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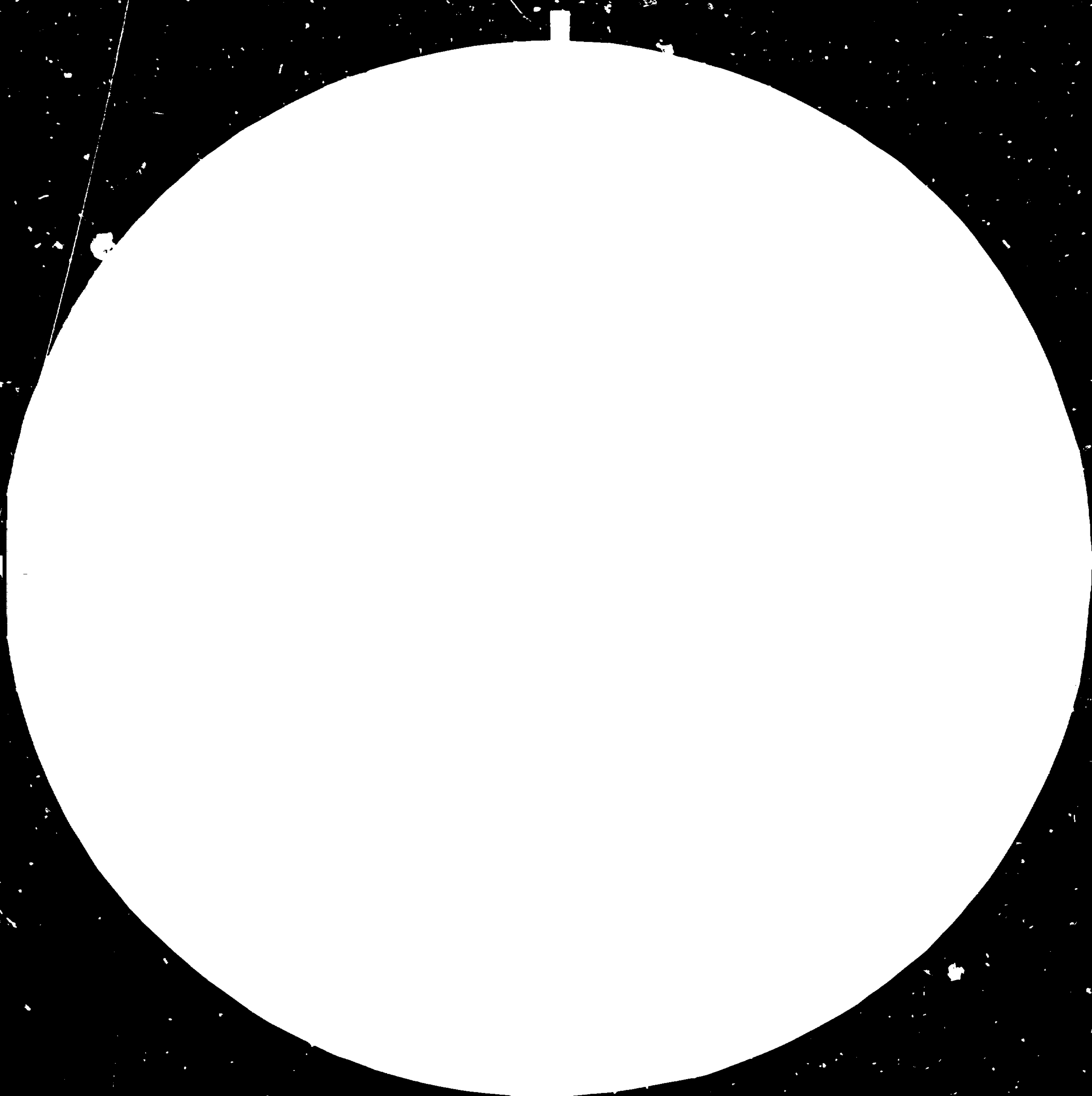

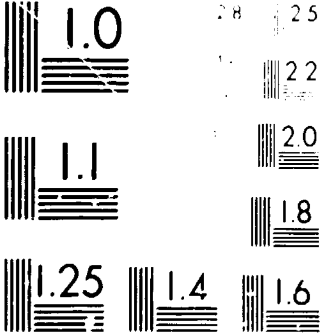
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Expert Meeting Preparatory to International Forum on Technological Advances and Development

Moscow, Union of Soviet Socialist Republics, 29 November - 3 December 1982

REPORTS OF WORKING GROUPS*

(Meeting on technological advances).

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INTRODUCTION

The expert group meeting, held in Moscow, Union of Soviet Socialist Republics from 29 November to 3 December 1982, constituted six working groups to examine specific aspects of technological advances and developments. Since the reports of the working groups contain, in general, expert assessments in the respective areas, they have been brought together and published in this volume.

Working Group Report: MICROELECTRONICS

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A. General considerations

1. Microelectronics is an extremely important system of related technologies which can play a significantly beneficial role in the economic and social development programmes of most developing countries. Applications of microelectronics-based systems improve manufacturing efficiency and the quality of the products and can lead to significant improvements in various fields like agriculture, education, health and transport which have a direct bearing on the quality of life of people. It is necessary for each country to examine its own needs and review what microelectronics has to offer. It is vital that each country builds up an applications capability and plans for further participation depending on local capabilities, needs, priorities and costs. Manufacturing involvement may range from design and production of systems using

foreign components, to manufacture, starting from relatively simple components, right up to the manufacture of advanced microelectronic components. The commonality of application areas and the shortage of technically qualified people in the developing countries and benefits of 'economies of scale' make the microelectronics industry ideally suited for implementation of the technical co-operation among developing countries (TCDC) concept and regional co-operation.

B. Fields of application

2. As a large proportion of the population in developing countries lives in rural areas, special emphasis needs to be put on applications of microelectronics in villages. As an example of this approach, the Indian microelectronics programme envisages the use of microelectronics for improvement of agricultural production (e.g. by developing instruments to measure the humidity of the soil; improvement in education by providing educational television; and improvement in health by providing better communication links and electronics-based diagnostic services.

3. The specific applications programme of the Soviet Union may serve as an example of a programme aimed at improvements in industrial efficiency and scientific research. The programme has therefore prepared standard equipment and software suited to process control, computer-aided design and scientific laboratory automation.

4. It is an important general principle that application experts should be involved in the development of applications together with the electronics engineers. Once an application is developed, the farmers, teachers, medical auxiliaries or whoever needs to apply the devices must be trained in their use and these groups may help in further developments.

C. Manufacture

5. The concept of the silicon foundry has been mentioned as a possible easy way for developing countries to gain access to the manufacture of chips for their own specialist needs. A silicon foundry requires a broad

industrial infrastructure, large inputs of highly skilled specialist labour and large capital investment. On the other hand the manufacture of relatively simple components may lead to a training and development process which could eventually lead to the manufacture of more complex chips.

6. The Working Group regards the application of microelectronics as the highest priority and feels that this not only leads to immediate benefits but also to the building up of general expertise and knowledge which are prerequisites for manufacturing involvement.

7. The manufacture of systems, instruments and equipment, together with their software, may be the next step in building up an electronics industry, thus broadening the base of experience and of applications knowledge.

8. It is estimated that if the manufacture of relatively advanced chips is to be contemplated, a threshold initial investment of $50 million is required and the product may require subsidies or protection for many years to come.

9. Attention needs to be paid to peripheral technologies and products and interface items like transducers etc.

D. Regional co-operation

10. The TCDC concept should be used as the first option whenever external assistance of any kind is to be provided to a country. This is particularly so for training, consultancy, software development, maintenance and other activities which are highly manpower-oriented. The same concept may be extended to manufacture, and trade in components and end-products. This would help generate the economies of scale which may make such activities economically viable and help in developing self-reliance in the developing countries.

11. As part of the TCDC concept, regional centres and perhaps one international centre as the nodal agency, should be set up primarily for development of microprocessor-based applications, equipment and systems.

R and D centres based on similar lines also could be considered. All such regional centres must be set up only in developing countries.

12. Standardization on the 'building block' level (computer/microprocessor family, CAD/CAM[1/] graphics presentation, software languages for real time control etc.), co-ordinated with major standards in the other branches of industry - instrumentation, machine tools, telecommunications - will help to create the effective mechanisms for technology transfer in the most critical application areas. Such mechanisms would facilitate a wider choice of options in developing countries and circumvent the problems of frequent retraining for the growing user base. Application-oriented features of new products and services will in the long run play a more important role than adhering to the newest LSI[2/] technology achievements.

13. To assist in standardization, a 'menu' approach may be adopted where the Government by bulk purchase, easier import and availability and perhaps fiscal concessions and subsidies may encourage the use of a standardized range of chips, which ultimately may be manufactured in the country (or under a TCDC arrangement).

14. The rapid development of technology in this area leads to a building up of considerable pressures within developing countries to either scrap production based on slightly older technology or, worse, to a clamour for import of end-use equipment using the latest technology. Thus investments made may not lead to adequate returns and are tied to a never-ending import spree. Conscious decisions need to be taken to protect such investments for specified time frames and a constant monitoring system should be evolved. As far as possible parallel R and D activities should be encouraged to develop existing technology.

1/ Computer-aided design/computer-aided manufacture.
2/ Large-scale integration.

