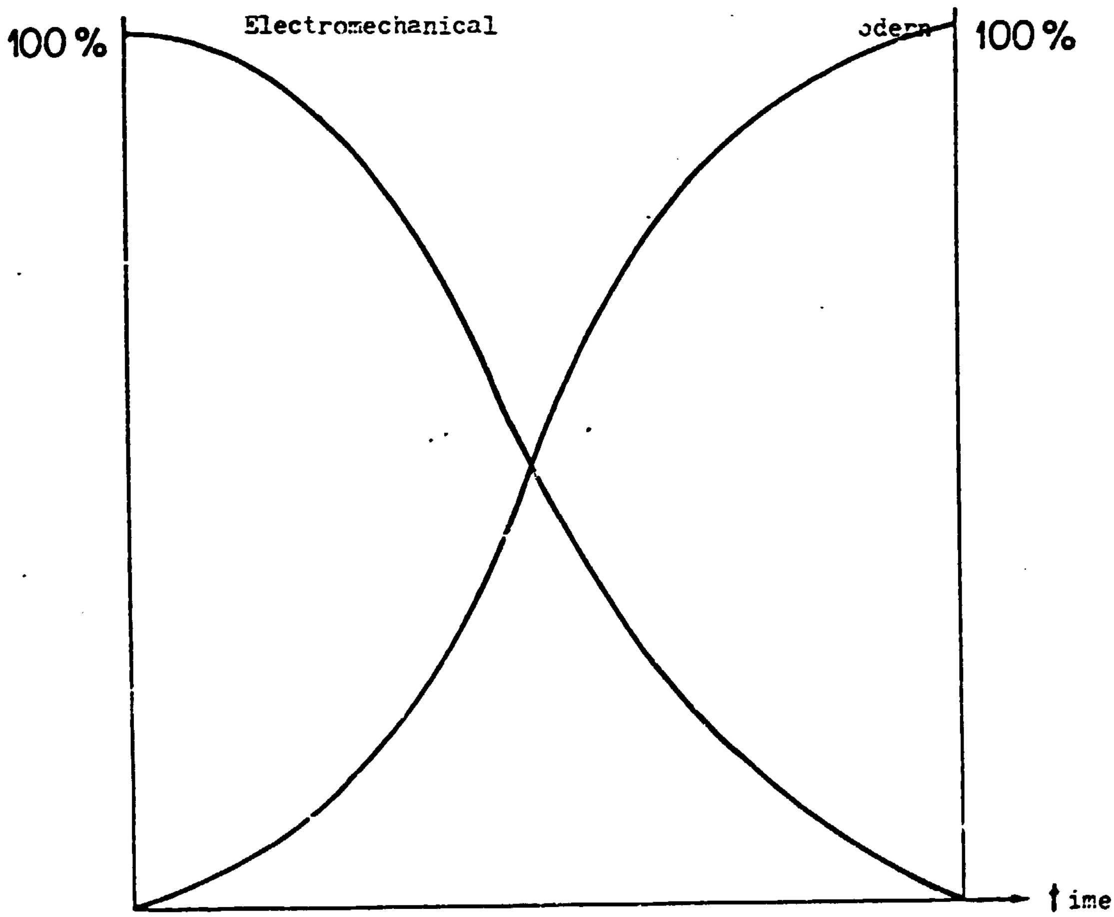
COMPONENTS OF PUBLIC TELEINFORMATION NETWORK

