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(*Contd. on cover page* 3)

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CONTENTS

Problems of the Pharmaceutical Industry in India

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Central Drug Research Institute, Lucknow

The pharmaceutical industry is intimately linked with the health of the people and the status of the industry may therefore be considered as a reliable index of the importance attached to national health. In combating disease drugs are at least as important as public health measures.

The history of the origin and development of this industry in India is well-known. The Bengal Chemical and Pharmaceutical Works, Bengal Immunity and Alembics can rightly be called the pioneers in the manufacture of pharmaceuticals and the credit for this must go to the initiative and vision of their founders, the late Acharya P. C. Ray and Captain Dutta and Prof. Gajjar. The Bengal Immunity particularly showed great foresight in creating a research department and till recently this was perhaps the only pharmaceutical firm in this country to lay such stress on research. Later a number of other manufacturers entered the field but most of these confined themselves only to the preparation of galenicals and extracts and were not interested in the development and production of synthetic drugs. This was partly due to the non-existence of a chemical industry, both basic and fine chemical, in the country as most of the raw material for modern pharmaceutical has to be supplied by the chemical industry. In spite of this drawback, the last war gave a great impetus to the pharmaceutical industry resulting in the start of a large number of units which did not attempt basic manufacture but concentrated mainly on formulation with imported ingredients. With the advent of independence, however, the government, in conformity with its general policy of encouraging indigenous production in every sphere, started laying great stress on the actual manufacture of pharmaceuticals. As a result a number of concerns came into existence, usually as subsidiaries of foreign firms, which imported partly finished products sometimes even up to the penultimate stage, from their principals and processed these one or two steps further. This was perhaps a necessary intermediate stage before the setting up of actual manufacturing units. A stricter enforcement of government policy in this respect through the issue of licences only to those units as were prepared to progressively manufacture drugs from raw materials available or manufactured in India gradually led to collaboration between foriegn concerns with their Indian counterparts for the manufacture of certain items. But since the rate of development of the industry in the private sector was still too slow the government itself entered the field and, with the assistance of the World Health Organization, started the Hindustan Antibiotics for the manufacture of penicillin. This has the first really big venture in the pharmaceutical industry. Since then this factory has expanded its production and has now added a unit for the production of streptomycin. It has also become a regional centre for the training of personnel for antibiotics production and has considerable research to its credit. This was followed by the erection, in the private sector, of large units at Baroda and Bulsar and later at other places. The most significant event in this field, however, has been the formation, in the public sector, of Indian Drugs and Pharmaceuticals, which with the collaboration of the U.S.S.R., is setting up four large units: one each for synthetic drugs, antibiotics, surgical instruments and phytochemicals. It is anticipated that once these units begin full production the country will be more or less self-sufficient in its requirement of essential drugs. Most of these pharmaceutical concerns, whether in the public or private sector, have been set up with foreign collaboration, though the technical know-how in many of these cases was not of a highly specialised nature.

As regards research in the field of pharmaceutics the Haffkine Institute and the Bengal Immunity Research Institute were perhaps the pioneers. The setting up of the Central Drug Research Institute in 1950 as one of the National Laboratories was the first attempt at organized research on a large scale and the recent foundation of the Ciba Research Centre in the private sector is the second big step in this direction.

Thus the situation, as it can be assessed from the production targets laid down in the Five Year Plan, is that the country is likely to become more or less self-sufficient by 1968 in its requirements of major drugs. There is no doubt that this has been a major achievement but at what cost ? Most of the technical know-how has been obtained through foreign collaboration and a considerable part of the industry is subsidiary to foreign firms. Besides the fact that we have to pay heavily for this collaboration in foreign exchange, we remain in almost the stage as we were in regard to the know-how for future development. This point is particularly important in relation to the pharmaceutical industry where new drugs are constantly replacing old ones at a rapid rate. This is partly due to the rapid introduction of improved drugs but mainly to the constant change in the pattern of disease. Moreover, there are some diseases which are more prevalent in one country than another and hence are a special problem of that country alone. This makes it imperative for us to be self-reliant and develop our own methodology for producing new drugs. This is only possible if our pharmaceutical research and technology are brought to the same level as that of the more advanced countries. Thus it is evident that the progress of the pharmaceutical industry is largely dependent on a high level of organized research in this field.

The problems associated with the future development of this industry will now be discussed under the broad headings of (i) Research, and (ii) Production.

Research

Screening Programme—Drug research is a multi-discipline effort, the success of which is dependent on close collaboration between a team of chemists, pharmacologists and biologists. In spite of the great advances made recently in the methodology of discovery of new drugs and the study of structure-activity relationships, it is still very difficult to predict with a reasonable degree of certainty the biological activity of any compound, whether synthesised or of natural origin, and hence its biological screening is most essential. It is well-known that quite a number of recently introduced drugs, particularly antibiotics, have been discovered not by chance but as a result of a systematic screening programme. The frequency of finding new drugs is to a large extent dependent upon the range and efficiency of the biological screen through which substances can be put so that the chances of missing any type of activity are greatly minimised. The success of most pharmaceutical houses is dependent upon their efficient screening programmes.

In an institution like the Central Drug Research Institute, whose function is drug research, such screening forms an essential if not major part of its activity. Besides these organisations, however, a large amount of work on the synthesis of new drugs is also being carried on in the various chemical laboratories of different universities, but since there is no arrangement for biological testing at most of these centres the compounds synthesised there remain merely as exercises in organic chemistry. In addition, quite a large number of compounds are synthesised purely for their chemical interest and it is quite likely that some of these may possess biological activity. It is, therefore, most important to evolve an arrangement by which these compounds could be effectively screened so that the large amount of chemical work in the country could be profitably utilised.

Instead of having one centralised institution for handling the screening programme, it would be more desirable to set up several small regional units, located at existing major centres of chemical research. This would ensure closer collaboration between the chemical and the biological groups. These units would only carry out the primary screening, which must necessarily be as broad as possible and include as many of the following tests as possible:

1. Pharmacological screening.
2. Anti-bacterial (including mycobacteria and resistant strains).
3. Anti-fungal.
4. Anti-protozoal.
5. Anti-viral.
6. Anti-helminth.
7. Anti-fertility.

Some units for biological screening have already been set up under the aegis of the Indian Council of Medical Research and the Pharmaceutical & Drugs Committee in different medical colleges but it would neither be possible nor desirable for them to undertake broad routine primary screening of this kind. Since these units are attached to academic institutions having highly trained personnel they could devote themselves more usefully to more specialised and sophisticated tests and thus function as centres of specialised screening. Once a compound has been labelled for a particular type of activity by the primary screening unit it could be passed on to the specialised centre concerned for detailed testing of the particular activity. This will of course require proper planning and coordination which could be entrusted to a committee (under the I.C.M.R. or P. & D.). The committee would meet once a year go through the data in detail, look into the structure-activity relationship and suggest future lines of work. Representatives of various groups co-operating in this programme should also be present at this meeting to discuss their ideas personally.

In this connection it may be pointed out that university chemical laboratories prepare compounds in amounts just sufficient for their chemical purposes. For biological in testing large quantities will be required and this may necessitate a certain amount of financial assistance to these laboratories under this scheme.