E. Role of UNIDO

15. It is suggested that as the theme of the International Forum on Technological Advances and Development is to be the impact on developing countries, significantly more participation from developing countries should be arranged. It is not necessary that a microelectronics industry exists, in any shape, in a country for it to be a participant in the conference. Such participation would ensure that the developing country viewpoint is expressed about priorities in development and identification of areas and fields of application most relevant to the developing countries. It would also expose them, if not already so, to the relevance, importance and key role which microelectronics can play in significantly improving the economy and the quality of life of their people.

16. As TCDC and regional co-operation are a very major corner-stone of developing the microelectronics industry in all its aspects, perhaps a co-ordinating agency with representatives of the participating countries within the United Nations framework may be set up to co-ordinate activites and draw up and implement various plans. This agency should have a scientific and technical secretariat to assist its activities.

17. The Microelectronics Monitor published by UNIDO was considered an excellent first step in the right direction. It was felt that its scope and coverage should be further extended and both the Soviet and Indian experts present offered to help in this enterprise.

18. It is necessary to extend information services including those of UNIDO very considerably. This may lead to setting up new data banks and making arrangements with existing data banks on microelectronics applications. Perhaps a special meeting of experts on this topic could be arranged. India has offered to host and organize such a meeting with the assistance and co-operation and sponsorship of UNIDO.

19. Concern was expressed at the difficulties of 'portability' of applications software. It was felt that the problems might be solved by a standardization approach, using only one type of microprocessor. The alternative lies in more flexible hardware, which may come about through market pressures within developed countries.

20. In this connection, the recommendation was made that UNIDO, in co-operation with the International Organization for Standardization (ISO), should work towards standardization, whereby ISO would promote standards and UNIDO would assist in the creation of application possibilities.

F. <u>Discussion of the note prepared by the UNIDO secretariat: "Microelectronics and developing countries: towards an action-oriented approach" (ID/WG.384/5)</u>

21. The group of experts discussed the UNIDO draft paper ID/WG.384/5 in some detail and endorsed most of its content, except for the following corrections and additions: para 5(a) should read: "Microelectronics technology is capable of carrying out information handling and storage tasks with great efficiency, speed and reliability and can thus aid some human decision-making tasks";

para. 5 (d) should read: "Microelectronic devices are reliable and effective and can increase the efficiency of resource utilization in many fields, including the efficient use of energy";

para. 6. The emphasis of this paragraph should be on improvements in agricultural efficiency and improvement in medical, educational and information services with resultant improvements in the quality of life. Direct opportunities of gainful activity in production of electronic systems may occur but are less important.

para. 10. Employment losses in instrumentation and quality control are trivial and should not be confused with the general problem of unemployment.

para. 12. The Working Group regards the threshold capital investment required for chip manufacture to be of the order of $50 million. The fact that other industries also require large capital sums means that priorities have to be set.

para. 18 (c) may need some clarification, as a distinction needs to be made between the manufacture of electronic instruments and equipment on the one hand and the manufacture of components on the other.

paras. 18(i) and 21 were regarded as of particular importance as in a fast moving technology and a fast moving world nothing is more important than constant review of changing circumstances.

(Footnote 7 was regarded as unhelpful, while it was felt that footnote 8 was of extraordinary importance deserving a major paragraph in the main text.)

G. Concluding remarks

22. The most important feature of microelectronics is the great variety of its applications. It is therefore essential that each country should take steps to be well informed on the potential of the technology and should consider this in the context of its own specific problems,needs and capabilities.

23. UNIDO can be of considerable assistance in providing information and acting as a catalyst for regional co-operation between developing countries.

24. The needs of developing countries are very different from those of developed countries and therefore developing country applications need to be developed. Equally, developing country assessments of wider social impacts need to be made. There are complex trade-offs between the labour-saving potential of microelectronics and the benefits to be gained through increased efficiency. These need to be considered in each specific context and case.

Working Group Report: GENETIC ENGINEERING AND BIOTECHNOLOGY

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A. Planning and Education

1. The socio-economic impact of scientific discoveries and technological advances is realized through decision-making which is based on sectoral forecasts and on the analysis of trends that emerge as a consequence of the interaction between various sectoral developments.

2. The sectoral developments must be studied over a time range which prevents over-reactions caused by a strong focus on innovation clusters that seem to meet particular social needs but actually produce microcycles of expectations and disappointments.

3. The claim that microbial protein derived from fossil fuels would solve the world's food crisis caused such a microcycle of attention in the field of bioengineering. It was followed by enzyme engineering which promised to generate a new chemical industry but where, after fifteen years of academic achievements, seven major industrial applications can be recorded. Hardly had the attention of this area faded before genetic engineering appeared as a major force in health and agriculture. When the "shake-out" of the consequent industrial activities now starts, decision makers ought to regard this as a natural phase in a third microcycle which derives special significance from the fermentation knowledge gained in the first cycle and the new biotechnologies that were introduced in the second. It is the likely impact of such technological interactions that provides the argument for developing countries to participate in international monitoring activities and to initiate and oversee appropriate national programmes.

4. The selection of such national priorities also requires awareness of the potential socio-economic impact of sectoral convergence and of the synergistic effects that may develop between superficially unrelated disciplines. Such second order effects are of course very difficult to predict, but historic experience provides some guidance. At the present time it should be noted that the use of both bioengineering and microelectronics may reduce the scale-factor dependence, the centralization trends and the capital requirements that are characteristic of many traditional industrial practices. Genetic engineering, applied in the energy, agricultural and health fields can also add new options for settlement planning and act as a potent catalyst for innovations with a positive effect on the environment and on the employment situation.

5. Science policy and educational planning related to bioengineering is of particular relevance for developing countries with a high agricultural potential, a strong economic dependence either on single cash crops like sugar, or on fossil or metal resources that can be upgraded or increased by microbial means.

6. Educational planning should encompass all training levels and present the recent advances in genetic engineering and biotechnology as a challenge both to young students and to the women in developing countries who, through their involvement with traditional fermentations, constitute a largely underutilized resource. In fact, developing countries can now ill afford to waste any resources, be they people, information, energy or materials.

7. Obviously, developing countries need both people versed in technology assessment and scientists capable to translate the advances in genetic engineering and biotechnology into practices that are appropriate to their countries. This means that there is a need both for the high-level training that might be provided by the UNIDO-proposed International Centre for Genetic Engineering and Biotechnology and its associated national laboratories, and for the fostering of an indigenous creativity that might be stimulated by work periods in other developing countries.

B. Energy

8. The role of microorganisms in enhanced recovery of oil has recently been emphasized. Genetic techniques can be used to develop microorganisms that will be able to digest the highly viscous paraffinic component of oil producing CO_2. Such bacteria can also be made to produce surfactants and biopolymers *in situ*, at the same time as they consume undesirable paraffinic components. They are expected to produce the driving force to push the oil out of the rock structure. In addition, various other characteristics, such as production of acids to corrode the carbonate rock structures, or desulphurization of the residual oil, when sulphur-containing organic components of the oil are consumed, can be imparted to the genetically-engineered bacteria. Thus, they can not only enhance further oil production, but also the quality of the oil so produced.

9. Biomass-derived energy holds great promise for increasing the self-reliance of many developing countries. Certain crops like sugar-cane or cassava can be regarded as energy crops in the sense that there are

established techniques to convert them into liquid fuels like alcohol. This can, for instance, be used in captive markets such as municipal transport fleets or co-operative farm machinery. Other crops can yield vegetable oils that may replace up to 30 per cent of the diesel oil used to run trucks or irrigation pumps. But stationary engines can also be run on biogas if the level of hydrogen sulphide is kept low, and biogas is easily produced from a wide range of vegetable and animal waste materials. They are particularly significant to developing countries since their use does not compete with food and fodder applications. However, much remains to be learned about the details of those microbiological activities that determine the optimal design of a reactor. This might in fact vary considerably depending on local circumstances both with regard to raw materials and construction facilities.

C. Bioconversion of lignocellulose

10. In recent years increased attention has been given to those renewable resources that might meet the world's increasing needs for food and fuel. In this connection, cellulose-containing materials are regarded as the most promising, in particular wastes from the food and paper processing industries, sugar-cane residues, cotton lint and straw etc. The potential of bioconversion aimed at such materials is illustrated by the fact that the world's natural production of cellulose is somewhere between 100 and 700 billion tons annually. A vital scientific and technological objective therefore is the development of methods to convert cellulose (a) from its inedible form to food (sugars); (b) from a native (or waste) state to motor fuel; (c) to single-cell protein, particularly for use as fodder.

11. There are two basic approaches to the utilization of agricultural waste materials: the thermochemical and the biological. The former produces either synthetic gas for the manufacture of methanol and ammonia or solid (charcoal) liquid (oil) or gaseous fuels. It is normally large-scale and capital intensive, but fuel gas can also be produced on a small scale for running combustion engines. However, bioconversion

seems to offer a more flexible approach to developing countries. This does not mean that they should neglect to follow the development of small-scale thermochemical catalytic converters since they might eventually provide new feedstock for bioconversions geared to the needs of petrochemical processes.

