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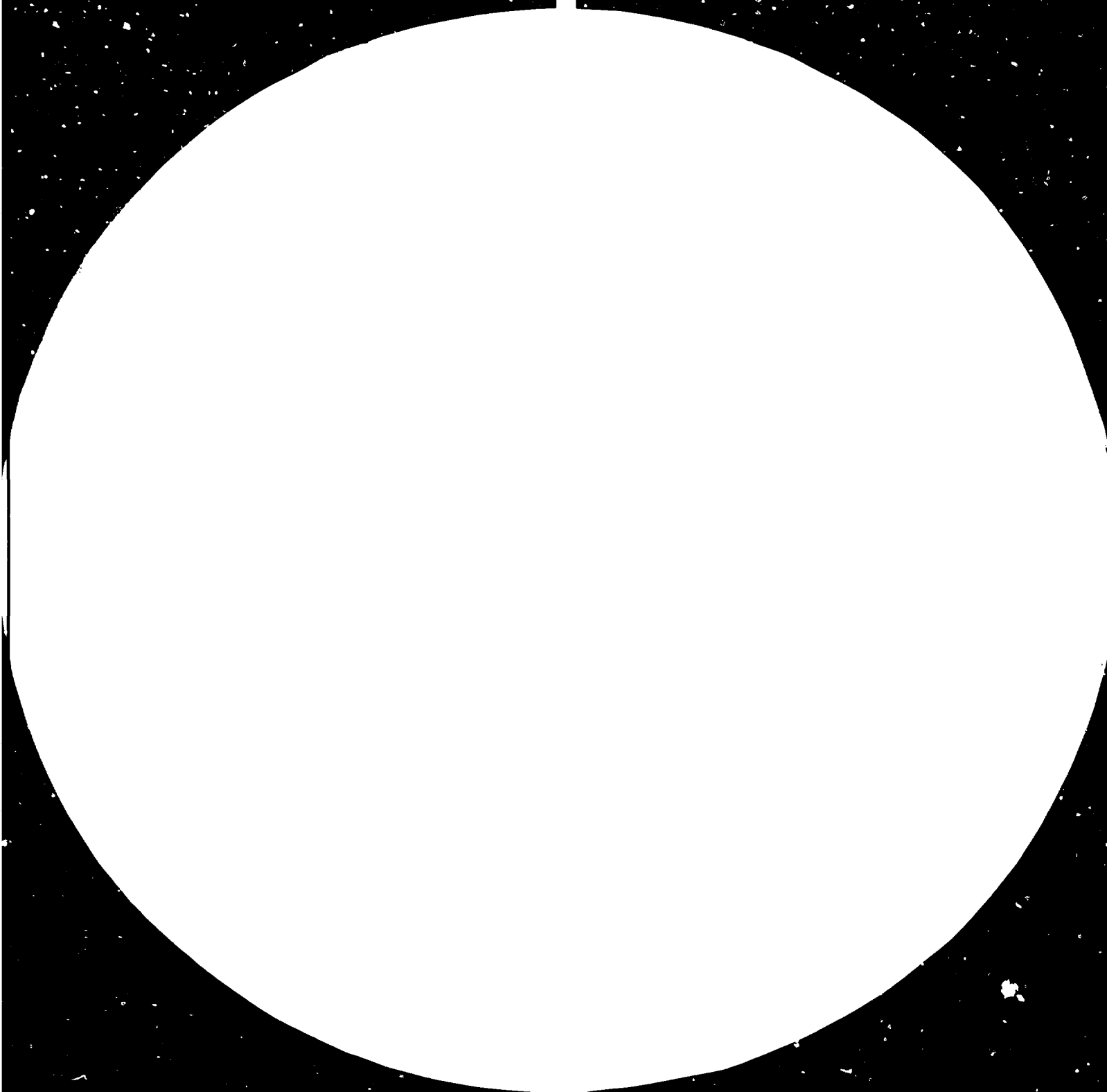