Indigenous Drugs—The role of indigenous drugs in relation to modern therapy is a highly controversial issue. With the introduction of chemotherapeutic agents and antibiotics the trend in drugs has undergone a radical change and in most western countries drugs of plant origin are being rapidly eliminated from pharmacopoeias. In India too the same trend is apparent and there is a strong and influential body of opinion that there is no future in plant drugs. Even the meagre efforts for a scientific assessment of their value with a view to their incorporation in modern medicine are looked upon with suspicion as signs of obscurantism and chauvinism. Equally strong is the opposite view that these indigenous remedies which have been in use for centuries can be the solution for all diseases. The correct position perhaps lies between these two extremes. It would be unscientific of us to either reject outright or to accept unquestioningly these claims. In this context I shall quote a few words from Jawaharlal Nehru: "Learn all you can from the ancient Indian knowledge of medicine and surgery but do not believe that the last word could have been said a thousand years ago". I am personally of the opinion that there is much useful information contained in the records of the indigenous systems of medicine, and also in folk medicine which is practised in all parts of the country. Unfortunately, this information has now become suspect as a result of mutilation and association for a long period with quackery and supernaturalism. For its proper utilisation this information has to be classified and scientifically analysed.

As far as the organised indigenous systems of medicine are concerned the existence of authoritative ancient treatises and also the availability of published scientific information on a number of medicinal plants mentioned therein makes the task of selecting suitable information for further analysis relatively easy. But what is equally important is to collect data about folk remedies of which there is no written record. In general, these remedies vary from region to region according to natural resources and the fact that they have survived for so long and are still the source of medical relief for a large proportion of the population would suggest that some of them must be effective. It may be worthwhile to collect these remedies. This could be done by survey teams visiting various regions. As the whole country is more or less covered by community development projects, the assistance of the block development officers could be sought for this purpose. After the data is collected it would have to be properly scrutinised and analysed.

All this information has to be tested either pharmacologically or clinically and in individual cases both the methods may have to be followed. For compounded remedies and other preparations, the safety of which is well-established in indigenous medicine, the best course would be direct clinical trials without prior biological screening. Units should be set up in various hospitals where clinical trials can be carried out under the joint supervision of the medical men of both the systems so that final answers can be obtained in the minimum amount of time. Those remedies which show promising results should then be subjected to detailed chemical and biological investigations. For other drugs, screening should be carried out in the primary screening unit mentioned earlier. If these two methods are followed it would not be unduly optimistic to say that within a decade it should be possible to obtain a correct appraisal of the utility of a number of drugs mentioned in the indigenous systems of medicine or used as folk remedies.

The organisation of this comprehensive research programme will naturally entail a certain amount of financial outlay. As the benefits of this research will flow to the pharmaceutical industry, both in the private and the public sector; it would be in the fitness of things for the industry to subsidise this programme through the levy of a compulsory cess on its turnover. This would also give the industry a sense of direct participation in the research effort and would be an inducement to the various units to refer their development and production problems for solution.

Production

Production targets for various items of the pharmaceutical industry have already been laid down and, as stated earlier, the fulfilment of these targets will make the country self-sufficient in the requirements of essential drugs used today. In regard to the future organisations and planning of this industry certain suggestions are put forward so that we can maintain this self-sufficiency and also become self-reliant in the development of new drugs. We have been and are still too dependent on foreign collaboration, partly due to lack of know-how and capital but mainly due to lack of confidence in Indian scientists. This continued dependence on foreign aid must be discouraged. This will require a determined effort to assess the future requirements of the country in regard to various pharmaceuticals, to assign priorities and to phase the production schedule accordingly. Any developmental or production problems that may be anticipated can be referred to existing research laboratories and universities for working out the full details within a prescribed time limit. A common criticism of Indian scientist and of the national laboratories is that they have not contributed significantly to industrial development. I am quite certain that Indian scientists, like any other section of the community, are keen to play the role expected of them. Unfortunately, there has been lack of cooperation and liaison between the pharmaceutical industry and the laboratories concerned with drug research and hardly any problems have been referred by industry to the scientist. The procedure suggested would avoid the wastage of time involved in prolonged (and sometimes, fruitless) negotiations with foreign firms and would lead to greater confidence in indigenous know-how.

The planning and execution of this programme should be entrusted to a centralised agency constituted of representatives of private industry, Indian Drugs & Pharmaceuticals, research laboratories, the Health Ministry and Development Wing and the Planning Commission (at present most of these agencies have independent plans which often overlap and sometimes even work at cross-purposes). This agency would be responsible for analysing requirements, assigning targets and coordinating the manufacturing programmes of various individual units.

Synthetic Drugs

In this Industry the availability of intermediates is a most vital factor in the production of even very common items. Dependence on imports not only raises the cost of a drug to an uneconomic level but discourages the production of items which, though essential, do not have a large market. Until such time as there is a fully developed dye-stuff and plastics industry in the country to supply the intermediates, the pharmaceutical industry will have to manufacture its own requirement of these starting materials as an integral part of the industry. The central agency mentioned above would be responsible also for assessing the requirement of intermediates, integrating their production with that of pharmaceuticals and developing the necessary technical know-how.

Phytochemicals

In the production of phytochemicals too, the crucial problem is the availability of crude drugs of standard quality. Present requirements of the industry, which is by and large, still in the primitive stage of manufacture of galenicals and tinctures, are met by collection of wild growing plants. The uncertain supply position of raw materials has discouraged the modernisation of the industry by entrepreneurs willing to undertake production of pure active principles. With the wide range of climatic conditions available in India there is no reason why most of the important medicinal plants cannot be cultivated successfully. In order to build up this branch of the industry this problem requires first priority. The fact that certain foreign firms have leased large areas of land for cultivation should be an eye-opener. The setting up of the Central Indian Medicinal Plants Organisation under the C.S.I.R. is the right step in this direction. This organisation should immediately concentrate on the cultivation of the following indigenous and exotic medicinal plants of established efficacy.

1. Rauwolfia serpentina
2. Digitalis lanata/purpurea
3. Ephedra vulgaris
4. Podophyllum emodi
5. Dioscorea spp.
6. Atropa acuminata belladonna
7. Ergot of rye
8. Ipecac
9. Hyoscyamus muticus
10. Mentha piperata
11. Colchicum luteum
12. Pyrethrum

The proposed plan of the Indian Drugs & Pharmaceuticals envisages the setting up of a composite unit for the production of certain phytochemicals. In order to reduce the cost of transportation of crude drugs from the farm to the central factory and, what is more important, to eliminate the possibility of their deterioration during storage and transit, it would be more desirable to set up 3 or 4 regional units in areas where the plants are to be cultivated. In some cases it may even be worthwhile to consider the posssibility of setting up simple extraction and concentration units right at the site of cultivation; the concentrates could be transported to the regional units for complete processing. These processing units need not be large and their integration is not essential because, unlike the production of synthetic drugs, each process is independent and these factors do not significantly effect the economy of operation.

Glandular Products

This is perhaps the most neglected branch of the drug industry. The methods of manufacture of these products are not at all difficult and the processes can be easily modified to suit indigenous raw materials. But again the bottleneck is the supply of raw materials. Oft-repeated suggestions made in this regard, but not implemented, may again be reiterated. Steps must be taken to expand and remodel the slaughter houses in one of the big cities like Bombay, Calcutta or Hyderabad and to make suitable arrangements for the collection and storage of tissues and blood under hygienic conditions. The processing unit should be set up near the slaughter houses itself because transport of tissues under frozen conditions will be not only quite expensive but also involve other difficulties.

Vaccines and Sera

Inspite of the fact that the production of these items was organised in the early part of this century in certain government laboratories, neither has production been expanded nor has the technology been modernised so that we have still to depend upon imports for meeting our requirements. Their non-availability in adequate quantities has been a factor in their non-utilisation on a wide scale in public health measures.

Neither the public sector nor private industry has given much thought to their production. In addition to the expansion of the productive capacity in existing centres, new units employing modern technology, should also be set up in the public sector.