12. The degradation of cellulose to glucose (and then to ethanol, amino-acids, vitamins etc by means of fermentation) can be performed by physical, chemical and enzymatic methods. The latter require much 'softer' conditions than acid hydrolysis or gamma-irradiation, and the sugars obtained consequently contain far fewer toxic by-products. Depending on the raw material available, the final product desired, and the technology used, the biotechnology normally includes pretreatment of the raw materials, their enzymatic destruction to monomers, and fermentation of the monomers to yield the final product. Direct microbiological conversion of the raw material into intermediates or a final product is also conceivable. The processes for which effective technologies are now being developed are:

(a) enzymatic production of glucose from cellulose-containing raw materials (industrial and agricultural wastes);

(b) bioconversion of cellulosic and lignocellulosic materials into ethanol;

(c) hydrolytic (possibly oxidative-hydrolytic) destruction of plant biomass to enhance its nutritive value for livestock;

(d) enzymatic or microbiological destruction of lignin to obtain alkylphenoles, oxyphenoles and other phenol derivatives as likely primary products for polymer chemistry.

It is believed that the processes (a) and (b) will have been implemented industrially in the next 10 years and (c) and (d) in the following decade. The effective implementation of the biotechnological processes will largely depend on progress at the molecular level (basic) studies, and on the development of improved techniques for the fractionization of various vegetable materials. Interdisciplinary basic studies will be critically important: biochemistry/microbiology/molecular biology/genetic engineering/enzyme engineering/macrokinetics/bioengineering etc.

13. Major projects concerning the enzymatic hydrolysis of cellulose are currently being implemented in North America, the Soviet Union, Japan, Scandinavia and India and also, on a smaller scale, in Eastern Europe, Latin America and the Far East. So far the developments have not gone beyond the pilot scale, but in the Soviet Union a national programme on the enzymatic conversion of cellulosic waste was established in 1981. The goal of this programme is the industrial conversion of cellulose into glucose and other useful products at the end of the 1980s. Quite obviously there is much scope for international co-operation, and the current plans to stimulate this by means of "computer conferencing" may be of particular significance to developing countries.

14. Problems, which are related to the development of the biotechnology of ligno-cellulose, are associated with at least four factors:

(i) raw materials;
(ii) enzymes;
(iii) process;
(iv) engineering.

The raw materials are regional and thus the profile of their use may vary from country to country. The last three points can best be solved as a result of joint efforts involving various scientific and applied centres in different countries, both developed and developing.

D. Agriculture

15. Genetic engineering is expected to have a major impact on agriculture. The cloning of nitrogen-fixing genes from bacteria in plants would allow the latter to fix their own nitrogen and thereby eliminate the need for petrochemical-based nitrogen fertilizers. This is thought to be technically possible in the near future, although major hurdles in terms of an inevitable energy requirement and protection of the nitrogenase enzymes from oxygen still remain. A more rational goal is to genetically improve the nitrogen-fixing symbiotic bacteria (Rhizobia) that nodulate leguminous plants. Recent evidence indicates that the nitrogen-fixation and nodulation genes are carried together on large plasmids in such bacteria.

The specificity of the nodulating bacteria towards particular leguminous plants might be changed by alteration of the nodulating genes so that such bacteria would nodulate a different plant from the original host species. It is expected that further genetic alterations may allow nodulation of such bacteria on the roots of important cereal crop plants such as rice or wheat thereby greatly enhancing the nitrogen supply to such plants.

16. Another major impact of genetic engineering is expected to come from the introduction of completely new foreign genes into the plants themselves. Development of the appropriate expression vectors for the introduction of foreign genes in plants, coupled with the development of protoplast fusion techniques and growth of complete plants from single cells of agriculturally important plants, will allow the development of plants that can grow under unfavourable conditions such as high or low moisture, saline soils and higher or lower temperatures than those normally encountered. Introduction of the appropriate genes in plants may also allow such plants to develop resistance to various viruses, insects and pests, or to produce high quality protein. Characteristics leading to rapid growth or the production of new and improved fruits may also be imparted to many plants.

17. Genetic engineering also holds promise for the production of biological pesticides that will be effective against a variety of insects and pests. This would eliminate the use of the chlorinated pesticides that are often both toxic and persistent in the environment.

18. It should be emphasized that bringing about fundamental improvements in plant characteristics is a long-term goal that will probably be reached only in the 1990s. Although some improvements in plant growth and other characteristics will undoubtedly be made in the middle to late 1980s, the lack of knowledge about the organization and regulation of the plant genome - coupled with a rather long generation time for growth and the lack of cell culture techniques for many agriculturally important plants - may delay the most fundamental and important discoveries for a decade or more. Nevertheless, the future impact of genetic engineering on agriculture will certainly be far-ranging and profound.

19. Another recent achievement is the introduction of foreign genes into animal germ line cells. This makes future breeding of agriculturally important animals feasible. It has been possible to introduce cloned foreign genes, such as rabbit globin genes or human interferon genes, into mice cells where such foreign genes undergo integration with the chromosomes of the mouse embryo. Such genes have been shown to be transmitted to the progeny as a normal chromosomal component. If functional and temporal expression of foreign genes in various animals such as cows, steers, etc. can be demonstrated, it opens up possibilities for upgrading agriculturally important animals by genetic engineering.

E. Geo-microbiology

20. Nowadays new technologies for mineral resource extraction by specific microorganisms have been developed. Since these technologies do not require sophisticated equipment and are based on the stimulations of microbial activity under natural conditions, they should have great interest for developing countries. Various technologies are based on the activation of Thiobacillus bacteria that oxidize the sulphide in ores into sulphates. The solubilized metal can be then easily obtained. These technologies are now used for the extraction of uranium, copper and other metals and they now are starting to attract attention in developing countries as illustrated by the Training Course on Microbiological Leaching of Metals from Ores arranged in Moscow by the State Committee for Science and Technology and UNEP/UNESCO/ICRO in the summer of 1982.

21. The content of methane in coal mines reaches several cubic metres per ton of this material. During mining, methane evolves and creates a danger of explosion and raises the ventilation costs. Special microbiological methods for decreasing the methane content both in coal beds and in the mine atmosphere have been developed in the Soviet Union. A suspension of methane-oxidising bacteria are injected either into a coal bed directly or into the work area. When treating a coal bed, additional aeration through bore holes is required but while treating a workout area, aeration of the microbial culture takes place as a consequence of ventilation.

F. Health care and medical services

22. The recent applications of genetic engineering to the biomedical field can be classified into two major groups. First, the synthesis of drugs and secondly, the synthesis of vaccines. In the first group the most impressive recent development is the synthesis in E.coli and yeast cells of different types of human interferons. This was achieved by different groups in Japan, the Soviet Union, the United States and Western Europe. The human growth hormone and insulin now are also available from genetically engineered microorganisms. Those drugs have exactly the same biological effects as the hormones from human sources. Another exciting field for the application of genetic engineering is the production of blood-proteins and thrombolytic agent for disintegration of blood clots. Genetic engineering techniques are already on the market and insulin produced by the other drugs mentioned will also be on the market very soon.

23. In the second group genetic engineering provides a unique opportunity for developing safe vaccines both for humans and animals. The list of vaccines that are already produced in this way includes preparations active against diseases such as Hepatitis-B, foot and mouth disease and rabies. An influenza vaccine is next in line. The production of important bacterial antigens is also promising for the development of vaccines against a wide range of enteric diseases.

24. The listing of biomedicals that have been already obtained by genetic engineering generates optimism with regard to such problems as giving help to millions of malaria sufferers. One could even imagine the creation of vaccines for leprosy. Finally it should be mentioned that there are several major attempts to solve the problem of population control.

25. In developing countries there is also a need for simple and reliable diagnostic aids for doctors and veterinarians. In the development of such devices enzymes can be used as superactive catalysts to detect small

concentrations of various antigens, and on this basis, efficient methods for the immunochemical diagnosis of many human, animal and plant diseases have been developed. The history of immuno enzyme assay (IEA) development for the last 10 years has shown that the method is gradually replacing radio-immuno assay all over the world. The advantage of IEA is:

(a) stability of reagents which are nonradioactive;

(b) simplicity of equipment for detection;

(c) sensitivity.

For these reasons the use of IEA has very great significance for developing countries. In spite of the fact that, at present, the IEA method is the subject of great development efforts, many problems have yet to be solved and their solution will greatly depend on local conditions. Particularly nonradioactive immunochemical methods, such as immunofluorescent methods, have considerable relevance to developing countries.

G. The potential of gene amplification techniques

26. Highly productive strains are the basis for the efficient industrial production of many practically important compounds like antibiotics, amino-acids, enzymes, vitamins, organic acids, monomers for the polymer industry etc. Genetic engineering has expanded the possibilities for constructing production strains of different natural compounds and for the creation of principally new types of products. In this area the progress in the production of L-threonine, L-homoserine, riboflavin, L-amylase, proteases and other biologically active compounds should be noted. Putting genetic engineering to use for such purposes requires the development of new efficient systems for cloning and expression of genetic information in various species of microorganisms such as bacilli, actinomycetes, yeast, pseudomonades and fungi. Thus it is necessary to investigate the genetic transformation systems for various species of microorganisms to create efficient vector molecules which are available to induce gene amplification, to study the genetic control and regulation mechanisms in the synthesis of primary and secondary metabolites and to construct the basic strains required for industrial use. Genetic engineering can also improve protein composition in single-cell protein production which is now a big industry in the Soviet Union.

H. Recommendations

27. As a consequence of the observations made in the preceeding paragraphs, decision-makers in developing countries should:

(a) develop national committees capable of evaluating such developments in genetic engineering and biotechnology that might be relevant to their countries, be it in terms of participation in international activities or related to their relevant designated national centres;

(b) Utilize all training facilities and communication channels that are available, in particular those that are specifically geared to the needs of developing countries such as the International Centre for Genetic Engineering and Biotechnology proposed by UNIDO;

(c) Initiate research programmes geared to their national needs.