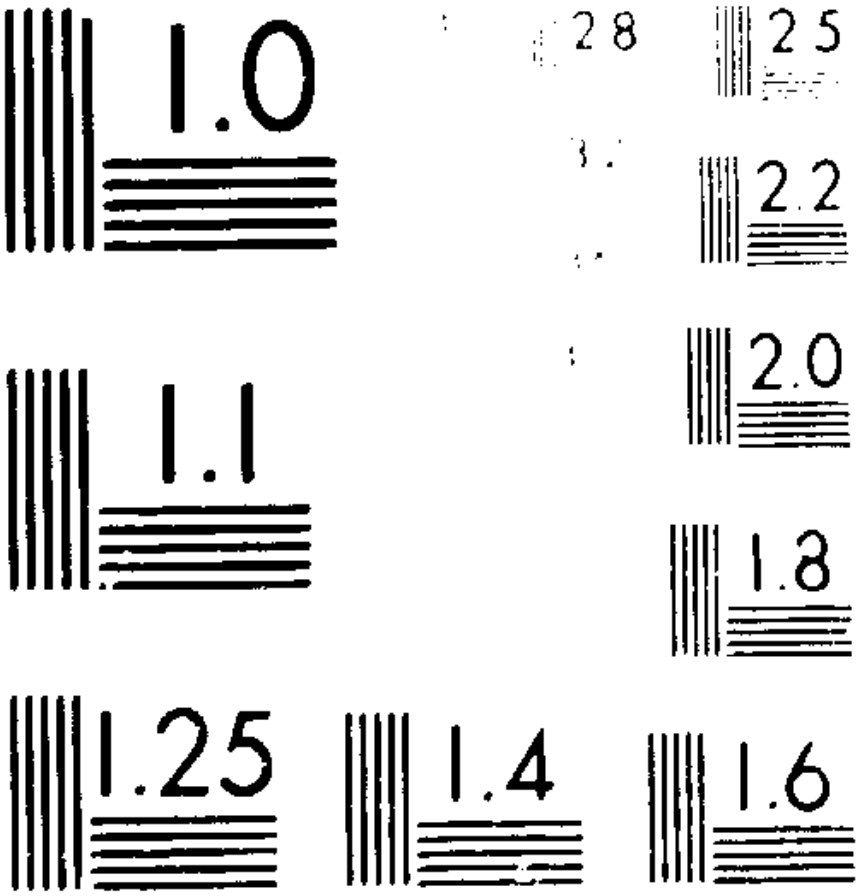
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

HIGH-LEVEL EXPERT GROUP MEETINGS PREPARATORY TO THE FOURTH GENERAL CONFERENCE OF UNIDO

International Forum on Technological Advances and Development

Tbilisi, USSR, 12–16 April 1983

REPORT: Forum on technological advances and development.

Contents

INTRODUCTION

1. The International Forum on Technological Advances and Development, being one of the High-Level Expert Group Meetings Preparatory to the Fourth General Conference of UNIDO, was held at Tbilisi, Union of Soviet Socialist Republics (USSR) from 12-16 April 1983 in co-operation with the USSR and Georgian State Committees for Science and Technology. The list of participants is given in Annex I and the list of documents in Annex II.

2. The objectives of the Forum were:

(a) To examine the potentials and limitations of selected technological advances for the industrial and economic development of the developing countries, in particular their industrial development;

(b) To consider the implications of technological advances in their interaction with one another and their impact on industrial and other sectors;

(c) To identify ways and means by which specific industrial and technological capabilities may be developed by the developing countries in order to be able to avail themselves of the benefits of the advances, where appropriate and feasible;

(d) To identify policy actions to be taken by the governments of developing countries including ways of integrating policy responses to technological advances with their existing policy framework for industrial and technological development;

(e) To identify the lines of international action and in particular action by UNIDO;

(f) To make suggestions and recommendations for consideration by the Fourth General Conference of UNIDO (UNIDO IV).

3. The Forum was opened by Dr. Abd-El Rahman Khane, Executive Director of UNIDO, who drew attention to the fact that the nature of technology and the way it is applied, critically affect the development process itself and human development in general. The challenge of advanced technologies for the developing countries is most evident in the case of industry which is where the first order impacts of technology are being felt and which is often the carrier of change to other sectors of the economy. In approaching the question of technological advances, the human being must continue to remain at the centre of our concern both as the user of technology and as its beneficiary.

4. Some eight years ago at the Second General Conference of UNIDO held at Lima, developing countries expressed their aspiration to achieve a minimum of twenty five per cent share of world industrial production by the year 2000. To this target is added the new dimension of technological change which will affect the rate and pattern of industrial production. There is emerging a perception of the interaction of industrial and technology policy. More than ever strategies of industrialization and development in general will be ineffective if they do not take into account technological advances. Dr. Khane stressed the need for developing countries to strengthen their technological capabilities and to motivate, educate, upgrade and improve human resources. In this connection he reiterated an appeal he made to developing countries at the Seventh Conference of Heads of State or Government of Non-Aligned Countries at New Delhi in March 1983. He had appealed to the developing countries to invest at least 2 per cent of their GNP, or even more, in scientific and technological education if they are to reach or come closer to the Lima target of world industrial production.