The problem of outmoded patent laws which have often been pointed out as a major obstacle to the development of the pharmaceutical industry need not be discussed here as it is understood that the government has under active consideration the abrogation or substantial modification of these laws as they relate to the manufacture of foods and drugs.

Design and Fabrication Centre

One of the greatest problems faced by a manufacturer wishing to enter the pharmaceutical industry is that of obtaining expert advice regarding the design of plants and their fabrication. This often compels them to seek foreign collaboration. This is a service which should be made available to the industry. It is suggested that a Design Centre should be set up in the Central Drug Research Institute which should act as technical consultants particularly to the small and medium industrialists advising on all matters relating to processes, equipment, costing etc. In the initial stage the Centre may assist only in the design of equipment and act as liaison between actual fabricators and the industry, but gradually after assessing the country's potential, it may even undertake fabrication of specialised equipment for the pharmaceutical industry.

Training of Personnel

Drug research and industry, as a multi-discipline effort, will require personnel having training in various disciplines. In keeping with the special requirements of the profession it would be worthwhile to have an integrated training programme which would supply the major requirement of personnel. As in any other scientific and technical activity two categories of staff will be required—routine technicians and scientific staff.

Technicians—The non-availability of suitably trained technicians is a bottleneck in our scientific and technical development and often a scientist is perforced to waste his time doing non-creative routine work. The training of technicians for taking over such routine work is therefore a pre-requisite for rapid progress, particularly in screening programmes. Two types of training are recommended:

(*i*) Certificate course (of 3 years duration) for which the minimum qualification may be the matriculation examination. This course would produce analysts, dispensers, laboratory helper and technical hands for industry. There should be a general training of 2 years in subjects of common interest followed by specialisation in any of the above subjects in the third year.

(*ii*) Diploma course (of 1 year duration) for BSc's who do not have the ability to profit by further academic training. They would be taught the basic principles of drug research and given the practical training necessary to carry out the screening programme and specialised laboratory work.

Scientific Staff—The pharmacy courses in various universities were started with the idea of providing integrated training for personnel to man the pharmaceutical industry and ancillary branches like quality control and dispensing. With the change in the pattern of the pharmaceutical industry these courses have now become outmoded and require a radical reorganisation in order to provide the right type of personnel, for example, subjects like routine dispensing, formulation, pharmacognosy and analysis are not as important as before and may be deleted from the degree course. Instead greater emphasis may be laid on the fundamental sciences which should include organic and physical chemistry, mathematics, chemical engineering, fermentation, biochemistry, pharmacology, and microbiology and the students could specialise in any of the subjects having a direct bearing on drugs both for graduation and for post-graduate work. In addition, it is suggested that courses in pharmaceutical technology should also be started in various Indian Institutes of Technology. The scientists and technologists with this training should be in a position to man the production units of the pharmaceutical industry, the development departments, quality control sections as well as research laboratories. Only the pharmaceutical scientist and technologist trained in the above disciplines can effectively perform all the different functions expected of them.

Pharmacologist and Microbiologist are important members of any drug research project. At present in India all pharmacologists and most microbiologists are recruited from medical graduates. As it is, there is a great shortage of medical men and it is essential to conserve the available supply for manning hospitals and public health departments and for purely clinical research. How is the demand for pharmacologists and microbiologists to be met then ? The only way out would be to treat these non-clinical subjects as pure sciences and introduce them in the curricula leading to science degrees. After all a person who is finally to specialise in any of these subjects need not have a knowledge of all the other subjects necessary for medical graduates. Such a step is long overdue in the country. The reorganisation of the pharmacy courses as suggested above could perhaps also provide for specialisation in pharmacology and microbiology.

Recommendations

1. Organisation of regional primary screening units.
2. Establishment of secondary specialised screening units in medical colleges.
3. Levy of cess on the pharmaceutical industry for financing research and development programmes.
4. Collection of data on folk remedies.
5. Clinical trials of important drugs used in the indigenous systems of medicine.
6. Establishment of a central agency for the planning and integration of research and production in the industry.
7. Emphasis on the cultivation of medicinal plants under the supervision of CIMPO.
8. Establishment of two centres for the collection and processing of glandular products.
9. Setting up of two centres for the production of vaccines and sera.
10. Organisation of personnel training.
    a) Certificate and Diploma courses for technicians.
    b) Reorganisation of pharmacy courses.
    c) Teaching of pharmacology and microbiology apart from medical courses.

SCIENCE NEWS

Asia's biggest blast furnace commissioned at Bhilai

The fourth blast furnace of the Bhilai Steel Works has been commissioned on December 8, 1964. This is one phase of the expansion programme for increasing the annual production capacity of this plant from 1 to 2.5 million tonnes of ingot steel. The programme envisages the erection of two such blast furnaces of 1719 cu. metre capacity each of useful volume. The annual output from these furnaces is expected to be 1,216,600 tonnes of pig iron.

Constructed at a cost of Rs. 103 million, the furnace employs the most modern, efficient and progressive technique and is the biggest so far constructed in Asia. It has a rated capacity of producing 1738 tonnes of pig iron per day.

Res. & Ind. 9(12), 385.

* * *

Most Modern Steel Plant

A new plant that combines the latest techniques of pneumatic steelmaking, continuous casting and universal beam rolling has gone into trial production at the Staffordshire works of Shelton Iron and Steel Co. Ltd., Stoke-on-Trent, England.

Developed at a cost of nearly £20 million to replace two older mills, the new plant is designed to produce a larger variety of sections, joists, columns, beams and rails at a much faster rate. Within four hours, a steel billet weighing several tons can be transformed into a load of steel joists aboard a lorry on its way to a customer. Previously it took between four and seven days.

The plant, which uses large quantities of oxygen, produces a "heat" in $1\frac{1}{2}$ hours, compared to $10\frac{1}{2}$ hours in the old type of open-hearth furnace.

This feeds a continuous casting plant, which produces blooms in sizes from 24 in. by 17 in. —believed to be the largest continuously-cast bloom in the world — down to $5\frac{1}{2}$ in. square. The blooms pass to the structural rolling mill, said to be the largest in Europe. A 31-in. roller in this mill can be changed in 30 minutes, compared with the $2\frac{1}{2}$ hours normally required.

(*Brit. Inf. Serv. BF* 876)

* * *

Rs. 100 crore Russian loan for Bokaro

The Soviet Union will give a loan of 190 million roubles (about 100 crores) for the Bokaro steel plant. The amount of the loan will be stipulated in an Indo-Soviet agreement on the construction of the Bokaro plant, which has been signed recently. The broad terms of agreement have already been settled in the course of negotiations between a high power Soviet delegation led by the Vice -Chairman of the Foreign Aid Committee, and an Indian team led by the secretary of the Steel Ministry. The agreement will provide for maximum utilization of indigenous equipment in the construction of the plant. It will cover the construction and commissioning of the first stage of the Bokaro plant, which will have a capacity of between 1.5 and 2 million tonnes. It is expected that the loan will cover the cost of imported equipment and the fee for technical know-how.

Res. & Ind. 9 (12), 382

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Single-Stage Process For Fertiliser Manufacture

A process, developed, by a Scottish firm, reduces to a single stage the production of agricultural fertilisers in hard, dry, spherical granules of uniform size. Each granule, a complete and balanced plant food in itself, is built up layer upon layer, rather like onion skins, in two revolving drums of a re-cycling system, and the chemical energy liberated as heat during the process is used to evaporate all the water present. The interaction of sulphuric, nitric and phosphoric acids with ammonia produces the constituents of the granules, and potassium salts are added to form a complete synthetic fertiliser.