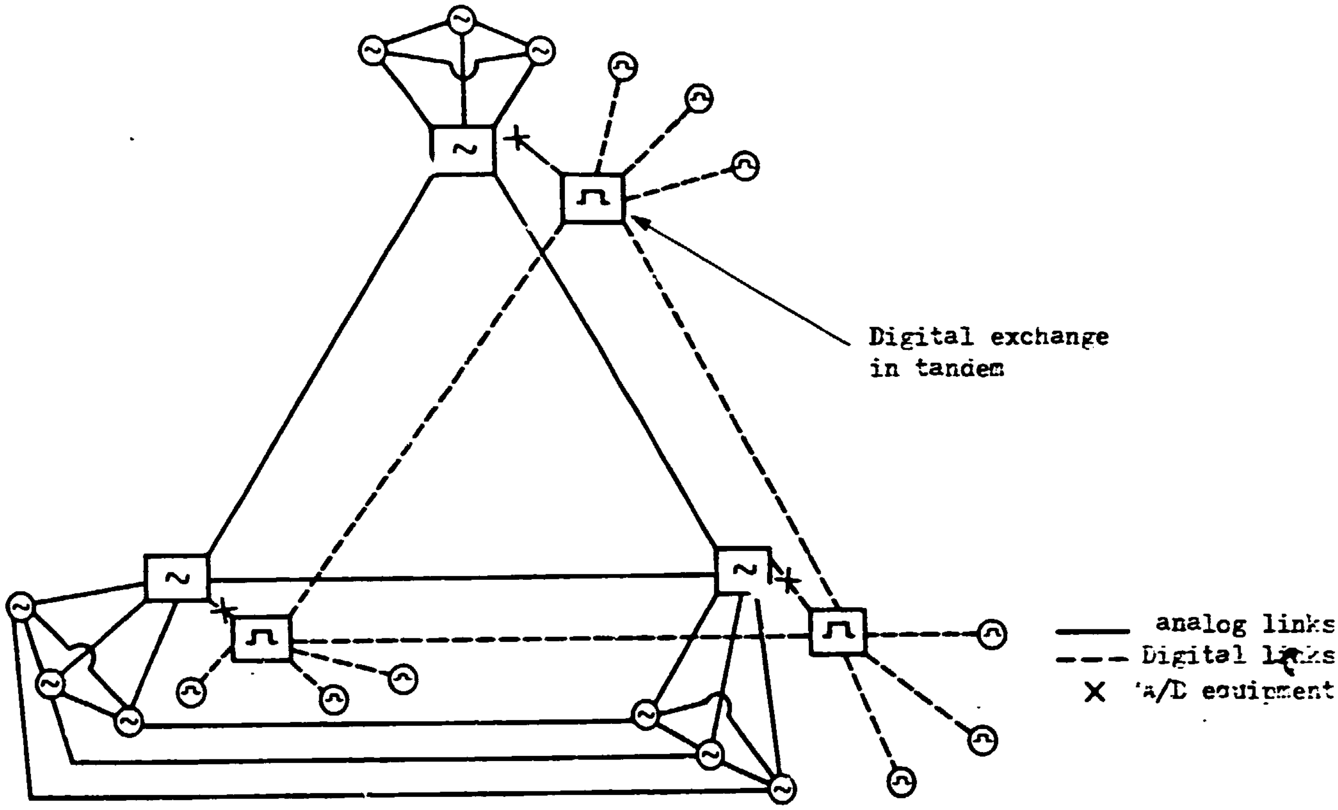


Services used in ISDN

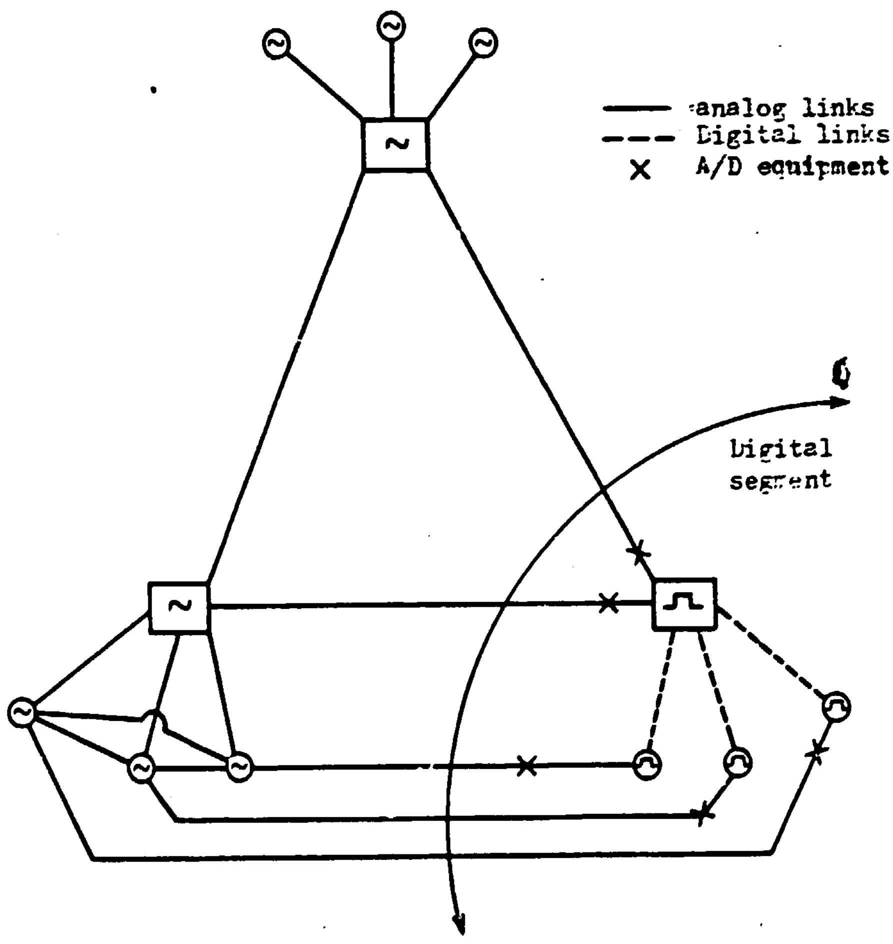
Basic services
Transparent circuit switching links for speech and Data Transmission at 64 kbit/s
Packet switched links for access to packet switched network
Telephone service
High speed facsimile service
Teletex service
Service Videotex
Data modem service