28. Simultaneously, intergovernmental and non-governmental organizations active in the promotion of science and technology for development should:

(a) Note the significance of genetic engineering and biotechnology for leapfrogging some of the hurdles that are inherent in traditional approaches to industrialization, agricultural development and health care delivery;

(b) Promote the exchange of information between developing countries about the experience thus gained and between the scientists in developing countries and those experts in the industrialized world that can contribute to the solution of current problems by the application of the knowledge which is now generated in the fields mentioned. Special attention should be given to lignocellulosic waste materials as a resource for rural development in developing countries;

(c) Develop a network of co-operating laboratories around a 'node' in the form of an International Centre with resources for advice and advanced training as well as for the innovative research and the troubleshooting that is necessary to optimize the impact of genetic engineering and biotechnology in areas such as agriculture, geo-microbiology and fossil fuel management.

29. Finally, UNIDO should:

(a) Continue its efforts to establish the International Centre mentioned;

(b) Act as a United Nations catalyst for international activities aimed at the application of science and technology to development;

(c) Make an effort to demonstrate that a systematic utilization of the potential of genetic engineering and biotechnology can serve as a powerful introduction to rural industrialization gained through high technology (the RIGHT approach).

Working Group Report: MATERIALS AND NEW TECHNOLOGY

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A. General considerations

1. The role of materials in contemporary society is obvious as can be seen from today's homes, cities, farms, offices and factories. Clearly

the degree of success in working with materials has an important bearing on economic and social well-being and economists have often shown the correlation between the consumption of materials and the standard of living. Perhaps, therefore, it is almost axiomatic that the economic growth of the developing countries requires a positive materials development and utilisation activity.

2. Unlike many of the other Working Groups at the preparatory meeting, the effort of this Working Group was an initial step towards the preparations for the Tbilisi meeting in April 1983 and the Fourth Conference of UNIDO in 1984. The Working Group had for its review and use the following documents:

(a) "Implications of New Materials and Technology for Developing Countries" prepared by the UNIDO secretariat (ID/WG.384/1);

(b) "Some Significant Advances in Materials Technology" prepared by E. Epremian (ID/WG.384/10);

(c) "New Materials, New Technology" prepared by N.S. Enikolopov and S.A. Volfson (ID/WG.384/11);

(d) "Development and Application of New Materials: A Prospective View" by N.A. Makhutov (ID/WG.384/12).

In addition, the members of the Group made many substantive contributions beyond the above documents such as, for example, Mr. Lutsau on basalt fibres for composites, and Mr. Shorshorov on steel and other metallurgical technologies.

3. The approach used by the Working Group was to consider two classes of technology. First, traditional materials, where there are new and better technologies and secondly, new materials and new technologies. The combined knowledge of the Group covered the full spectrum of materials including: inorganic materials (concrete, brick, ceramics), natural (timber) and synthetic organic (polymers) materials, metallic materials, and reinforced composite materials of many kinds. Because of the enormous

span of the materials field, the Group focused its attention on a few selected topics, chosen for their importance but with the understanding that this selection was illustrative of the opportunities among traditional and new materials and that further review would reveal other candidates.

B. Review of the state-of-the-art and anticipated developments

4. As a general observation, it was noted that materials technology is in a highly developed state among the industrialized nations and the transfer of this technology to the developing countries would save the latter considerable time and expense. In keeping with the spirit of the meeting, it was hoped that the developing countries would not have to suffer the same learning experience of the industrialized countries, but could benefit from past experience. The Group further noted that it would be useful for the developing countries to recognize the principle, wherever possible, of developing multipurpose materials rather than specific products for each and every application.

5. The four examples selected by the Working Group were:

- Steel
- Plastics
- Composite materials
- Powder metals.

Each of these topics, which deserve more detailed treatment, are reviewed briefly below.

Steel.

6. During the past two decades, steelmaking practice has benefited from many significant improvements. For example, the basic oxygen process whereby 200 tons of steel can be made in less than one hour as compared with eight to ten hours required in an open hearth furnace; continuous casting whereby continuous sheet products are produced by direct processing from molten metal rather than the traditional ingot procedure; vacuum degassing to control undesirable impurities; inert gas protection during pouring of metal; and many other innovations.

7. There also have been many significant accomplishments in the product area, of which the high strength low alloy steels (also known as microalloys) are particularly noteworthy. This family of steels, based on the

use of minor alloy additions and now in commercial production, provide superior combinations of strength, toughness, formability and weldability. Applications include automotive body and structural parts, truck and bus frames, cranes, heavy equipment, appliances, bridges, prefabricated buildings, railroad freight, cars, shipbuilding. and line pipe.

8. At present, 66 developing countries are involved in steelmaking to varying degrees. The Working Group recommended the attention of the developing countries be directed to the new advances in steel, particularly since steel is basic to an industrial economy.

Plastics.

9. The dramatic developments in plastics technology and the potential for it to contribute to economic and industrial growth has already been recognized by UNIDO and has been the subject of a programme with the developing countries during the past decade.

10. Because of increasing energy costs and the necessity of conserving petroleum feedstocks, the Working Group focused attention on the use of fillers in plastic materials where some new important advances have been made and there is good potential for further improvements. This approach provides an effective means for materials conservation and recycling. Fillers may be classified as inorganic and organic, both natural and synthetic. The inorganics include minerals, slags, quartz sands, wastes from ore and metal processing and fly ash from thermal power stations. The organics include wood flour, ground nutshells, rubber powder, and polymer scrap. As part of the new technology in this area, a non-conventional technique has been developed whereby monomers are mixed with the appropriate filler and polymers are mixed with the appropriate filler and polymerization takes place on the surface of the filler particles. Another significant advance is a new milling technique which combines shear with pressure at elevated temperatures. Originally developed for use on polymeric material, the technique has applicability in several other fields such as milling flour from bran and other grains, the production of wood flour as a more reactive feedstock, and to reclaim rubber in the form of powder from waste rubber.

11. The Working Group recommended consideration of new developments in plastics technology including the use of fillers and the applicability of the aforementioned new milling technique in various areas.

Composite materials.

12. Fibre-reinforced composites have emerged as a new class of materials which can be appropriately called "engineered materials". By selecting the fibre and matrix materials, the proportions of each and the manner in which the fibre is embedded and oriented in the matrix, an unusual combination of properties can be obtained. The range of composite material systems is broad and continues to expand with further research and development. The following paragraphs outline several important composites.

13. Newly-developed basalt fibres produced by drawing from a melt of rock raw material have mechanical properties comparable with glass fibres and can be processed into the forms necessary for use as a reinforcement in polymer, concrete and other materials. These fibres, which are now being produced and used at an industrial level, are very inexpensive to use and enjoy an abundant raw material base. New composites are being used to reinforce concrete, produce pipe for oil, chemical and irrigation applications, make high temperature insulation mats and sheets, and for low temperature insulation.

14. Glass fibre-reinforced plastic is a mature commercial material which is well known for its application in boat hulls, auto and truck bodies, appliance and equipment parts, storage tanks and electrical equipment components. Its cost/performance characteristics have led to its extensive use, including in some developing countries.

15. The aromatic polyamide fibres, known by the generic name aramid, are spun by a technology similar to that used to produce nylon. Aramid fibre-reinforced composites are now established commercially and are finding increased use in aircraft, boat, and marine applications. A related polymer fibre is being used for tyre cord and to reinforce belts or hoses.

16. Carbon fibres, which are produced by the pyrolysis of an organic fibre precursor, can be obtained in many combinations of strength and

modulus of elasticity by varying the process conditions. These fibres provide composites with strength-to-weight and modulus-to-weight ratios far above all previously established levels. These fibres are better suited for high performance applications, are at an earlier stage of technical and commercial development than fibre glass, and are more costly. Thus, use has been for those applications where weight savings and performance are critical such as aircraft, automobiles, and sports equipment.

17. Yet another class of composites consists of those which are based on the use of natural fibres as reinforcements. Sisal fibres and bamboo fibres have both been used for this purpose and are readily available in many developing countries. In this regard, there is the exciting possibility of using grafting techniques or genetic engineering to produce natural fibres which are especially useful as reinforcements.

18. In sum, the fibre-reinforced composites field is assured of steady growth and industrial expansion and as such is worthy of consideration by the developing countries.

Powder metals.

19. In contrast with the usual processing methods of melting, casting and working of metals, powder metallurgy involves the production of metal powders, compressing them, sintering the compacts, and performing the necessary finishing operations. The field is old and well established, but is now going through a revival because of a combination of new technical advances and economic considerations. Generally powder metallurgy is favoured over fusion metallurgy when it offers one of the following:

(a) the best or only way to process the material, e.g. cemented carbides;
(b) lower processing costs;
(c) superior properties in the manufactured part.

20. A noteworthy advance in powder metallurgy technology is the newly developed rapid solidification techniques using quenching rates up to 10^6 degrees per second to produce very fine particles (less than 50 microns in diameter) which are especially uniform in composition and microstructure. These powders, after consolidation and heat treatment, provide superior properties as compared with conventional powders or fusion metallurgy for many

alloy systems.