The uniformity of the granules' shape and size makes for an even pattern of distribution, and since they contain less inert matter they are more concentrated. The fertiliser is available in two forms — one with a high potash content and the other with a high nitrogen content.

(*Brit. Inf. Serv. BF* 876)

* * *

New Storm Warning Radar

A new meteorological radar system, which can track and pinpoint storms and rain-producing clouds within an area of 125,000 sq. miles, is being produced by a British firm.

High power, long range, ease of installation and relatively low cost are four of the main features of the system, say the makers. It is suitable for use at airports, where it can provide first-hand meteorological information for air traffic control staff. Because of its mobility and ease of installation, it is also suited for meteorological surveillance in large areas, where a number of installations may be needed.

(*Brit. Inf. Serv. BF* 1155)

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Fluorescent Tube Provides A More Natural Light.

A fluorescent tube which gives a more natural light has been developed by a British firm. The tube is claimed to give a truer rendering of skin textures and to have a higher light output in the popular 5 ft. length than any other comparable tube. It is particularly suitable for clubs, hotels, public houses, restaurants and beauty parlours.

A more powerful light is a result of changing the pattern of the colour spectrum of the fluorescent tube. By using new phosphors, developed by the company, the cold blues and greens at one end of the spectrum have been subdued, while the warmer reds and pinks at the other end have been strengthened.

(*Brit. Inf. Serv. BF* 150)

* * *

New smokeless fuel

A new process for producing a smokeless fuel, with coal as raw material has been developed by National Coal Board, Warwickshire, U.K. In this process, coal is first washed to remove ash producing constituents. Then it is crushed to small particles, subjected to low-temperature treatment in fluidized-bed reactors and compressed into briquettes. The resulting material, though very low in ash and moisture content, retains the important characteristics of coal because only minimum of volatile matter is driven off.

Chem. Eng. 71 (*No.* 16) (1964), 44.

Control Unit For Automatic Machines

An inexpensive control unit, designed to avoid damage to automatic machines when they fail to eject manufactured articles, is being produced by a British firm.

Suitable for all types of automatic presses, diecasting machines, moulding and plastic forming machines, the control unit has been designed to register the ejection of an article. An electrical impulse is passed to the sequencing mechanism so that the machine only continues operation when the article has been ejected.

The ejected article falls on to a diaphragm plate and bounces off into a container. Behind the diaphragm plate is a very sensitive quartz crystal which converts the impact energy into an electrical impulse which is fed to the control unit. This pulse is then amplified and operates a relay, the contacts of which provide the pulse for the sequencing unit controlling the operation.

(*Brit. Inf. Serv. BF*229)

* * *

New Japanese process for man-made fibres

A new fibre now in the pilot-plant stage and to be made commercially in a 3-ton/day plant next year by Tokyo Chemical Co., Yokohama, introduces the process of emulsion spinning, said to be unique, and different from both conventional solution and melt spinning. The fibre resembles wool more than does any other artificial fibre.

The new fibre 'Super Envilon' itself is a graft copolymer of polyvinyl chloride and polyvinyl alcohol. A mixture of polymers is stirred for 18 hr in a dilute caustic soda solution at 150° F. and the combined solution spun through a nozzle to form threads that are coagulated in a warm solution containing less than 10 per cent sulphuric acid and sodium sulphate.

It is possible to make non-woven cloth from the new fibre and the yarn is highly resistant to both acid and alkali, and is non-static. The advantage of the process is claimed to be in the direct utilization of the polymers in liquid form without being pelletized.

Chem. Tr. J., 154 (No. 4015) (1964), 728.

* * *

Indian engineers training at Antwerp Phone Factory

A team of Indian engineers are undergoing training in the Antwerp factory (in Belgium) of the Bell Telephone Manufacturing Company, which is providing technical assistance for the Indian Telephone Industries expansion to manufacture a new line of telephone equipment called pentaconta system. Bell Telephone Manufacturing Company is a subsidiary of American International Telephone and Telegraph Company which is also a party to pentaconta deal with India, which was made possible through a loan given by World Bank. Several Belgian engineers are already at work in the factory of Indian Telephone Industries which is establishing a new unit to manufacture pentaconta telephone exchange systems. The Belgian company has a contract to provide the know-how which will enable the Bangalore factory to manufacture, in about three years, at the rate of about one lakh lines of pentaconta cross-bar automatic telephone exchange equipment. The Antwerp factory is also supplying 48,000 lines of ready-to-install pentaconta exchange equipment to the Indian Posts and Telegraphs Department. A team of Indian P & T technicians will also be trained in Belgium in installation work.

Res. & Ind. 9 (12), 383

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Chlorine in tablet form

Chlorine in a tablet form (Reddichlor) for purposes of water sterilization has been introduced by Messers Reddish Chemical Co. Ltd., Cheadle Hulme, Cheshire, U.K. It dissolves very quickly in hot water.

The tablets have been so designed that one tablet dissolved in a bucket full of hot water will give 200 p.p.m. of available chlorine.

The chlorine base in the tablet is quite stable and harmless, and safe to handle under all normal working conditions.

Indian seafoods, 2 (No. 2) (1964), 17.

Microwave Heating Process

New industrial heating processes, using microwave techniques, have been developed by a British firm, which was the first to pioneer the microwave cooking oven for the catering industry.

The firm have used microwave heating for such varied jobs as breaking up rocks and concrete, and seasoning timber. The new processes are also suitable for fast drying in the printing, fabrics, plastics and paint industries.

(*Brit. Inf. Serv. BF* 150)

Instrument Servicing in India —an appraisal

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It is logical to expect that instruments which are put to use will break down at the weakest point sometime or the other. If they are well designed and sturdily built, the first breakdown may occur after long use, under the normal circumstances.

Now it is surprising to see that while service contracts are written out for type-writers and similar office equipment which may cost only a few hundred rupees a piece, practically no thought is given to the maintenance of instruments which may cost thousands or tens of thousands of rupees each. We think of this aspect only when the instrument stops working.

Varieties of Instruments

There is hardly any industrial, medical, research or educational institution which does not use instruments in one form or the other. Leaving aside the category which we may call as appliances and another one which may be called entertainment instruments, there are still a vast number of types of instruments which find extensive use in the laboratories. The Industry uses pH meters, level indicators, Insulation testers, Plating thickness gauges, Ultrasonic flaw-Detectors, Colorimeters, Moisture meters, to name a few. Medical institutions use spectrophoto-meters, Nphelometers, Electro-cardio and encephalographs, Cautery and Diathermy, Blood Oxygen Analysers, Electrophoresis, Chromatographs, and a host of other devices. Research institutions use the widest variety, from Oscilloscopes, Linear and non-linear Amplifiers, Radiation detectors, Strain Gauges, Vacuum Gauges, Pulse Generators, Electron Microscopes, Timing devices, Communications and Microwave equipments and myriads others. Educational institutions on the other hand may be using simpler basic instruments but may not be lacking in variety, e.g. Galvanometers, Bridges, Spectrometers, Balances, Potentio meters, Constant temperature baths, Microscopes, Kymographs etc. In spite of the multiplicity of instruments or devices all of them could be listed under the generic titles —purely mechanical, electrical, electronic, optical or a combination of the physical principles in the above disciplines.

In India, we have not been paying sufficient attention to the maintenance of instruments. Such cases are rare, where the user can look after the equipment by himself. The complexity of the present day instruments and the diversification of the specialisations contribute to such a state of affairs. For example, an Anthropologist may need to use a photo-electric reflectometer for his experiments but he may not be remotely interested in the mechanics of the instrument.

The majority of instruments in India are bought by the government and semi-government institutions and because of the peculiar rules and rigid adherence to formalities such as the three quotation system which is applied to service jobs as well, even those equipments which can be serviced, generally do not get the benefit of such attention.