REPLACEMENT OF ELECTROMECHANICAL EXCHANGES
BY MODERN EXCHANGES

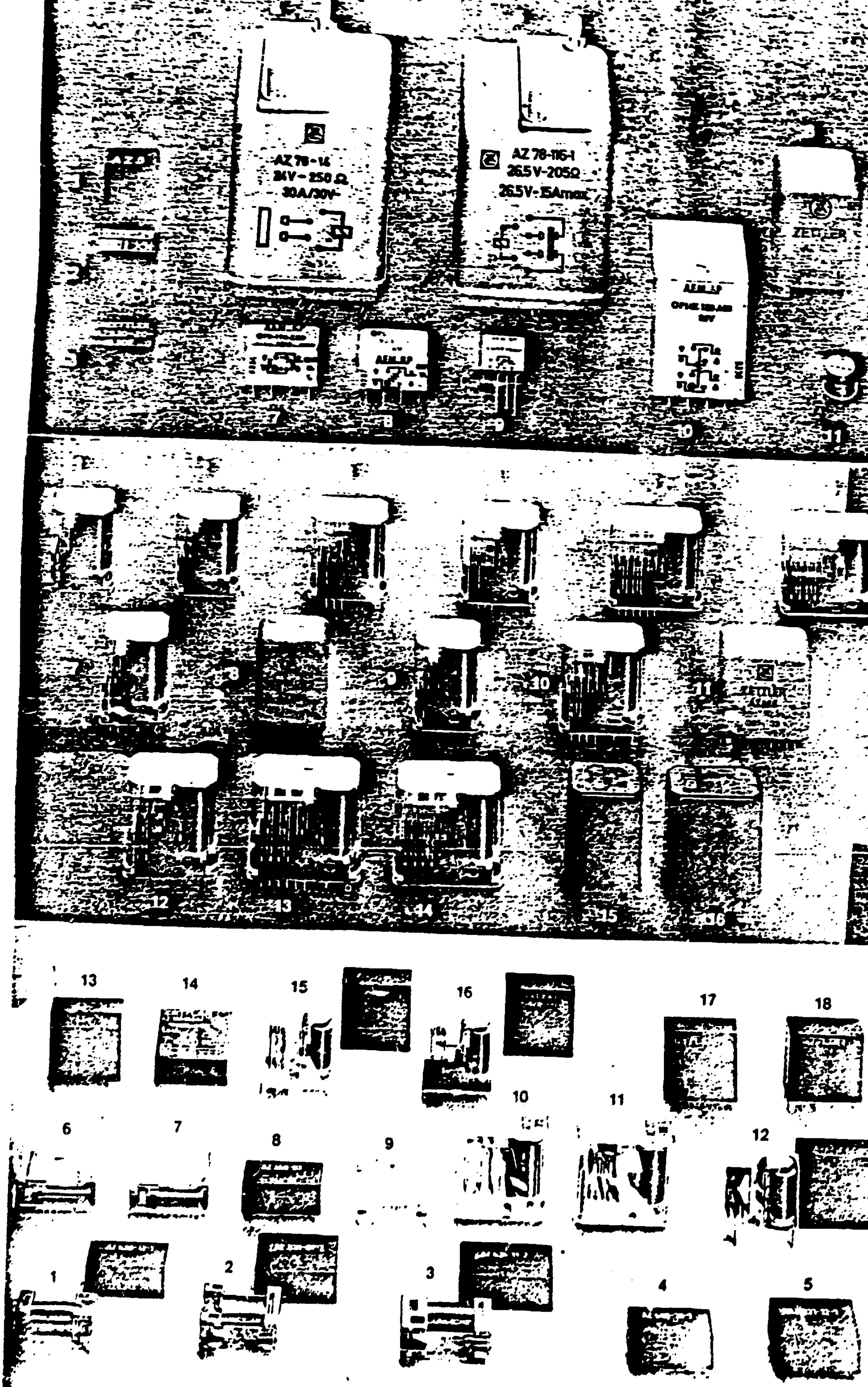




Structure of network with overlay



Structure with digital segment


AZ 78-14
24V - 250 Ω
30A/30V~
AZ 78-116-I
26,5V-205Ω
26,5V-15Amax
ZETTLER

ESTIMATED DEMAND AND MINIMUM VOLUME OF PRODUCTION

EQUIPMENT			Annual demand (1980-1990)		
			East Afr Groupe	ECOWAS Groupe	Total
Electromechanical Switching	Main lines	50-100	20-60	35-150	55-210
Electronic Switching		100-500	20-60	35-150	55-210
PABX	Internal lines	10-20	3-6	5-15	8-21
Telephones	Sets	250	50-150	75-375	125-525
Multiplex transmissions	Circuits	1-5	2-4	2-8	4-12

(in thousands)

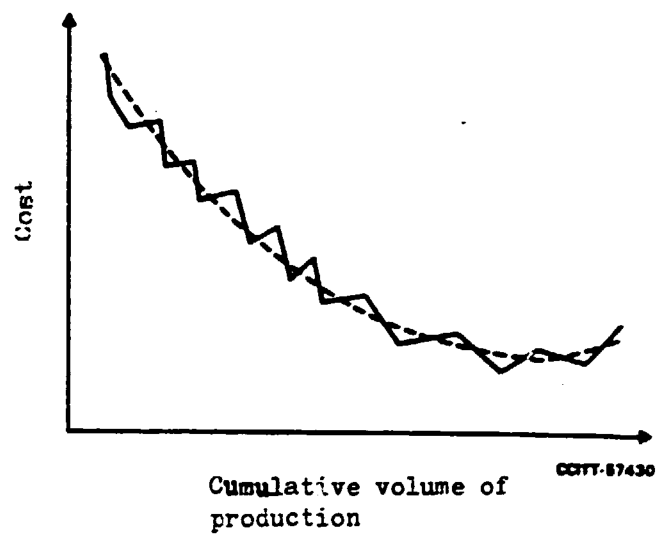


Illustration of the "progress factor"