21. Another innovation is the hot consolidation of powders to produce near net shape for cost savings and achieving superior properties. The general procedure is that a container of the shape of the final article is filled with metal powder, evacuated, sealed, and placed in a pressure vessel surrounded by a furnace. Under heat and pressure, the container compresses the powder isostatically into a densified shape.

22. The attention of the developing countries is drawn to powder metallurgy because: (a) it is a highly flexible technology and provides a useful supplement to conventional fusion metallurgy; (b) there is a well developed state-of-the-art, some of which should be useful to the developing countries; (c) the opportunity exists to develop facets of the field which are particularly suitable for the developing countries; (d) entry in the powder metal industry can be done on an incremental basis starting with a partial activity and subsequently expanding the process and product scope.

C. Impact on developing countries

23. Each of the technologies discussed above would have impacts on the developing countries which could be detailed in separate reviews with more time and space. For present purposes, the Working Group characterized the impacts for the selected topics as an aggregate.

24. To varying degrees, all of these techniques require specific training of personnel and education of professionals. For example, the new steelmaking processes and the thermal mechanical treatment of low alloy high strength steels require process and quality control to higher levels than conventionally needed. Special training in the theory and practice associated with the advanced technologies would be essential.

25. Occupational health and safety are a consideration in some cases; for example, the health effects associated with the production of some plastics and the fire and explosion hazard potential of fine metal powders,

26. With regard to the impact on employment, it is believed that the technologies discussed above tend to increase rather than displace jobs. Composite technology, for example, can be practised in a labour-intensive manner by fabricating the materials by hand lay up and press moulding which are suitable for small and moderate size markets.

27. Economically, these technologies offer new building blocks for the industrial economy and all of those discussed here offer good added value. The investment requirements vary widely. Steel is capital intensive, but to a country with existing capacity, the high strength low alloy steels offer the producer a higher value product than the plain carbon grades they replace, and at the same time, are more cost effective in service. Composites, on the other hand, may be produced with modest capital investment.

D. Potentialities and options for developing countries

28. The materials technology advances outlined by the Working Group need to be examined by developing countries individually, in the light of their respective industrial policies and plans including consideration of their comparative advantages. In the materials area, a primary consideration is the raw material position and, since materials are generally energy-intensive, the national energy base. Also of obvious importance is the existing production capability in a particular field or in related fields which serve in an interactive and supportive manner.

29. A primary option for the developing countries with regard to any of the new materials technologies discussed above is the choice between fully integrated or non-integrated production. The nature of the materials industry permits participation on a partial basis, using trade to complete the material/business chain. This situation gives rise to a wide range of strategies with a sequence of expansion in scope.

E. Problems in utilizing the technologies

30. All of the materials technologies under consideration present problems in their use. As example, the following can be mentioned:

(a) Practice of the most modern steelmaking practices require better pollution control systems, more accurate and rapid instrumentation and control, a source of inert gas, new refractories and generally stronger infrastructural support,

(b) Plastics manufacture depends on an assured source of raw materials;

(c) Composite materials often require a high degree of integration of materials design, mechanics, structural design fabrication, and non-destructive testing as an iterative process.

F. Suggestions for action

31. At the time of preparing this draft, the Working Group felt that it had not had sufficient time to examine this question adequately. Nevertheless, several suggestions were made.

32. The Working Group endorsed the suggestions made by the UNIDO secretariat for an information bulletin on materials technology similar in nature to the existing quarterlies on microelectronics and genetic engineering. The participants from the Soviet Union expressed a willingness to prepare summaries of information from the USSR for use by UNIDO and also suggested the possibility of preparing analytical studies and survey papers.

33. It was recommended that UNIDO convene a symposia on materials topics selected by the participants in the Tbilisi Meeting. This symposia would bring together technologists, economists and policy makers from industrialized and developing countries to examine the subject and its implications in suitable detail for decision-making and action planning.

34. Throughout the discussion of topics the Working Group constantly noted the need for training and education. This must be emphasized but need not be detailed since these activities are an integral part of UNIDO's continuing programme.

35. The Working Group noted the absence of an international body for the fields of materials science and technology, but in the time available was not able to discuss the matter and form any convictions regarding the necessity or feasibility of such a body.

36. Some opportunities exist for regional co-operation and collaboration in the materials field. In Latin America this already exists for steel. Other possibilities lie in composite materials, plastics and powder metals.

Working Group Report: PETROCHEMICALS

Working Group Participants

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A. Methodology of Discussion

1. The Petrochemicals Working Group organized the discussions employing a paper entitled "Catalytic cracking - perspective branch of oil processing" prepared by E.A. Karakhanov and S.V. Lysenko and a paper entitled "Emerging petrochemicals technology: implications for developing countries" (UNIDO/IS.350), commissioned by UNIDO and distributed to all participants of the Expert Meeting Preparatory to the International Forum on Technological Advances and Development.

2. Following a brief presentation by V.R.S. Arni, Group members discussed major technical, economic and institutional parameters in the field of advances in petrochemicals, bearing in mind the Aide Mémoire circulated by the UNIDO secretariat outlining the principal issues and questions to be determined at the plenary meeting of 30 November. On practically all of the issues discussed there was consensus.

B. General Considerations

3. The Group noted that there were two basic issues facing them and decision-makers in developing countries. The first of these was that the basic materials that are used and are likely to be used in the future in the field of petrochemicals are very similar, or identical to those used for the derivation of energy. Thus, technological developments in the field of petrochemicals and those of energy materials are interactive. Technical and economic developments in one field will influence the other.

4. The second issue that was recognized was that the needs of materials and technologies in the oil-producing developing countries are likely to be quite different from those in countries which do not have adequate national resources of conventional petroleum hydrocarbons. The Group, therefore, had to divide its attention to these two different situations.

5. In its deliberations, the Working Group used the term "petrochemicals" to also cover identical or similar materials which may have non-petroleum sources.

6. Even in attempting to address themselves to countries with and without adequate petroleum-type hydrocarbons, the Group recognized that resource environments of individual countries varied greatly. Thus, it was found more useful to look at developing countries on the basis of regional groupings defined in terms of common or accessible resources.

C. Impact on Developing Countries

7. It was the opinion of the Group that countries in certain regions, where there is a general shortage of conventional hydrocarbons, have a large demand for new technologies. These technologies are those that can utilize abundant or low cost raw materials as petroleum residues, coal and biomass. Natural gas as a petrochemical raw material might be considered as belonging to the group of non-conventional materials.

8. However, it was recognized that some regional areas, presently rich in conventional hydrocarbons, may also derive economic or strategic advantage by employing new technologies.

9. The Group felt that if new technologies, using non-conventional raw materials did not emerge, the present disadvantaged position of some developing countries would become all the more serious. It was important to recognize in this connection that because of their structural properties and low-energy intensities, polymer materials are already very important constituents in the materials mix of developing and developed countries.

10. In the final sense, it was opined that new technologies meant not only new or enlarged materials of commerce but basically new ways of obtaining intermediate feedstocks such as ethylene, propylene and the aromatics from which practically all polymeric materials are obtained.

D. Review of the state-of-the-art and anticipated developments

11. Except perhaps in relation to the processing and application of heavy oil fractions and petroleum residues, most of the technologies that have relevance to developing countries have not been developed beyond the pilot scale. Therefore, it cannot be said that they presently have technical or commercial significance. However, looking at international technical advances, it was the view of the Group that there are unlikely to be major technical hurdles to the development of the technologies. Without developing country inputs, the emergence of mature technologies, and the timing of that entry, will depend almost wholly on the economic, strategic and resource situation of the advanced countries.

12. In respect of key research work at the international level, it was the assessment of the Working Group that the conversion of methanol to ethylene and propylene, the conversion of synthesis gas to chemical intermediates, the production of 'coal liquids' by hydrogenation and the conversion of methanol to petrochemical end-products were the areas that would be of greatest benefit to developing countries in the context of a 20-year time frame. The importance of biomass-based technologies was also recognized.

E. Options for developing countries

13. The Group opined that, in the main, developing countries had the following institutional options in the development of technology:

(a) to depend on conventional technologies and/or conventional feedstocks, and thus to continue to import technologies or materials from (largely) the industrialized countries (as hitherto);

(b) to develop new technologies that would be appropriate to their needs;

(c) to act at regional or international levels to influence the development of new technology by the industrialized countries;

(d) to act at regional or international levels to develop new technologies, an alternative whereby there is the possibility of forming development consortia with industrialized countries.

14. It was the general opinion of the Group that while some developing countries may have the capability to develop the technologies started earlier by themselves, many developing countries' research capabilities have not yet reached the stage where they can undertake autonomous research and development in the field of new petrochemical technologies and they may require external assistance.

15. In regard to options to intermediate feedstocks, the following were highlighted: improved technologies for producing synthesis gas, methanol, lower alcohols of the Fischer-Tropsch type and lower olefins from new cracking processes. It was noted that most of these technologies are under development by the Soviet Union and that the developing countries may have this reservoir of skills and technology to draw upon.

F. Suggestions for action

16. In terms of technological development the Working Group emphasized the following three areas:

(a) R and D, and most importantly the development of technologies for creating metal-tolerant catalysts for the utilization of heavy petroleum residues and for the deep-refining of heavy oils for petrochemical feedstocks (an aspect which has equally important implications for energy materials).