Self-Service Department

There are certain departments which by their very nature cannot exist without a maintenance facility, e.g. the Telephone Department or the Meteriological, Geologic, Atomic Energy or the Air-lines who, besides, have sufficient volume of work for their own instruments. We will call these as "Closed Departments" for our purpose since they do not accept work other than their own. The Telephones and the Air-Lines, being commercial facilities must not only have a service department, but must have an efficient one in order to exist.

But please consider this aspect. The telephone, like a radio receiver is one particular instrument with one particular circuit or minor variations of it and its servicing is a matter of training technicians who could go through a trouble-shooting chart to locate the defect and make a replacement since all parts are kept in stock.

However, when dealing with the varieties of instruments mentioned in the beginning, which are used in the research laboratories of physical sciences, life sciences, medical or educational or industrial institutions who do not have sufficient number of instruments by themselves to warrant their having own Service Departments or the ones in the borderline category who are badly in need of such facilities but are not convinced of the worthiness of the project—with them we come up with the problem, the possible solution which is the purpose of this article.

Service Engineers Required

These instruments are clearly beyond the scope of the technician or the diploma-holder level of persons whose training is necessarily limited, barring exceptions, because of the variety of instruments involved and the specialised techniques of engineering used in their manufacture. These instruments are expensive and the risk is equally great and their servicing can be entrusted only to Engineer-level persons of proven competence. Also in this type of work, competence is soon put to test in contrast to say, Design or Development work where the results of skill or lack of it may take some time to unfold.

Theoretical and Practical Knowledge

Servicing of instruments requires a good knowledge of the theory of Physics and Electronics of at least the degree level, a good grasp of laboratory procedures, an analytical mind and a lot of the invaluable commodity experience. A definite aptitude in the handling of delicate mechanisms and tools is also essential. No wonder that service engineers of such calibre are expensive and also hard to find. Such a training is not available at many Universities or engineering institutions and has to be acquired elsewhere. This is one of the reasons for the paucity of commercial firms which offer service facilities for a variety of instruments.

A manufacturer is in a position to offer service facilities for instruments made by his company since the know-how, the test facilities and the components are available with him. He should provide this service to keep the confidence of his buyers in his equipment and this reflects in the long run, in the increased scales. In India however, it is a seller's market at present and since any instrument will sell without much difficulty, the servicing angle is apt to be neglected. There is also a genuine snag in the case of instruments assembled in India with foreign-made components. The margin of spares allowed to be imported is narrow and these are likely to be sold to petty manufacturers rather than be available for servicing.

This applies with even greater emphasis to instruments of entirely foreign origin whose manufacturers are not even represented here. We refer to the instruments received under the various Aid programmes of the foreign countries concerned. In these cases, the components required for proper maintenance are practically impossible to get in the open market.

Uneconomic Proposition

Another reason for lack of service facilities in the commercial field is that servicing taken by itself is an un-economic proposition. In manufacturing a particular instrument, the manufacturer creates a supply-line for all components used in them and since assembly-line methods are followed, one can calculate with reasonable accuracy, the costs and the profits. This is not so in servicing. One cannot tell in advance as to how long it may take to locate or rectify a fault in a complicated machine and at what cost. Instrument servicing requires individual and continued attention with rather expensive test equipment and since the main elements involved are time and skill—both expensive as well, it is difficult to make advance calculation of profits. An instrument gets serviced after its fault is located and the replacement for the faulty component is available, the latter as stated above, is rather uncertain in many cases.

So the problem remains. Apart from the dealer who must have some sort of an arrangement to look after the instruments (for damages in transit etc.) before they are sold, the service facilities for a large varieties of instruments are either non-existent or are so expensive (in order to be economic to the operator) that they are hardly used. Such a service has, therefore, to be subsidized and run by either a national institution or an organisation with a similar outlook and which can fulfil the conditions for an efficient set-up as indicated below.

This service is meaningless unless it is efficient in the matter of time taken and is reasonably cheap to the customer. This means that it would be staffed with engineer-grade persons with considerable experience and diagnostic skill and they should have appropriate test and calibration equipment and also a supply line of imported spares such as galvanometer suspensions, photocells, meter rectifiers etc. so that the waiting period for the components is reduced to a minimum. Also, such a service can be operated best from a bigger and well developed industrial city wihich has the advantage of already existing spares markets and such ancillary facilities as motor and transformer winding, machining, welding painting, vacuum impregnation etc. which need not be duplicated by a service center located in or near such an area. In service work it is completely un-economic to stock-pile a variety of spares because the same defect may not repeat in scores of similar instruments unless if it happened to be a manufacturing defect.

Up-to-date Information

The staff should have convenient access to technical books and magazines because a lot of background reading is necessary in the case of complicated equipments, apart from the manufacturer's data supplied with them. And since more and more use is being made of newer components and techniques e.g. solid state devices and miniaturisation—the service engineer will be lagging behind unless he keeps up with the developments. This facility has to be provided by the institution.

Here is an inkling of the magnitude of the work involved. In a survey of CSIR institutions alone, we counted 1260 foreign made instruments in the 30 national laboratories obtained over a period of time from 1950 onwards. The average cost of an instrument was Rs. 5000/- The outlay is of the order of 1260 × 5000-6.3 million rupees. Even if one fifth of these, on a conservative estimate, had gone out of order, it still means a million rupees locked up for CSIR alone. Now if we included the hundreds of hospitals, medical institutes, agricultural institutions, universities and research establishments all over the country, the number of instruments lying idle can be staggering. We have to make a solid begining in this neglected field and with the advance that the indigenous industry is now making in the manufacturing field, the present is as good a time as any.

Below is given the details of an attempt that the National Physical Laboratory, New Delhi has made in this direction and the methods adopted for the smooth running of such a service.

National Physical Laboratory—the Right Place for Instrument Servicing

The National Physical Laboratory, by its position, location and outlook fulfils most of the conditions necessary for such a service. The organisation is large enough to have its own Service Department for the instruments used in the laboratory and with spare capacity it can cater to the needs of a wide area around it. The laboratory is located in a big city which has a sizeable radio, electrical and mechanical goods market. A large variety of components are even manufactured in and around this place. Again the laboratory has a fine workshop, a good technical library and a top-ranking glass-blowing shop where mercury switches or vacuum joints or glass-to-metal seals can be made to measure to fit the job in hand. The laboratory already has established Departments which maintain standards and do Calibration work for a variety of electrical, electronic and other instruments—which is incidentally a necessary and complimentary requirement for the serviced instruments. With such facilities of its own to depend upon and the laboratory-atmosphere, the place is appropriate for offering service facilities to others as well.

The laboratory is offering this Service now to Hospitals, Public and semi-public institutions, Industrial Establishments and other actual users of instruments. What follows now, is a short account of how this service is conducted and some peculiar situations that we have come up within the course of this work. Formerly this was also a "Closed" service but this limitation has been removed.

The original idea was to help the sister institutions in the CSIR (Council of Scientific and Industrial Research) and other public institutions which usually have long-winded procedures requiring quotations giving estimates even for minor jobs. Later on, a major percentage of jobs started coming in from the hospitals and medical institutes. In the light of experience, we have drawn up a set of terms of business which suit the type of customers that we have had to deal with, in general, and although at first sight, some of them may appear a little hard, they have worked out very well in practice.