5. Dr. Khane stressed the importance of the integration of technology issues with other important policy issues for industrialization. This would provide an integrated theme and a medium and long-term setting for the deliberations of the Fourth General Conference of UNIDO. He expressed the hope that the Conference will facilitate the reorientation of perceptions and the revision of industrial strategies. An understanding of the new technologies and the development of a capability to use them to advantage lie at the core of the development strategies of the future. To help developing countries build such a capability should be the major aim of international co-operation in a changing world. This meeting, as well as the other four preparatory meetings of UNIDO IV, will facilitate an in-depth examination of each subject area, the definition of issues, identification of common approaches and formulation of action proposals for consideration by the Fourth General Conference of UNIDO.

6. In his address to the Forum, Mr. O.E. Cherkesia, Vice-Chairman of the Council of Ministers of the Georgian Soviet Socialist Republic, stressed the fact that technological advances present humanity with a number of important tasks which need immediate action. Experience shows that the progress of any country is closely connected with the full and rational utilization of its natural resources and manpower. This progress is achieved by means of socio-economic transformation which help to strengthen the real independence of the country. There is no doubt that the problems of industrial development, agriculture, urbanization, ecology etc. must not be dealt within a narrow technological frame based only

on today's needs. Mr. Cherkesia gave a brief account of social, educational and industrial progress achieved by the Georgian Soviet Socialist Republic. He hoped and believed that one of the tasks of UNIDO was to formulate long-term and practical measures aimed at directing science and technology to human needs and ideals.

7. Academician J.M. Gvishiani was elected Chairman of the Forum and in his introductory statement called the attention of the participants to the main conclusions of the preparatory meeting of the Forum held in Moscow. He stated that all mankind, including the developing countries, can and must successfully employ the latest advance of science and technology such as microprocessors, biotechnology and new types of materials for creative purposes, for the solution of complex problems of social and economic development. The outstanding achievements of modern science and technology should be employed for the purpose of peaceful development; their application should not be a monopoly or privilege of industrially developed countries, but should serve the purpose of development of newly independent countries. This would require the creation and strengthening of the scientific and technological capability of developing countries. The developing countries could employ the entire range of available technical means and technological processes including the conventional ones, depending on specific conditions of a particular country, availability of capital for high technology production, conditions with regard to employment and availability of skilled work-force. Not being an end in itself, scientific and technological progress must be accompanied by socio-economic progress and by necessary social reforms and economic changes. The task of the Forum is to explore the potential opportunities provided by the latest directions of scientific and technological progress, and the probable impact of their utilization on social and economic development.

8. Mrs. O.M. Lipede, Mr. H. Mayagoitia and Mr. U. Svedin were elected as Vice-Chairmen of the Forum and Mr. S. Jirapongphan was elected Rapporteur.

9. The Provisional Agenda of the Forum was adopted.

10. Mr. G.S. Gouri, Director, Division for Industrial Studies of UNIDO, explained the background to the Forum and its purpose. The International Symposium on Trends and Perspectives in the Development of Science and Technology held at Tallinn, USSR, in January 1979, and subsequently the United Nations Conference on Science and Technology for Development held at Vienna in August 1979, had drawn attention to a number of rapidly developing fields in science and technology which will have significant impact on the longer-term development problems which will face humanity in the years ahead. In view of this, the UNIDO Secretariat initiated

a programme on technological advances to sensitise developing country policy-makers and to assist the developing countries in formulating policies and strengthening capabilities in relation to the technological advances. The Forum would serve to consolidate and take stock of the experience gained through UNIDO acitivities and also to provide inputs to the Fourth General Conference of UNIDO so that the issue of technological advances could be linked to the overall issues of industrialization and its prospects. This was necessary because some of the frontier technologies have assumed a new dimension in the industrialization efforts of developing countries. The results of the Forum would not only provide inputs to the agenda item for the Fourth General Conference on the subject of technology but also provide an important background to the overall discussions in the Conference. The results would also be relevant to the other preparatory meetings for UNIDO IV on the subjects of industrial strategies and policies, human resources development, energy and industrialization and industrial co-operation among developing countries.

11. The Agenda of the Forum and the documentation thereof were designed to help the development of a general perspective on technological advances based on an examination of several specific technological advances and their potentials and implications for the developing countries. Thus, the specific technologies examined were: genetic engineering and biotechnology, microelectronics, petrochemicals, renewable energy with specific reference to biomass and solar photovoltaic energy and materials and related technologies. Based on the examination of those advances, an attempt should be made to make an assessment of the combined impacts of such technologies on each other, on the industrial sectors and the international technology market structure. The experience of policy response to technological change in several developed and developing countries was also considered relevant for the developing countries in formulating their own approaches.