By way of illustration, the tables below shows the percentage distribution of labour and capital resources, according to CCITT studies:

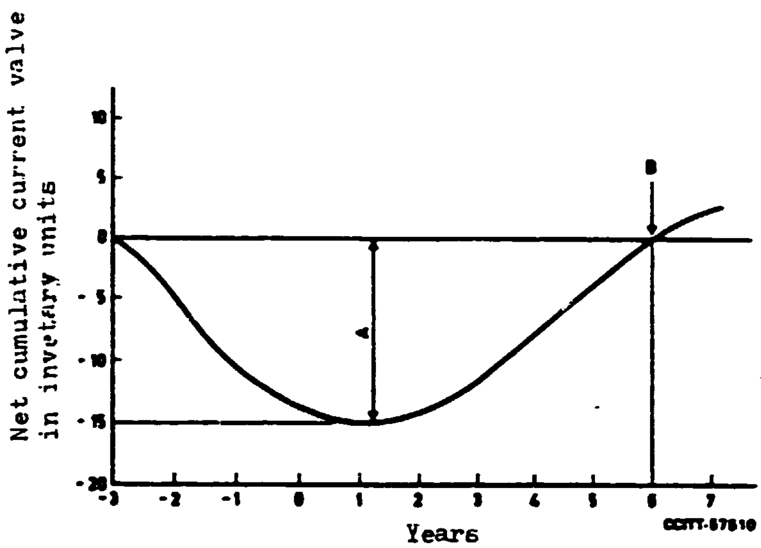
LABOUR REQUIREMENTS	Telephones Stations	Electronic Switching equipment	Transmission equipment
Manufacture of components	40	20	10
Assembly and tests	60	80	90

CAPITAL REQUIREMENTS	Telephone Stations	Electronic Switching equipment	Transmission equipment
Manufacture of components	90	70	40
Assembly and tests	10	30	60

STATUS OF PRODUCTION

A preliminary survey carried out by PATU in 1982 showed that a small number of countries do have production units, geared essentially towards covering some of the country's needs in respect of a limited range of items:

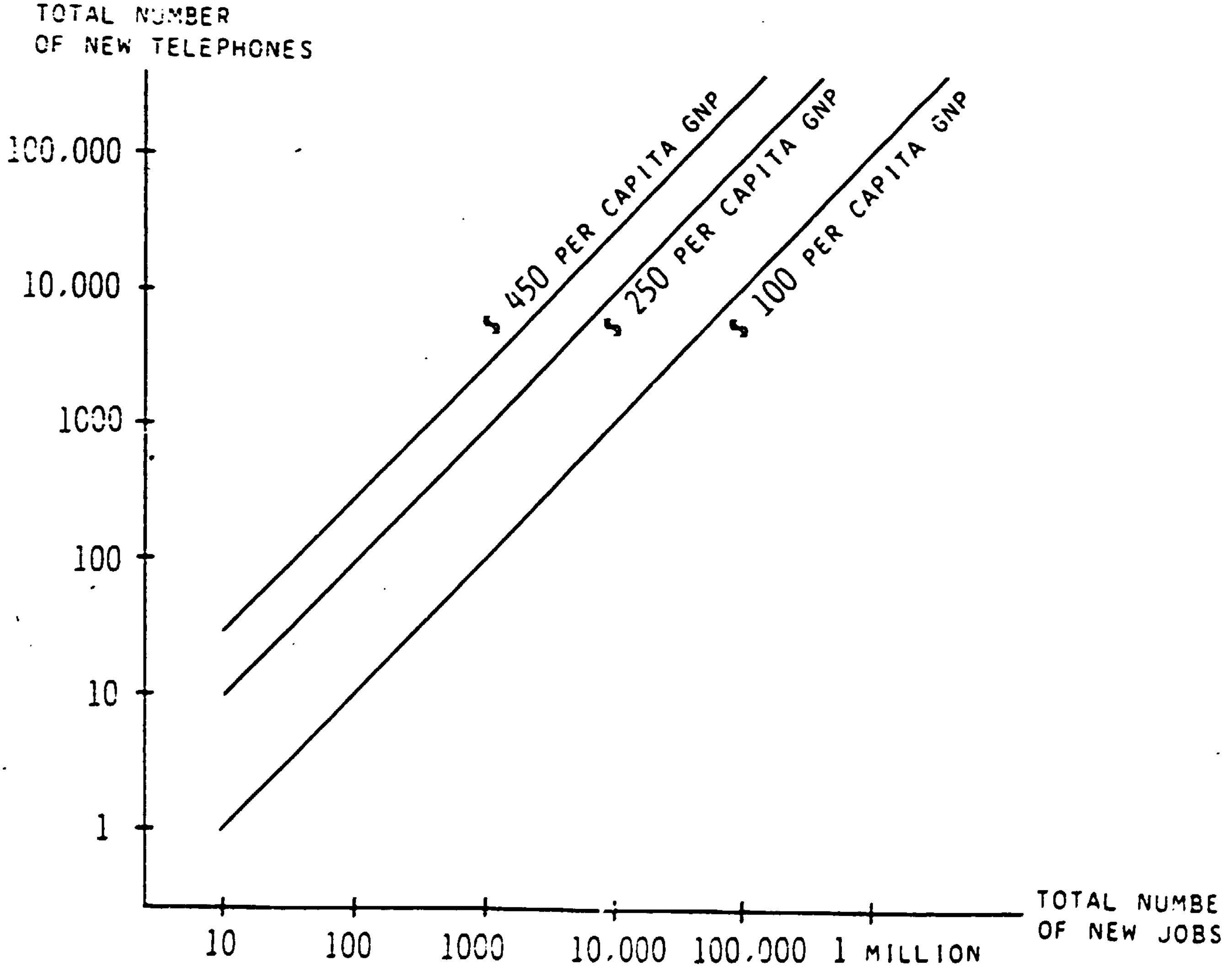
ITEM / COUNTRY	Cables and wires	Telephone sets	Switching equipment	Transmission equipment
1 Algeria	x	x	x	
2 Cameroon	x			
3 Egypt	x	x	x	x
4 Sudan		x		
5 Tunisia	x	x		
6 Zambia	x	x		
7 Zaïre	x			