Our Conditions for Servicing

We accept work from the actual user or the Institutions directly and not through intermediaries. We require a letter authorising the repairs and accepting responsibility for payments which is againt billing in the case of public institutions. We like to have a short account of the trouble experienced by the user. This is kept in mind while working on the instrument because often what may appear to be a minor abberation to us may be a major source of irritation to the user. It is not sufficient to say merely that the instrument is in-operative or in-accurate which it would be anyhow, otherwise it would not have come here. Specific information on which controls do not work or which indications appear to be wrong give us the starting clues to the trouble. Moreover, we may not necessarily be looking up at every defect in the apparatus except those pointed out by the user or except the ones basic to the working of the instrument. We put this information down on the receipt form where apart from the make, model and the serial number of the instrument we have space for the above instructions from the customer and also note down any obvious shortages of knobs plugs, pointers, etc.

We also expect to receive the circuit diagram or the instruction manual of the manufacturer along with the instrument. On this point we are really sore at the Indian manufacturers of instruments. They usually do not supply the circuit diagrams to the original customers. This is un-justifiable. We even know of instances where we bought Indian-made instruments ourselves and we had to extract this information with great difficulty. Contrast this with the foreign instruments manufacturers who have given us circuit diagrams even for our customer's apparatus by return of post, whenever we requested it. One Indian manufacturer once made the plea that if they gave out diagrams, some customers would tend to meddle with the equipment. We submit that some customers would do this even if no diagrams are supplied.

No pre-Estimates Given

Due to the varied nature of work undertaken, we do not give pre-estimates. A bill is made out for a part or for the full servicing done. This may appear odd or high -handed. But an explanation and an analogy might help to clear the situation. An instrument may have, on first check, an obvious defect and if an estimate was based on this, one may be sadly mistaken when the actual repairs are carried out, because similar to the punctures in a bicycle tube, the defects have a habit of multiplying on closer examination; there may be multiple defects and the obvious one may be only the beginning. So the estimate can prove to be grossly undercharged. On the other hand trying to be on the safe side, one would tend to give a gross over-estimate which would defeat the aim of a reasonably priced service to the customer. (It is true that in restricted types of jobs, the charged could be itemised and a fair estimate given but this does not hold when a wide variety of work is accepted). By the time one is ready to give a fairly accurate estimate, the equipment is practically repaired and if the customer decided to withdraw the job at this stage, one may end up with wasted effort for which one cannot charge morally, since it was only an estimate-giving.

In a test case, we give an estimate to a government organisation which insisted that they had to obtain a financial sanction for the expenditure before they could let us proceed with the work. The reply came in three months, after a number of reminders. The instrument lay dismantled for this period holding up our work space. It took us repeated this mistake of giving an estimate and getting stuck with it.

When the Stores-Purchase try to equate a purchase with a repair job by asking for three estimates to be received, they are completely off-the-mark. Three or any number or quotations do not hurt the instrument which is to be purchased, but three estimates for a service job can ruin the instrument in the process. Also since profit is not our main motive, the Audit people accept this term of ours with mild murmurs. As an analogy we would compare this service to that given by a specialist hospital. The patient goes there considering the reputation of the surgeon and does not insist on estimates for what may appear from the outside to be a stone might turn out to be a cyst and story may be quite different.

Components and Spares

Any spares which are not stocked by us are to be supplied by the customer. Normally we stock or try to locate a spare part ourselves and in the process, we have built up a reference index of the buyer-guide type from where we can find out as to who makes a standard cell or a wire-wound resistor or rotary switches or thermostatic capsules in India. However, since some customers have better resources than us, we let them arrange to get a photo-cell or an electrometer tube or a helipot, in order to save time.

Not more than two instruments are accepted at a time from a party. This is done to keep the work on hand to manageable proportions and to avoid the creating of godowns or establishment. With a fairly quick turn-over this does not become a bottleneck, at all. If a large back-log exist in any Institution, special arrangements can be made. We also expect the work to be accompanied because we believe that no customer can pack the equipment as well as was done by the original manufacturer and since the instruments are liable to be received loosely packed or in un-packed form, it is safer for the instrument (and us) if it was brought in person.

Just as the Doctors require the patient to be brought to the hospital for an operation, we expect the instruments to be delivered to and collected from the Service Department where we have elaborate facilities, tools and test equipment and clean surroundings. We do not accept on-the spot work as we find it generally more inconvenient and time-consuming and there are more chances of small parts being mislaid. Also most of the jons are such that they cannot be done just anywhere. In Hospitals and Industrial establishments, especially, there is hardly any elbow room around the instruments.

No Deadlines

For our peace of mind, we do not work to any dead-lines set by the customers. While we try to finish a job as quickly as possible, in the spirit of this a article, but considering the supply position of the spares or special fabrication jobs and also the fact that being a government department ourselves, we can be hamstrung by the secretarial procedures of our system—the familiar three-quotation system and the like, there can be unavoidable delays. We have also found that as a rule, that the same customer who tries to be in big hurry to get the job done, suddenly becomes listless when the information is sent that the job is ready for delivery and it may take weeks or even months before the collection is made. We can almost sense by now whether the stated emergency is real or imaginary.

We insist that the apparatus before it is taken back, should be checked by the user or a competent person at our workshop. This has two objectives. First, the user can get any modification made while it is still convenient to do so. Secondly it gives us an opportunity to explain the proper use of the equipment to the user (or sometimes to get to know this for ourselves). Also there are no repeat calls and wasted labour and nor arguments as to whether the apparatus was satisfactorily repaired or not. Again, when an instrument is beyond help, or is an uneconomic proposition, it is easier to explain by demonstration than by letter-writing.

On the matter of repeat jobs—since we do not work with our nose to the grind stone and since we do not have the outlook of a private clinic who would like to have the patient keep coming back, we spend a little more time and do a sturdy job the first time itself and also give instructions for its proper use. This has kept the repeats down to a very low figure.

Should The Instrument User Do Some Servicing?

Often the question is put to us; should the user do some servicing of the first-aid type himself ? We will say no, unless he is sure of what he is doing. We once received an Oscilloscope costing Rs. 8000/- in which the user had replaced the 500 ma. fuse with a 5 amp one and consequently ruined the entire power supply portion (using rather hard-to-get components) a fault in which had blown fuse initially. So if one must change fuses, the original ratings must not be exceeded. We also know of a case, where to avoid screechy sounds, the customer had generously greased all the contacts, in the switches of a potentiometer costing Rs. 2000/- with the result that the sound had disappeared but so did all the readings that he was trying to get. We would certainly suggest that the user should obtain at the time of purchase, spares of components which breakdown by their very nature, such as filamentary lamps or rubber belts etc. in consultation with the manufacturer, if necessary. We had to reluctantly, return a Rs. 10,000/- Fundus Camera in which pilot-lamp type of bulbs of special construction and ratings had burnt out in normal course and for which no replacements existed.

How to Set Up A Design Shop

We should like to recommend to any organisation which may be considering the Designing and Development of Instruments, to set up a Service Shop and put all the Design and Development staff through it. This is the best way to learn about another Designer's work, understanding it and then using the knowledge to develop further instruments. Although it would be cheaper for all concerned if all the basic knowledge of the subject was acquired at a University or a Technical Institution, but to fill in the gaps or even for its own sake, a seminar type of activity should be encouraged among the staff so that new instruments and newer techniques can be discussed, understood and appreciated. A person who cannot locate a fault in an already designed instrument or after locating it, cannot explain it to others, can hardly become fit enough to design or develop instruments. Learning and training is a continuous process and this one of the best ways of achieving it.

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Science & Engineering in Ethiopia

Like many other developing countries, Ethiopia is now passing through her first stage of development. By this is meant that the Government and the population are embarking on a development scheme that mainly deals with laying basic foundation on which further and more comprehensive plans are to be based upon.