Experts from the Soviet Union indicated that commercializable technologies with their new catalyst systems could probably be ready within five years;

(b) New catalyst systems for the production of methanol from syngas should be pursued so that the temperatures and pressures at which methanol is produced can be very substantially reduced. In this connection it was recognized that such development will aid developing countries which are able to obtain syngas from biomass, coal, heavy petroleum residues, etc. Also, new catalyst developments will help vastly to upgrade already established technologies;

(c) The development of technologies for the large-scale utilization of methanol feedstock for the production of ethylene and propylene. In this connection it was noted that world production of methanol is increasing rapidly and that senior Soviet experts have forecasted that the trend is for methanol to become a major international feedstock. In the Soviet Union itself methanol production is estimated to reach 30 million tonnes per annum by 1990 compared to the present production level of 2 million tonnes.

17. In terms of institutional mechanisms, it is necessary to examine the question of establishment of regional and institutional centres (including development consortia) for technology development and for the establishment of consultative bodies which the developing countries can approach for specific advice. However, the feasibility and direction of such institutional mechanisms should be examined in a situation when the opinion of several developing countries can be obtained. It is, therefore, urgent that UNIDO should attempt to convene a meeting of representative developing countries and obtain directions and priorities from them.

Working Group Report: ENERGY FROM BIOMASS AND SOLAR PHOTOVOLTAIC CELLS

Working Group Participants

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A. General considerations

1. The Working Group's discussion was confined to biomass energy and photovoltaic energy conversion since they represent two important areas of new energy technologies.

2. Biomass energy is a usable form of energy derived from all plant and animal materials. This includes forest-wood, agricultural crops and residues, animal manure and industrial and municipal wastes, freshwater and saltwater aquatic plants. From such a list it is not surprising that the quantities of biomass available for energy are very large, renewable and include an energy-storage mechanism in themselves. For example, the biomass productivity potential of the forests of the world has an energy content of nearly three times the world's current energy use. Biomass in its many different forms has many competing uses. Foremost, it competes with wood for pulp and paper, construction purposes, etc. Agricultural crops for energy compete with foods and animal feed production. It is therefore essential that the energy, food and raw material potential of biomass is balanced in an integrated approach in line with the particular needs, resources and relative advantages of the country in question.

3. Photovoltaic energy conversion is the production of electricity from solar radiation by semiconductor cells. It should be borne in mind at the outset that at present energy through photovoltaic systems can provide only a very small portion of the energy requirements of any developed or developing country. In the longer term, however, photovoltaics could be an important renewable source of electric energy, particularly to developing countries, if the electricity cost is reduced several times as compared to present levels. The longer lead time should enable countries to formulate well-considered strategies for the application of photovoltaic energy production. In the short term, photovoltaics technology lends itself to selective decentralized applications, particularly in areas which do not have other alternatives, although it should be noted that the energy-storage technology limits the application of photovoltaic energy conversion.

4. In general the Working Group pinpointed the different conditions for energy supply systems in urban and rural areas. In the urban areas centralized energy supply systems and grid distribution are called for from technical and economical points of view, whereas in rural areas local (decentralized) energy systems will be most appropriate for similar reasons based on fossil fuels as well as renewable energy forms.

5. The Working Group stressed the importance of "scientific-based low technology". This approach could lead to a several-fold increase in efficiency of wood-stoves, charcoal production units, bio-gas plants, etc.

6. The Working Group felt that immediate measures should be taken to:

(a) carry out and implement scientific-based low technology;

(b) implement programmes of energy forest plantation, wood collection and transporting systems for energy purposes;

(c) undertake peat and lignite prospecting and exploitation feasibility studies.

B. Energy technology routes, state-of-the-art, impacts on developing countries, potentialities and options, specific problems

7. The Working Group's discussion on these aspects is summarized in the following tabular form:

RESOURCE BASE

Route and state-of-the-art	Impacts	Potential	Problems
1. Large-scale forestry biomass production and collection in terms of land and area and wood output levels. Technology available.	Will influence land-planning. Machinery will have to be imported and adapted.	Could expand the raw materials for fuels and industrial purposes substantially. Will provide work opportunities in the countryside.	Calls for training of personnel from medium to highly skilled levels. Service back-up needed for mechanical components. Capital investment.
2. Improved utilization of forest residues, agricultural, industrial and municipal residues. More or less commercial technology.	Can be implemented. Low-cost, no major research needed. Influence on planning and infrastructure.	Will provide new raw materials for fuel-production (biogas, producer gas, firewood and charcoal).	No specific technical problems. Need training of personnel in developing countries.
3. Aquatic-biomass production. Technology at R+D level.	Will have impact on food/feed/energy balance.	Important potential but still at R+D stage. Fermentation of e.g. sugar and water hyacinths seems promising.	Technology is not yet developed and proven. Cost-intensive.
4. Application of biotechnology, e.g. improvements in plant species for energy use. Technology at R and D level.	Will have substantial impact on productivity. Links with biotechnology.	Will accept less productive land areas. Strengthen competitiveness to other land uses.	Highly-skilled scientific capacity needed.

RESOURCE BASE (continued)

Route and state-of-the-art	Impacts	Potential	Problems
5. Peat, lignite and coal prospecting and exploitation. Different type of technology available.	Can be implemented immediately. New energy-rich semi-fossil energy feedstock. Links with satellite surveying technology.	Vast and dense energy sources.	Not renewable. Highly skilled technical personnel needed. Qualified technical back-up needed.

BIOMASS CONVERSION TECHNOLOGIES

Route and state-of-the-art	Impacts	Potential	Problems
Thermochemical conversion			
1. Direct combustion. Advances in cooking technology (open fires and primitive stoves). New scientific advances based on low-technology, i.e. improved stoves and charcoal kilns, based on local materials and skilled manpower.	Immediately available and very wide potential. (250 million people face fuelwood shortage now and 1 billion in the near future)	Several-fold increase in efficiency (5-40%). Forestry resource base can be manufactured mostly with local materials and labour.	Needs information, education in manufacture and utilization.
2. Pyrolysis. Not generally available on a commercial scale; at R and D stage in some countries. A more efficient way of utilizing wood than charcoal products but investment costs are higher.	Wide potential in developing countries and especially for small-scale industrial applications because of gas and tar production; low to medium technology which eventually could be manufactured locally.	May cover small-scale local demand for gas and liquid fuel and industrial purposes.	The technology is not readily available. Capital investment and skilled manpower.

Route and state-of-the-art	Impacts	Potential	Problems
3. Gasification. Low efficiency technology is available but advanced technologies at research and development stage. Requires sophisticated process technology.	Prospects for countries with large deposits of peat, lignite, forestry and agricultural residues. Only covers local and short distance needs.	Provides clean fuel for households and industrial consumers. Can replace imported liquid fuel, little environmental effect.	Very capital-intensive. Equipment would have to be imported. High level of skills needed. Designed for single feedstock such as peat.
4. Direct liquefaction. Laboratory-scale research in developed countries	If possible and cost-competitive, would provide liquid fuels.	Can substitute for motor fuels.	Not proven technology. Catalyst and high cost R and D needed. High energy cost.
5. Biological Biomethanation (Biogas). Wide-scale application of low-level technology of batch type. Advanced continuous processes have been developed.	Very high, especially for tropical zones with agricultural residues, municipal sewage and aquatic biomass.	Improved sanitation, produces fertilizer of high quality and biogas energy source. Suitable for mass production in developing countries.	Advanced research, education and training needed. Under primitive conditions and variable feed, process is very slow and needs a new bacteria to speed up process. Therefore, stable feed content of homogenous type is needed for rapid process.

BIOMASS CONVERSION TECHNOLOGIES (continued)

Route and state-of-the-art	Impacts	Potential	Problems
Biological conversion			
1. Ethanol fermentation Commercial plants are available at small to medium scale.	Suitable only for countries with surplus grains and sugar. Competes with food production. Therefore relevant to very few developing countries.	It provides a high quality motor fuel or additive. Residuals can be used as animal feed.	Food/energy competition. High investment cost. Sophisticated process requires highly skilled personnel. Could give rise to problems of alcoholism.
2. Lignocellulosic fermentation.			
(a) Acid. Commercially available. Generally linked with large-scale pulp and paper production and timber industry.	Specially suitable for countries with a forestry industry. High potential.	As with ethanol fermentation, may cause environmental pollution. Production of lignin which can be used as a fuel or chemical feedstock.	High investment cost. Medium to large-scale. Limited to industrial plants. Corrosion problems in processing vessels.
(b) Enzymes. At laboratory research stage. Potentially very efficient in terms of energy efficiency and use of raw materials.	Opens up new ways to produce ethanol from ethanol from forest woods, preferably in conjunction with forestry industry.	Will expand the possibilities to produce ethanol from forest wood.	Highly-skilled R and D is required. Cost-intensive. Needs advanced way to decompose the wood into cellulose and lignin prior to enzyme treatment. Low capacity of the enzymatic reactions.

New technologies for separating the ethanol from the water-ethanol mixture produced in (a) and (b), such as membranes and adsorbents technologies, are at the R and D stage. These technologies are very promising alternatives to fuel-consuming distillation processes.

PHOTOVOLTAIC CONVERSION

Route and state-of-the-art	Impacts
Photovoltaic conversion utilizes semiconductor-cells for conversion of solar radiation to electricity. First generation technology is available commercially. New concepts leading to low-cost-levels are at the R+D stage, but at a very high cost per unit of electricity produced.	If the electricity cost is reduced several-fold (including cost of energy storage) this route could have an impact on electricity production in rural areas, and in the longer term in urban areas. Links strongly with new materials and manufacturing technology.