Note: Break-even point (B) = 6 years
Low point (A) = 15 invetary units

Curve of cumulative cash flow in current terms

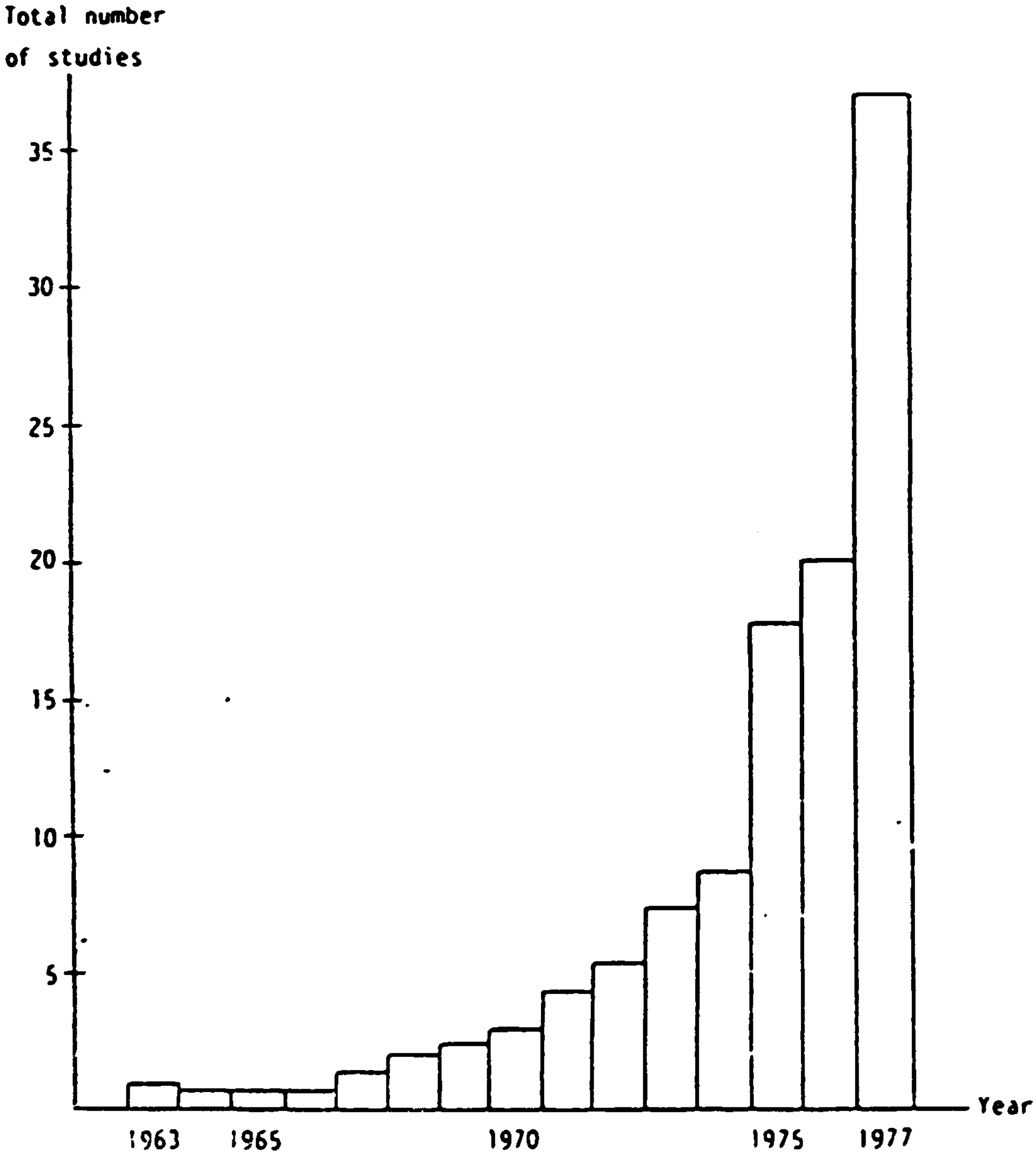
THE INDIRECT EMPLOYMENT-GENERATING EFFECTS OF TELEPHONES
AS A FUNCTION OF PER CAPITA INCOME