Educational facilities—both on the primary and secondary level, are being expanded throughout the country. An Institution of higher learning (the Haile Sellassie I University) has been opened since 1962. A considerable number of Ethiopians who have studied abroad and at home, are now engaged in various activities such as public services, teaching, engineering etc. Others are also working with private companies (foreign and national ones).

In 1957, the Government introduced the First Five Year Plan of Development. Main targets of the programme were:

1. to give priority to the development of infrastructure sectors of the country's economy (i.e. transport and communication);
2. to raise the quality of education;
3. to improve the agricultural economy of the country.

In 1963, the Government announced the Second Five Year Plan. According to the experts who drafted the development schemes (mainly Yugoslav engineers and economists), the Second Five Year Plan is believed to be a continuation of the first one. More emphasis is to be given to education and production activities. It is conceived that some light and 'propulsive' industries (e.g. food processing, leather industry) can be profitably installed.

Socio-Economic Conditions in Ethiopia

The population of the country is estimated to be about 20 million. About 90% of the people are engaged in agriculture, cultivation of grains and cash crops, animal husbandry etc.

Among the non-agricultural population, some are traders, factory workers, technicians, and public servants. A larger number is also engaged in non-productive occupations.

Agricultural production in Ethiopia is geared towards a self-sufficient household economy. Although such agricultural produces like coffee, hides, skins, and oil-seeds account for over 90% of the country's exports, the greatest part of agricultural income is subsistence economy and therefore it assumes a non-monetary form. The average per capita income is placed around US $40,00.

Illiteracy rate in Ethiopia is considered to be one of the highest in African countries. So far, only 5% of the population have had basic education. Of these about 10% have completed higher University education. The rural population is for the greater part outside the process of change.

Natural Resources

It is generally accepted that Ethiopia possesses rich and varied natural resources. Both the first and second Five Year Plans were drafted to provide guiding lines to effect the exploitation of existing untapped wealth of the country.

Agriculture

Of the available cultivable land, only 14% is being cultivated. Farming is done by obsolete methods; the imagination of the average farmer does not extend beyond a subsistence economy. Thus it is foreseen that with a relatively small improvement in agricultural technique and with an increased purchasing power, the output of agricultural produce can be vastly increased. It might be interesting to know that climatic conditions in Ethiopia are favourable for wheat, maize, millet, citrus and tropical fruits, and many other crops.

The country also possesses a wealth of forestry. But again this is an inactive asset. Another significant sector of agriculture is animal husbandry. Livestock population in Ethiopia is estimated to be quite large. But because of inefficient veterinary service, and because the traditional pattern of cattle raising is very poor, the livestock wealth is not contributing much to the country's economy.

Minerals

The mineral wealth of Ethiopia is largely unknown. But rough studies based on the geological structure of the country have suggested that mining could become a profitable industry. There are indications that deposits of mica, salt, iron ore, and non-ferrous metals (e.g. copper) do exist in sufficient quantities for practical exploitation. It is also foreseen that some areas might offer favourable prospects for discoveries of oil, for which prospecting is already in progress. To this day, only small deposits of gold are being exploited.

Hydro-Electric Power

Ethiopia's wealth of available hydro-electric power has been known for quite a long time. Preliminary studies conducted so far show that water power is the most important source of energy in the country. The potential of water power is estimated at about 145,000 million kwh per year, while economically usable potential amounts to about 45,700 million, provided that adequate storage basins are built on certain rivers. The Blue Nile contributes to 54% of this potential. However, small rivers like the Awash are considered to be far more significant for immediate utilization. One power station (capacity: 23,000 kw) has already been built on this river, and a second one is now under construction. A small station (9,600 kw) has also been installed on the Blue Nile. Total installed power of all the public power stations is now only 85,000 kw.

Irrigation Prospects

Preliminary surveys have shown that the Blue Nile and the Awash River can serve irrigation purposes. A sugar plantation is now being operated successfully on the Awash River. More projects are planned on the course of this river. An economical utilization of the Blue Nile for irrigation purposes would still need a further systematic study.

ENGINEERING AND SCIENTIFIC ACTIVITIES IN ETHIOPIA

The Government of Ethiopia has been engaged during the last 22 years in a host of activities that were designed to modernize the economy and the administrative machinery of the country. Immediately after the country was liberated in 1942, the Government laid down working policies of development which envisaged, among other things:

1. Development of Transport and Communication.
2. Construction of Power Stations.
3. Development and Improvement of the Agricultural Resources of the Country.

4. Public Health Improvement and Prevention of Diseases.

Semi-autonomous departments which would directly deal with these operations were created within the Ministries of: Public Works and Communications, Telephone and Telegraph, Agriculture and Health. As a result, a number of technical agencies and research centres have emerged. They were all started with the assistance of foreign experts, but now management has been mostly transferred into the hands of Ethiopians. However, there still exists an acute need for foreign experts in such significant activities like public Health and Medicine, Scientific Activities in the New University, and so on.

It should be pointed out that Ethiopia has not yet come to the stage of conducting detailed and useful scientific research. The shortage of engineers who should be working in industrial production and design problems is noticeable. The engineering and scientific activities in Ethiopia are:

Engineering

Highway Authority (H.A.)

This agency is entrusted with the maintenance of the existing road systems of the country. It is also authorized to extend roads to areas that promise economic development. Except for a small gauge railway line that runs from Addis Ababa to Djibouti, Ethiopia depends heavily on the existing road system in bringing out her agricultural produce for export, and in the distribution of imported goods. The HA has received loans from the World Bank. At present it employs fifteen engineers, about two thousand technicians and a labour force of twenty thousand. It runs a small laboratory on soil mechanics.

Water Resources Authority (WRA)

This department has been created with the assistance of American staff and financial aid. It has conducted a preliminary survey of the Blue Nile River Basin. In July 1963, management was formally transferred to Ethiopians - about ten of them. In addition to the systematic relief studies, it also records monthly and yearly water flows at strategic points on the basin of the river. Recently, a new department under the name of Awash Valley Authority has been created.

Civil Aviation Centre (CAC)

Air transport is proving to be extremely useful in Ethiopia. Rich Coffee areas that lie outside the existing road network, are served by air transportation. The CAC is authorized to administer the various airports in the country. But more significant is its training centre for radio technicians, aircraft mechanics, and meteorologists. People, who graduated from the training centre, are serving the Ethiopian Air Lines in all fields. The CAC is also running a Meteorological Research Station which is believed to be the best in the country.

Board of Telecommunications (BT)

This agency was established in 1952 with assistance from the Swedish Government. Its responsibility is to operate local and international telecommunication services. Management is mainly in the hands of Ethiopians. At present, there are ten engineers and about fifteen hundred technicians. The BT maintains a training centre for technicians who have proved to be very helpful in installing new equipment and in repair services. The agency has not given much thought either to research work or to the local manufacture of accessory tools and components.

Power Authority (PA)

This autonomous agency has the sole authority of producing and selling electric energy in the country. At present it runs two hydro-electric stations; one at Koka (Awash river) with a capacity of 23,000 Kw, and a second one at the source of the Blue Nile with a capacity of 9,600 KVA. A second power station is to be built soon on the Awash River. The Port of Assab will get electric power from a thermal generator before the end of 1964· There are twelve engineers working with the PA, the Deputy-Chief Engineer is an Ethiopian; the Manager is also an Ethiopian Engineer. The Agency maintains a training school for technicians.

Other Engineering Activities

Various foreign companies are engaged in building and construction works. A British firm of engineers is conducting a survey work under a contract with the Government. A Dutch company is successfully operating an irrigation scheme on the Awash River Valley where sugarcane is grown. (It might be interesting to know that this company is supplying Ethiopia's sugar consumption, and it also exports a sizeable amount of sugar to Sudan, and the Middle East). Most of the foreign companies employ Ethiopian engineers and technicians.