Potential	Problems
High potential. Solar radiation is usually abundant in developing countries. Conversion efficiencies are projected to reach 100-300 W/m2 on a sunny day.	High-technology is needed to produce the necessary purified raw materials for cell manufacture. Production costs high in the short to medium term (US dollars 10/W peak). Since electricity production is proportionate to incidence of solar radiation, electric-storage is necessary for loads such as refrigerators, radio transmitters, household lighting, but not for irrigation pumps, desalination plants, and some other applications. The cost of system compatibility, storage and support components is not assumed to be significantly lower.

C. Suggestions for action

8. The actions which should be taken are complex and multidisciplinary, therefore it is essential to take into account the ongoing and future developments of each of the component disciplines.

National level:

- Promote wider application of improved methods of direct burning of fuel-wood and charcoal production;
- Public awareness and information programmes relating to new energy technologies;
- Strengthening of education in the relevant areas in universities, schools and training centres;
- Identification of those biomass-energy and photovoltaic technologies for which the country has a relative advantage;
- Adaptation of existing local manufacturing plants for the production of equipment for biomass-energy and photovoltaic energy conversion;
- Provision for local R and D and manufacturing capability in selected and appropriate areas of biomass and photovoltaic energy conversion.

International level:

There are a number of options for international action relating to biomass energy technology, for example, establishing:

- An International Centre for biomass technology covering all aspects from production to utilization;
- Centres of excellence in selected developing countries;
- Links between and R and D bodies in developing countries and developed countries;
- Worldwide and regional network of research institutes working in the field;
- Monitoring and information system for advances in the various technologies concerned.

The role of UNIDO and other relevant United Nations agencies:

- To actually assist developing countries in the field of new and renewable energies for industrial application;
- To provide information on advanced energy technologies and low-technology based on scientific approaches;
- To set up special funds for financing of research and development and demonstration in the field of new energy technologies;
- To assist in promoting co-operation for R and D programmes between developing countries and between developing and developed countries.

D. Background reports reviewed by the Working Group.

"Implications of biomass-energy technology for developing countries" prepared by the UNIDO secretariat (ID/WG.384/6).

"Emerging photovoltaics" prepared by the UNIDO secretariat (ID/WG.384/2).

"Possibilities and limitations of utilization of renewable sources of energy" prepared by Y.V. Sinjak and M. A. Styrikovich.
A summary of this paper, "The global energy situation and strategies of energy development in the next 20 years" follows.

The Global Energy Situation and Strategies of Energy Development in the next 20 years

1. The energy supply of major world regions will remain one of the most pressing problems for the next 40-50 years. At present the level of global energy consumption is largely determined by the industrially developed countries whose share accounts for over 80 per cent of global energy consumption. However, by 2000 it is expected that about one third of the world energy will be consumed in the countries currently belonging to the group of developing countries. By 2025 this share will grow up to 50 per cent and by the end of the next century approximately two thirds of the energy consumed will be in this group of countries. At present the solution of the problems of energy supply creates certain difficulties in some developing countries, particularly in rural areas, where deforestation had had a disastrous impact not only on energy supply but also on food supply due to increased land erosion, desertification, soil salinity, etc.

The shift of the weight of energy problems from the developed to the developing countries in the next 50 years poses quite new problems of socio-economic reconstruction of the world, the solution to which should be sought now.

2. Different trends in the growth of prices for various energy carriers have led to a change in the priority of energy technologies. At present, the cost effectiveness of individual solutions proves cardinally different from those options which were available in the world up to the mid-1970s and it was during that period, lasting almost a quarter of a century, when the main part of modern energy systems was formed.

All this necessitates reconstructing the established pattern of the world energy system. It is extremely important to correctly assess an optimal structure of energy balance corresponding to prospective prices of individual energy carriers though the pattern of reconstruction will be different for the developed and the developing countries (and partly for moderate and hot climates). Transition to new technologies of energy production and utilization should be regarded within the reconstruction framework together with other actions.

3. World energy development and the world energy market in the next 10-20 years will be greatly influenced by the world oil market. The current situation in the world oil market leads to the conclusion that world oil prices for the period 1990-2000 will be considerably lower compared to earlier projections of 1979-1980. By 2000 world oil prices are most likely to range from 45 to 55 dollar/bbl (in early 1982 dollars) but not to double, as predicted earlier.

This conclusion is extremely important since for a long time the growth of oil prices will determine the rate of the reconstruction of the world fuel and energy balance in the first place by reducing the share of liquid fuel. Now it has become clear that this circumstance will put off economically justified wide-scale transition to alternative sources of energy and oil substitutes beyond 2000.

4. In the future, the energy supply of developed countries and urbanized areas of developing countries will be determined by the possibility of liquid fuel being replaced by available and less expensive sources of energy (coal, natural gas and nuclear energy) as well as by the introduction of energy-saving technologies. On the whole, these measures will be based on the centralized systems of energy supply requiring heavy investments (in the developed countries, their implementation will aim mainly at saving labour).

The future of the world energy system, first and foremost, will be characterized by higher rates of electrification of energy balance than occurred in the past.

At present, for virtually any large consumer using high-temperature heat in a base-load pattern, electric energy substitution for liquid fuel appears economically justified in all regions. That is why new high-temperature technological units should be based on electric heating. Railway electrification will proceed at higher rates. Low-temperature heat supply to scattered consumers, based on heat pumps, will prove more cost effective. The role of energy consumer-regulators capable of operating on off-peak energy will increase.

Taking into account the leading role of electric energy one should expect the most significant changes in this field. At present the base-load part of the electric load curve will be met, to an ever increasing degree, by coal-fired or nuclear base-load electric plants. To cover peak or semi-peak load, it is expedient to use hydropower plants as well as special storage systems - hydro storage power plants in mountainous regions, and air storage power plants, with gas turbine units, in flat country.

In urbanized areas, it is expedient to use centralized heat supply from large heat-generating units with combined heat and electric energy production. Gas or liquid fuel are usually used as fuel for co-generation units, though in the future the use of coal and nuclear energy will appear more cost effective.

5. The solution of socio-economic problems of providing rural communities of the developing countries with acceptable living conditions is inevitably connected with a rise in energy consumption which in its turn is hampered by the lack of capital. The solution of the problem of energy supply for the developing countries must principally differ from that for the developed countries, that is, options must be as cheap as possible, must provide maximum employment, be compatible with traditional lifestyle, cultural traditions and customs.

Hence it follows that in rural areas it is necessary to orientate toward small (local) sufficiently simple plants which can be manufactured and served by indigenous personnel instructed properly. Until recently the basic requirements of these areas were met by the so-called non-commercial (conventional) energy resources: fuelwood, charcoal and agricultural wastes. At the same time fuelwood remains cheap only in forest regions. So the search for ways of reducing wood consumption is a task of the highest priority for many developing countries.

This can be achieved by:

- improving the efficiency of fuelwood burning in conventional (domestic) wood stoves and, in many parts, in open fires;
- limiting the use of fuelwood by using other indigenous energy resources as its substitute (small-scale coal, lignite and peat deposits, agricultural and municipal wastes, etc.);
- increasing fuelwood resources through afforestation.

The above options of wood substitution and of increasing fuelwood resources do not exclude one another but are complementary. They should receive paramount attention in the government programmes of the developing countries as well as in programmes of rendering assistance adopted by international organizations.

While considering the problem of energy supply in rural areas of developing countries one cannot help mentioning the ways of electrification of the rural areas. The solution of this task will be different from that one accepted by centralized systems of energy supply.

The following technologies oriented toward meeting domestic energy needs should be regarded in the first place as alternatives to diesel fuel in decentralized systems of energy supply widely used in rural areas now.

These technologies are as follows:

- mini-hydropower plants on small water flows with a capacity ranging from a few kilowatts to a few megawatts;
- gas-motor electric plants operating on producer-gas and mobile units burning coal, peat, wood, dry agricultural wastes;
- wind electric plants, in some regions with favourable conditions with regard to wind velocity (mainly coastal regions);
- solar photovoltaic converters, though these technologies can be spread on a wide scale only in case specific investments are reduced by about an order of magnitude. Wind and solar electric plants need energy storage or back-up generating units that substantially increase the electricity cost generated by them.

Thus, the above technologies of decentralized electric energy generation can successfully compete with diesel electric power plants virtually in all parts and climatic zones of the world.

Working Group Report: POLICY ISSUES

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A. The context of new technological advances

1. The world is in a period of transition towards a new set of emerging or advanced technologies, many of which can be considered as "breakthrough" in the sense of leading to improvements in existing practices and techniques greater than the gradual improvements that characterize the normal evolution of technologies. The outstanding examples are genetic engineering, microelectronics, new materials, etc. which are the result of scientific discoveries related in particular to the internal structure of matter, cells, etc.

2. These technical advances have taken place in a conducive social, economic and political environment, and also in the context of government policies that have assisted the emergence of new technologies in a few highly industrialized nations. The roles of the private and public sectors, and that of the "pull" of market forces and the "push" of scientific

discoveries, has been different in specific sectors and countries, but it should be noticed that in all cases direct or indirect government policies have played an important role in fostering these advances.