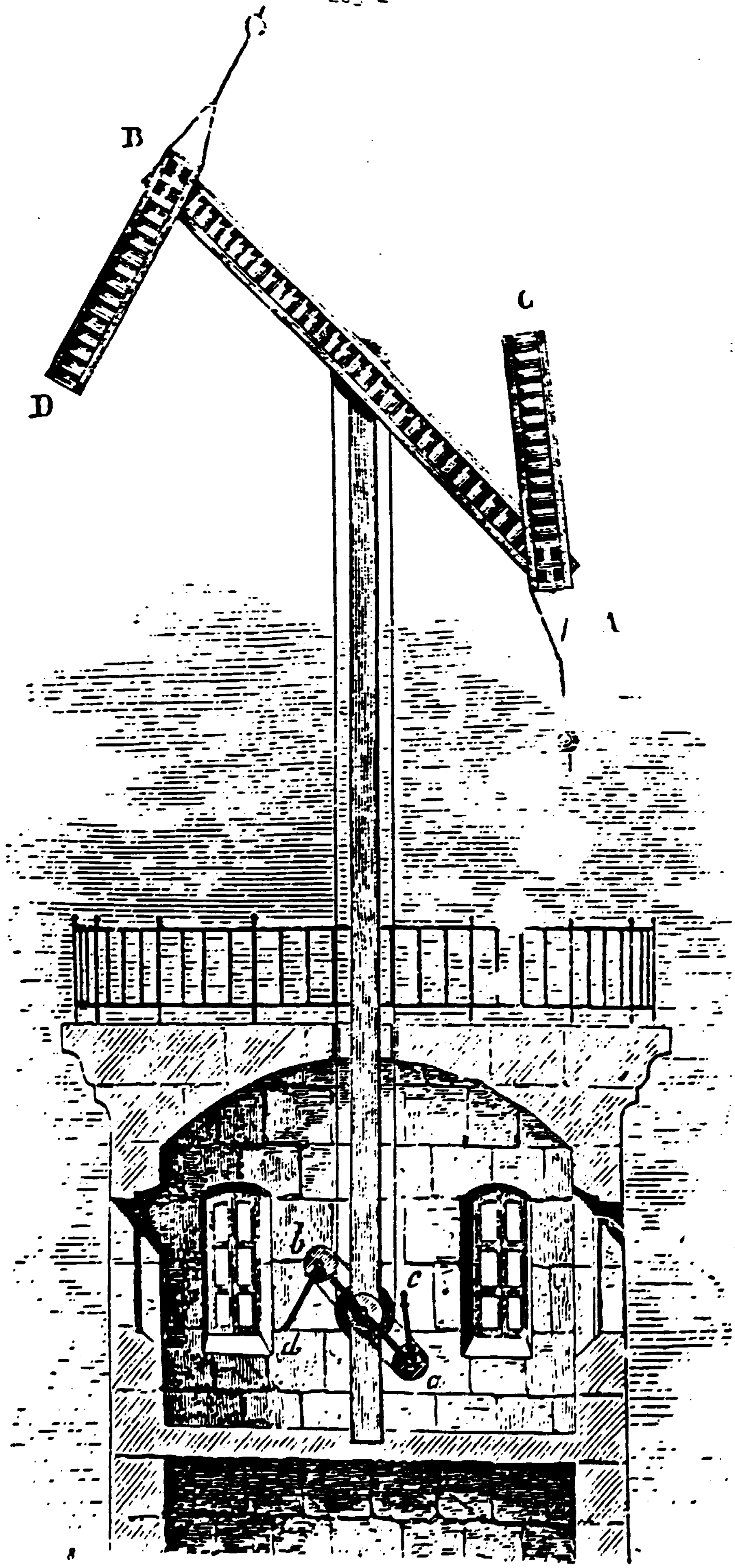


NUMBER OF STUDIES ON THE SOCIO-ECONOMIC EFFECTS OF TELECOMMUNICATIONS

PUBLISHED WORLD-WIDE BETWEEN 1963 and 1977

(Three-year averages)