Scientific Research and Operations

1. AGRICULTURE

(*a*) *Veterinary Research Centre*: (*VRC*)

This research centre was created to identify and control the spread of dangerous livestock diseases (primarily foot and mouth disease). It is now well known that an undeveloped veterinary service "has done much damage to the national economy through immense direct losses caused by a high percentage of livestock mortality, as well as through a total passivity of this national wealth which it is not possible to export". Unfortunately much remains to be done in solving this problem; it is hoped that this important centre will be vastly improved in the near future.

(*b*) *Crops Research Centres* (*CRC*)

It has taken quite a long time to establish this new agency. It has been known for many years that cereal crops grown in Ethiopia are of the poorest quality. The authorities who have opened the new CRC (Ministry of Agriculture) have expressed their aims to introduce better seeds so that yields can be improved. They also intend to conduct research on various kinds of soils. The FAO is rendering assistance in this undertaking. There are also plans to improve the quality of the Ethiopian coffee.

(*c*) *Locust Control Unit* (*LCU*)

In the past, Ethiopia has suffered from recurrent invasions by swarms of locusts. The locust has always been the scourge of the Ethiopian peasant farmer. Now with the co-operation of neighbouring countries (e.g. Sudan, Somalia, and others) the Government is financing a "locust control unit". So far the procedure has been to locate the eggs and to destroy them. The ultimate aim is to eradicate completely the existing reserves of locusts on the Red Sea Coast.

(*d*) *Forestry Research Centre* (*FRC*)

With an assistance from the German Federal Government, a forestry research centre was opened about five years ago. The aims of this centre are: to classify the various kinds of wood grown in Ethiopia; to determine their economic values; to suggest ways and means to prevent deforestation.

2. PUBLIC HEALTH

(*a*) *Malaria Control Unit* (*MCU*)

Malaria is a common disease in the lowlands of Ethiopia. Although most of these areas are cultivable, the peasants prefer to crowd on the high plateaus. With an assistance from the WHO, the Government is now trying to clear all existing reserves of mosquitoes.

(*b*) *Public Health College Research Institute:*

The Public Health College is a chartered unit of the new Haile Sellassie I University. Besides being engaged in the training of Public Health Officers, it is also conducting a systematic study of prevalent diseases in Ethiopia. So far, the research work of the Institute is limited only to a small area. There are plans to expand its activities by opening public health centres throughout the country.

(*c*) *Pasteur Institute of Ethiopia* (*PIE*)

This institute has been established with the assistance of French scientists. It is the only research centre in the country where scientific research has been carried out on a standard basis. Researches have been made on animal and plant diseases. A team of Ethiopian biologists and research assistants has been working in close co-operation with the French scientists for some time. The management and direction will shortly pass into Ethiopian hands.

3. PHYSICS AND GEOLOGY

(*a*) *Geophysical Observatory of the Haile Sellassie* (*I*) *University*

This Observatory was opened in 1957. Since then it has made magnetic and seismic recordings. It may be recalled that the Great Rift Valley passes through Ethiopia into Kenya. So the seismic recordings are believed to assume some importance in the near future. The Observatory publishes a bulletin twice a year. At present, the research work is purely academic.

(*b*) *The Geological Laboratory*

This laboratory has been opened by the Department of Geology (Faculty of Science, HS(I)U). The department is staffed by people who seem to have a keen interest in the geological structure of Ethiopia. Efforts are being made to test and classify the various rocks found in Ethiopia.

Broadly speaking, these are the major scientific and engineering activities in Ethiopia. It must be said that progress has actually been made in these fields during the last twenty years. In 1945, the country had none of these activities. It had no native engineer or scientist. So if one were to measure the absolute rate of change, one would be compelled to concede that spectacular changes have been introduced. But one must realize that the pace of change in the outside world has also been beyond the reach of the rate development in Ethiopia.

Absence of Active Scientific Societies in Ethiopia

It is now generally accepted that next to natural resources, the second requirement of a developing country is skilled manpower. A reference to the brief notes on natural resources of Ethiopia will indicate that the educational policy of the country should have given marked preferences for biologists, geologists, agricultural engineers, and chemical engineers. Naturally, the other branches of Science and Engineering will also find their usefulness.

It is a matter of great concern that Ethiopia has not yet produced the very responsible scientists and engineers who would have assisted in the development of the country. Trained biologists are needed in connection with the country's agriculture, forestry, and wild life conservation and exploitation. Unfortunately, they are not to be found. There is a great need for the geological survey of the country, as a preliminary step to mining activities, but the number of graduates in geology is very limited. It is proposed to develop chemical industries, but again the graduates are lacking. The shortage of scientists required for engineering and manufacturing developments is also very acute.

There are about two hundred engineers and fifty scientists in the country. In engineering, the civil engineers account for about half of the total number; they are followed by the electrical and mechanical engineers. There are no practicing chemical engineers, but very soon about ten people would be completing their studies.

Among the scientists, there are two veterinary biologists, ten pharmacists, three physicists, ten chemists, three geologists, and the rest would be specialists in agricultural sciences. There are about twenty doctors in the country.

The conclusion to be drawn from this overall picture of available skilled manpower is not favourable. The deficiencies are so great that economic development will be seriously hampered due to lack of skilled manpower. What is still frightening is that this deficiency will inevitably continue for some more years.

Due to such a small number of skilled manpower, there hardly exists any active scientific society in Ethiopia. Great efforts have been made to bring about a *professional association of engineers* and the three architects that are there in the country. Such a loose association does actually exist. It has not yet published a professional journal. Some serious thought is given to integrated research, but again this is only a dream in the minds of the few people who have understood the problems.

Scientists from the Pasteur Institute have collaborated with the faculty of Science (*HSIU*) to form a *biological society*. Out of twenty members, there is only one Ethiopian bio-chemist in this society. The society has so far published extracts from lectures prepared by its members. But it would seem that the society is mainly interested in academic research, and it is doubtful if its findings will ever be found useful in the economic development of the country.

The only professional society that has been truly established is that of "*Ethiopian Medical Association.*" The Association publishes a quarterly journal; it has sponsored lectures by prominent specialists from Sweden and Great Britain. The Association is also collaborating with the Haile Sellassie (I) University to open a Faculty of Medicine. It is interesting to note that this dynamic Association has been created by only a dozen of Ethiopian and foreign doctors. The number of engineers would be at least ten times the number of doctors; surprisingly enough, the "Ethiopian Medical Association" seems to be the lonely pioneer in the hard struggle of introducing scientific culture into the country.

Problems connected with the Organization of Science

The Ethiopian Government fully realizes that the success of the Second Five Year Plan depends on the availability of skilled and semi-skilled manpower. It has committed itself to expand educational facilities on the secondary level. The new University is also entrusted with the promotion and creation of scientific research.

The limited resources of the Government are so tightly budgeted that there is very little room for flexibility. It cannot afford to direct large funds into the promotion of science. This distressing fact is bringing out a new dilemma: It is well known that the progress and development is based on scientific education, but then there is difficutly in providing the much needed funds.

In the absence of active engineering and scientific societies in the country planning and coordinating the projects have proved to be a difficult problem. So far the objectives are only expressed in terms of general policies. It still remains to specify and regulate in detail the quality and quantity of scientific education that is desired by the economic prospects of the country.

To summarize then, the immediate problems connected with the organization of science in Ethiopia are:

1. Limited financial resources.

2. Lack of a detailed national policy on the promotion and organization of science.

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