3. The context prevailing in the few industrialized nations where these advances are taking place is rather different from that prevailing in the great majority of developing countries at present. The socio-economic context and government policies of many developing countries are not conducive towards significant technological progress, which makes it necessary to introduce changes and adjustments in the existing set of policies so as to be able to take advantage of the opportunities provided by advances in technology. However, in no way should their need for policy changes be interpreted as suggesting that developing countries should imitate the policies or the style of development of the highly industrialized nations.

4. Furthermore, a process of integration and cross-fertilization is under way among different groups of advanced technologies, with areas of application beginning to overlap. Taken as a whole, the combined first and second order effects of those technological advances are creating new opportunities for social and economic progress in all countries. They may provide the basis for different styles of development, new ways of organizing economic activities, and the (possible) use of underutilized natural resources, and this could alter significantly the world distribution of economic and social activities in the coming decades. For example, it has been estimated that the new technologies will in one way or another affect the sector that accounts for well over 65 per cent of the value of industrial production of developing countries.

5. However, these new opportunities may be limited and curtailed by the reproduction and extension of the existing market structures for technology which would put new technologies under the control of a few economic agents at the international level. It has been

reported that small independent companies that played a significant role in the development of many techniques in the field of micro-electronics have been absorbed by large corporations that have extended and consolidated their market position as a result.

6. There is a need for determined action at the national and international levels to preserve the possibilities of using and mastering the new technologies by all countries, so that the extreme degree of technological dependence that characterizes present technology markets could be avoided, at least by those developing countries that make an effort to establish their own capabilities and gain access to technological advances. However, preserving these options requires immediate action, for advances are proceeding at a rapid pace, market structures are shifting constantly in a direction unfavourable to the third world, and developing countries may see their opportunities rapidly closed as a consequence of inaction and hesitation.

B. Development objectives and technological advances

7. Developing countries have as general objectives: increasing the welfare of their population, achieving equity in the distribution of benefits derived from economic growth, and making more efficient use of their resources. However, there is a variety of ways and many possible approaches to the achievement of these general objectives, and each country places emphasis on different specific goals and roads to the achievement of these general objectives.

8. In spite of this diversity of ways and approaches, there is at least one common feature to all developing countries: at the close of the twentieth century it is impossible and even dangerous to disregard scientific and technological issues in the design of development strategies. If autonomy in the choice of objectives and the capacity to achieve them are valued, it becomes imperative to count at least a minimum level of technological capabilities in the problem areas and fields of importance to the development strategy.

9. The fact that there have been significant technological advances in the highly industrialized nations, and that they present opportunities that are in many senses unique for the third world, does not mean that developing countries must follow blindly the high technology path opened by the industrialized nations. There are many difficulties and pitfalls associated with the acquisition of capabilities in advanced technology fields. High technology is not an escape route to the problems of underdevelopment, and there is no hope of making a reasonable start in the fields of advanced technology unless basic capabilities in more general areas of modern science and technology are established. This requires significant investments in human resources at the technical and scientific levels; the establishment of a basic institutional infrastructure, and the provision of financial resources in a significant and continuous fashion. Furthermore, it is necessary to avoid the mirage of concentrating excessively on high technology options, focusing rather on the whole range of available technological options, from traditional to advanced, and learning to manage the "technological pluralism" that would be adequate in the light of the objectives possibilities, and limitations of a particular developing country. Special attention should be given the difficulties faced by the least developed countries, either in terms of income or of scientific and technological capabilities, for advances in high technology may be combined with traditional or conventional technological practices in unique ways that may be better suited to achieve their development objectives.

10. From a scientific and technological point of view, the first task should be to build a minium level of endogenous capabilities in fields and problem areas of key relevance to the development strategy of the country. At the same time, it must be realized that the establishment of these capabilities requires that several measures be taken - not only in science and technology policy - but also in related areas such as education, industry, finance, foreign trade, general economic policies, etc. These measures should create the basic conditions for the generation, importation, adaptation and use of technology in a continuous and self-reinforcing fashion.

Furthermore, taken as a whole, these measures would amount to significant transformations in the social and economic structure of most developing countries.

11. Another issue that must be kept in mind is that technological advances, and the products these new technologies generate, introduce changes in values, consumption habits, and even ways of thinking. These changes may be negative, as in the generalization of patterns of consumption linked to high income levels; or positive, as in the possibilities they create for decentralization of economic activities and decision-making. Developing country policy makers should be aware of the cultural, social and political changes that may be induced by the introduction of new advanced technologies.

12. In short, the high technology option should be considered as one key possible component of a country's development strategy, and must be an integral part of a broader technology policy that encompasses all levels of technology, according to the objectives, resource base, and existing capabilities of a given country. While considering this high technology option, the pitfalls, if any, associated with it should be identified, exploring at the same time new paths to the integration of technological advances into the design of development strategies and plans, and the definition of policies for scientific and technological development in general.

C. Policy Guidelines and Recommendations

13. The remarks in this section refer primarily to high or advanced technologies, but this does not mean that the other components of the technology spectrum are of less importance to the developing countries.

14. Policy-makers in developing countries should be aware of the need for a selective and differentiated approach to the formulation and implementation of technology policies in the different groups of

advanced technologies. There is no unique set of policies appropriate to fields as varied as genetic engineering, microelectronics, and photovoltaic energy conversion, and the specific scientific and technological features of each field introduce constraints into the policy-making process. However, while acknowledging these differences, interactions and cross-fertilization should be taken into account, as well as the need to design and put into practice policies to develop a common foundation of scientific and technological capabilities for all fields. Furthermore, the selection of fields to concentrate efforts should be made in the light of development objectives.

15. The particular characteristics of individual developing countries impose the need for different treatments at the policy level. Factors such as size of the country; the existing level of technological capabilities; the economic strengths and weaknesses; and the resource endowment will influence the content of policies to develop scientific and technological capabilities. However, one common characteristic to all developing countries is that development of these capabilities in the advanced technology fields will only come about as a result of deliberate government intervention, and these policy intervention measures must encompass not only specific science and technology activities, but the broader spectrum of economic, social, educational and even cultural policies, so as to make them congruent with the development of advanced technology capabilities.

16. A decision of fundamental importance for each field of technology refers to the level of capabilities that should be developed, and these levels may vary from one field to another. At a minimum level there is the capacity to adapt and absorb technology; while at a more substantive level, there is the capacity to generate the advanced technologies. There is no necessary linear sequence that should be followed in progressing from the first to the third levels, for it is possible to acquire and establish directly the capabilities to generate advanced technologies, particularly in some areas of the biotechnology field. Furthermore, the specific content of each of these levels must be reinterpreted for a particular group of advanced technologies, and

policies must be adopted with regard to the levels of capacity development in each case.

17. When referring to technology policies for individual activities linked to new advances in technology, it is necessary to consider at least four lines of action that refer to: the generation of technology; the importation of foreign technology; the absorption of technology by the productive sector; and the promotion of demand for local technology. These four lines of action will serve in different ways in the diverse advanced industrial technology activities in order to achieve the levels of capability described in the preceding paragraph. Two complementary lines of action refer to the information and training aspects that are common to the generation, importation, absorption and demand for industrial technology.

18. The design of policies to acquire high technology capabilities should take into account the level of resources required for this purpose. In so far as possible, detailed assessments of human resource requirements should be made (at the scientific, technical, support, industrial and policy-making levels); the infrastructure requirements should be specified (institutions, services, equipment, materials, facilities, etc.); and overall estimates of financial requirements must be made, so as to base the strategic decision to develop technological capabilities on a firm basis. However, the very nature of the new technological advances, and the uncertainties associated with them, make the precise estimation of these parameters a nearly impossible task, and there is a need for improving methodologies for assessment, and project evaluation, procedures to take these uncertainties into account. But in no way should this need for improved methodologies and procedures be considered as an excuse to delay making the crucial decisions that are required at present, if the opportunities presented by technological advances are to be grasped by the developing countries. Time pressures to take advantage of the present situation and opportunities in the new technologies preclude a leisurely approach to the development of methodologies and to decision-making with full information and minimum uncertainty.

19. The integration across fields, levels of technological capacities and lines for technology policies will provide an overall strategic perspective for the policies referring to high technology fields. The strategy adopted should confine the definition of priorities and the continuity of efforts in a particular field, with flexibility and the capacity to react quickly to new developments and changes in technology. A key component of any strategy and set of policies to deal with advanced technologies in developing countries will be the dimension of international co-operation, particularly co-operation among developing countries. In this regard the example of the International Centre for Genetic Engineering and Biotechnology (ICGEB) is one that should be closely followed with the aim of extending its approach to international co-operation into other areas of interest to the developing countries.

20. Policy makers should also be aware that to do nothing or to delay decisions with regard to the acquisition of advanced technology capabilities, constitute in effect an implicit strategy that will succeed only in deepening and strengthening their present degrees of technological and trade dependence on the industrialized nations. Possibilities would be wasted and the opportunity costs for developing countries are very high. Moreover, it must be realized that successes in mastering advanced technologies will also enhance capabilities in conventional modern technologies and in traditional technologies.

21. Finally, policy-makers should also be aware that the establishment of advanced technology capabilities is a viable and concrete proposition, not a utopian dream or a goal out of reach. These capabilities are being acquired by some developing countries and in many areas do not involve huge investments in financial or human resources. Furthermore, if developing countries do not acquire those capabilities, that are within reach, in the near future they will end up by buying the products of these technologies from the industrialized nations, or by importing the technology wholesale in a packaged form, repeating and reinforcing the technological dependence patterns that have characterized North/South relations.