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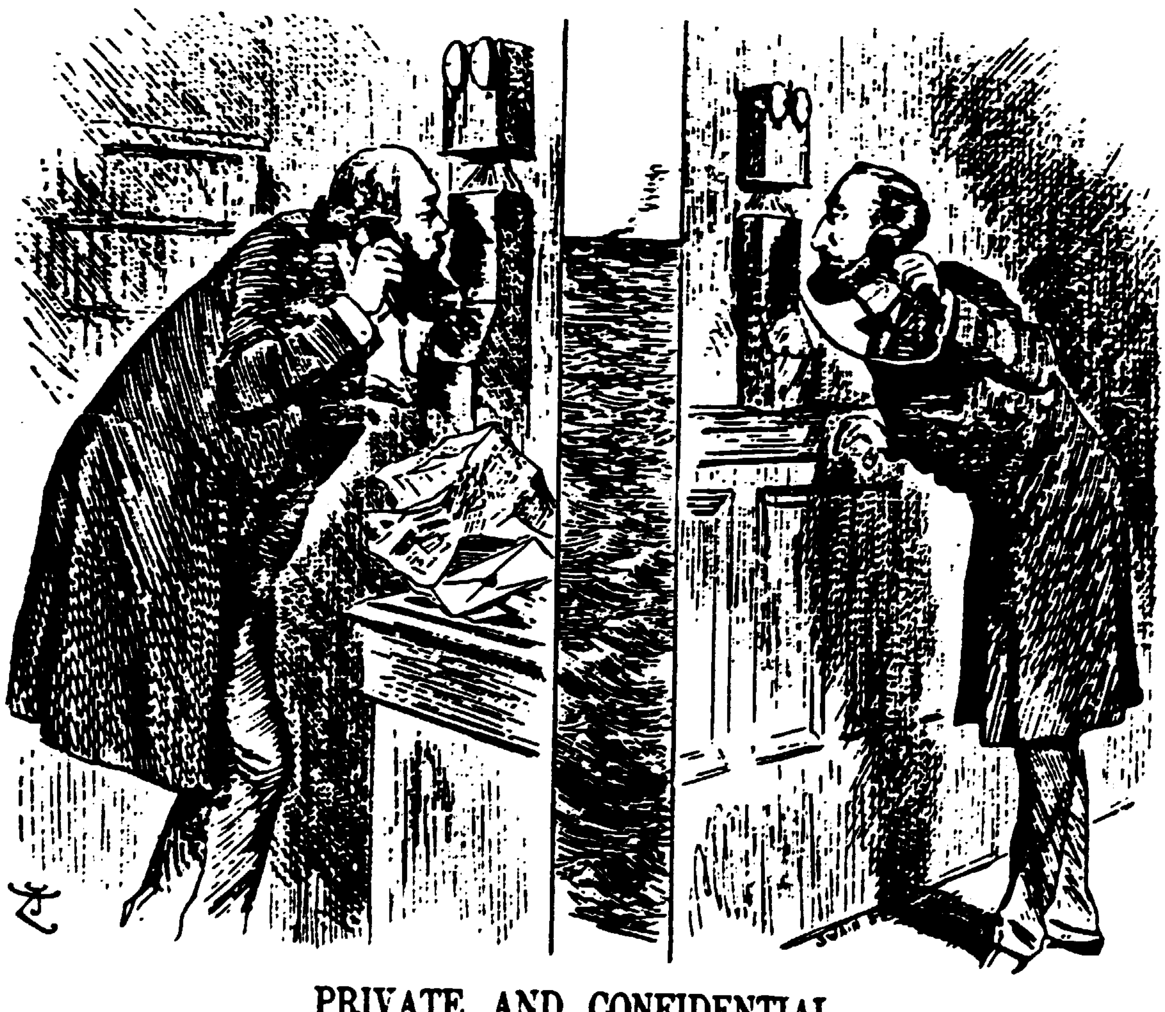
entre Paris et Londres (1891).

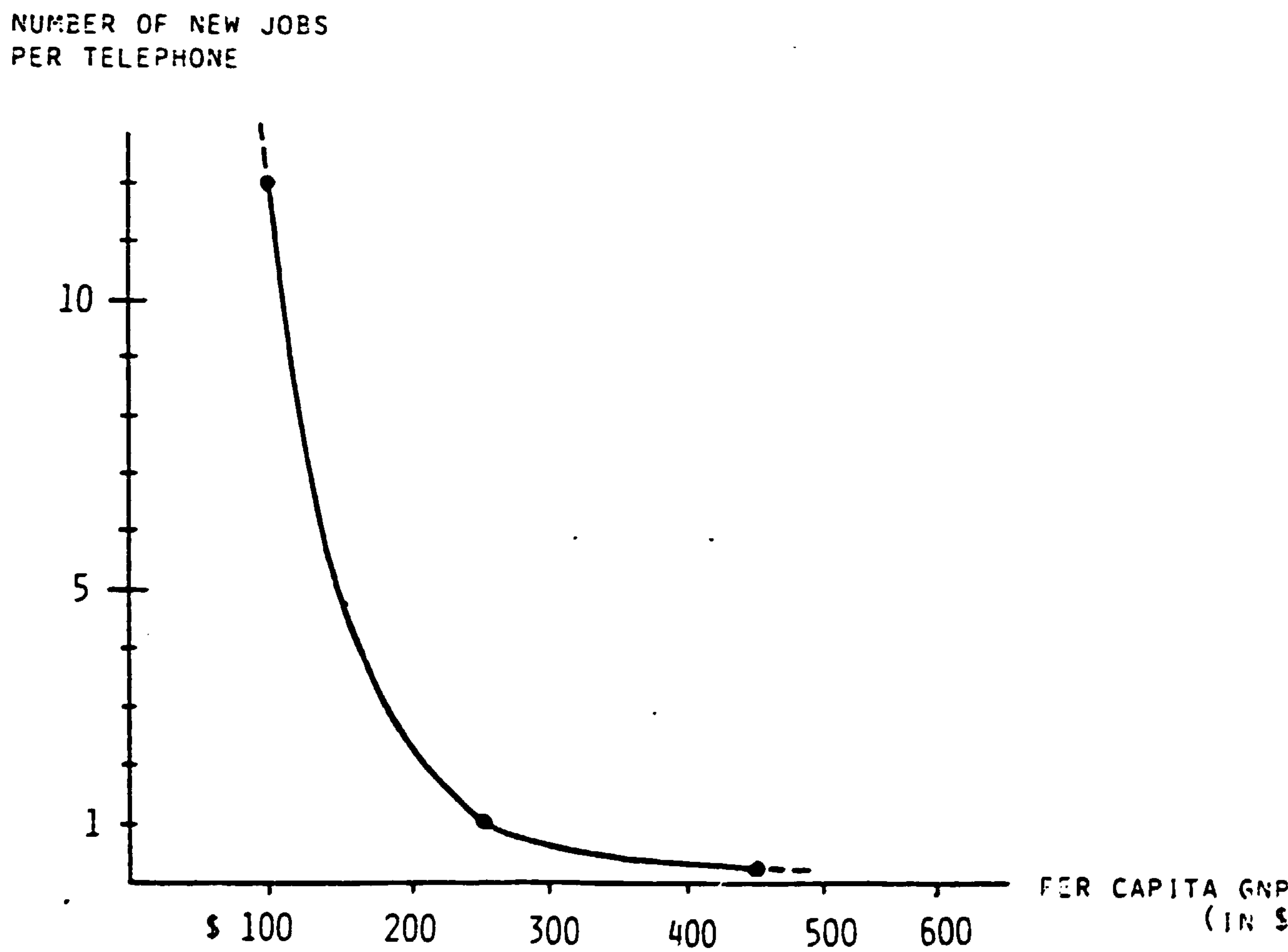


PRIVATE AND CONFIDENTIAL.

LORD SALISBURY. "HALLO!" M. LE PRÉSIDENT. "HALLO!" LORD SALISBURY. "YOU THERE?" M. LE PRÉSIDENT. "ALL THERE!"
LORD SALISBURY. "CAN YOU SUGGEST AN *ENTRÉE* FOR DINNER?"
M. LE PRÉSIDENT. "*HOMARD AU GRATIN*,—AND, BY THE WAY, HOW ABOUT NEWFOUNDLAND AND LOBSTER QUESTION?"
LORD SALISBURY. "NOT BY TELEPHONE, THANK YOU!!!"

[*Telephone between London and Paris opened, Monday, March 23rd.*

NUMBER OF NEW JOBS INDIRECTLY GENERATED PER TELEPHONE



Classification of telecommunications equipment

The telecommunications equipment manufacturing industry supplies the equipment necessary to provide all types of telecommunications services between all localities.

The annual expenditure on the purchase of telecommunications equipment reflects demand for the goods produced by the industry. This equipment accounts for about two-thirds of the total investment in the telecommunications network. The remaining one-third covers mainly expenses relating to installation, land and buildings.

In recent years, expenditure on telecommunications equipment has been divided approximately as follows:

Switching equipment for public exchanges:	32%
Local cables and networks:	44%
Transmission equipment:	17%
Telephone stations, including PABX stations:	7%
Total:	100%

Example of a list of articles to be taken into account in the preparation of a technical co-operation agreement with a technology supplier

Description of articles to be produced

Detailed study, even before the final contract

Exact description, including modifications, accessories, etc.

Documentation

Realization and finalization of documents

Transfer according to set schedule, with lateness penalties

Summary list

Production

Adaptation of technology

List and specifications of machines, tools and other equipment

Specifications for raw materials, components and other semi-finished products to be purchased

Right to purchase from exclusive suppliers

Transfer of technical know-how according to set schedule, with due account taken of progress in training

Right to use information obtained, with a possible restrictions on time, volume and area

Sales

Co-operation in sales

Licensing agreements, including exclusive marketing and other agreements

Other activities (as required)

Planning and implementation

Studies

Engineering

Installation, etc.

Provision by the supplier of raw materials, components and parts

Price list with fixed prices (and price adjustment formula

Short- and long-term conditions of sale

Training and technical assistance

Provision for systematic training, given on the supplier's premises, and on-the-job training

Access to all necessary information

Linguistic ability

Adaptation of training materials to suit local conditions

Continuing technical assistance to maintain a stable level of production

Level of access to computer software and used of computer for required applications

Conditions for technological enhancements

- To enbale the recipient to adapt new models to his domestic and export market

Conditions for the introduction of enhancements to transferred technology

Protection of the supplier's customers

Right to (or prohibition on) the use of the supplier's name or registered trade-marks, trade-names of goods etc.

Possibility of right to inspect product quality

Taxes

Arrangements for payment

Posting of quantities produced where pro rata rates are agreed