I. CONCLUSIONS AND RECOMMENDATIONS

12. In the different development strategies pursued by countries, there is a common recognition, with varying degrees of emphasis, of the central role of technology and the fact that it critically affects the development process. It is the unanimous view of the Forum that the impact of the emerging technological advances on development should be reviewed because of the inevitability of their diffusion in an interdependent world economy and because of their wide ranging impact, intensity and convergence. While the first order of impacts are and will continue to be felt in industrial development, the second and further order of impacts will have significance for the society and life styles of the people of the world. The technological

advances contain several features which have s significant potential for the development process in all countries including in particular the developing countries. The current concerns on the rate and pattern of development make it all the more necessary to find ways and means of applying the technological advances in a manner which will benefit the development of all countries and in particular the developing countries. Those advances could help the developing countries in leap-frogging some of the hurdles inherent in their traditional approaches to industrialization, agriculture, health delivery , social services etc. The advances have therefore a potential and a relevance for developing countries and are feasible of application. The opportunity cost for developing countries of overlooking the technological advances is high, both in terms of acquisition of inappropriate technologies and the aggravation of their technological dependence.

13. There is a need for every developing country to take concrete actions of both a short-term and long-term nature. Short-term actions would include forecasting and assessment of the socio-economic impact of technological advances, careful choice of technologies and equipment to be imported, and a strengthening of the negotiating capability for their acquisition. Long term actions will call for imaginative attempts to apply the technological advances for improving the standard of living and upgrading the general technological level of the population as a whole. Taken together, such responses should be made as a strategic activity involving, where necessary, structural changes in the industrial and economic development of the country but weaving them into the development vision of each country. It is recommended that developing countries consider establishing appropriate mechanisms individually or collectively to forecast, monitor and assess technological trends and their implications for social and economic development and develop, formulate and implement policies to maximise the potential benefits of the new technologies and to avoid their adverse consequences. Such an assessment should be an important input to industrial, technological and general development planning and the formulation of industrial, technological, commercial and fiscal policies and in decision-making on industrial projects. Such information should also be used to see how far the new technologies could be used to revitalize the development process in critical sectors.

14. It is also recommended that developing countries integrate their policies in regard to technological advances with the overall economic and technological policy. To enable such an integration it is recommended that the UNIDO

Secretariat should formulate guidelines for the consideration of developing countries on possible approaches, methodologies, models, and feasibility of alternative points of entry and targets.

15. It should be remembered that high technology cannot be thought of as an escape route from the problems of development, nor can the developing countries follow blindly the high technology path opened by the industrialized countries. High technology options have to be placed within the range of available technology options from the traditional to the advanced. Developing countries may have to adopt and manage a technological pluralism that will be optimal in the light of the objectives, problems and limitations of each country. High technology should also be used not only to start feasible new industrial activities but to upgrade the general industrial and technological capability of the country including its traditional and/or decentralized activities. Such application could result in advantages such as the elimination of human drudgery, prospects for substantial increases in productivity, decentralization of production and marketing and better quality control.

16. In considering the process of integration, it should be remembered that developing countries already suffer from weaknesses and shortcomings in regard to technology transfer and development. In the context of the emerging technological advances, it is recommended that developing countries individually and collectively, examine their existing state of technological capabilities and take steps to create or re-orient their institutions and structures as necessary and appropriate to respond to technological change in accordance with their own objectives and conditions. The application of technological advances requires significant investments in human resources in the field of technical and scientific development, the establishment of a basic institutional infrastructure for acquisition, research and development and the management and utilization of technology and the provision of internal and external financial resources in a significant and continuous fashion.

17. No uniform prescriptions should be sought or applied for countries at different levels of development nor indeed for each type of technological advance. It is recommended that each developing country follow a selective and differentiated approach in the light of its development objectives and present economic, social and technological situation. It will have to decide for itself the level of capabilities it wishes to acquire in the field of new technologies and in regard to the development or utilization of each technological advance. It is however suggested that each developing country give consideration to acquiring a minimum

level of capability in regard to important technological advances. Apart from the newly industrializing developing countries, the case of small developing countries in the early stages of technological development should be given special attention by their respective governments. Such countries would also need to possess the same degree of technological awareness as other countries, in an interdependent world economy. In regard to acquiring capabilities in selected areas of technological advances and the application of those advances, they may have to follow initially a selective policy in accordance with their priorities. A minimum programme in this field may include awareness; monitoring; assessment; strengthening the capacity for selection and acquisition of technology and equipment; capabilities to apply the technologies; and other elements needed to facilitate autonomous decision-making. It is recommended that the UNIDO Secretariat develop guidelines for a framework of national actions, particularly for the use of newcomer countries enabling them to take decisions on priorities; points of entry; degree of penetration; linkages and inputs required etc.

18. Within the context of the foregoing considerations, the Forum wishes to bring to the attention of UNIDO IV that the industrial and technological policies for the 1980s and beyond will have to be framed in the light of the potentialities and implications of the new technological advances. The emerging technologies make it imperative that future industrial policies should be designed keeping fully in mind the structural economic changes likely to be brought about by the new technologies. Industrial development policy in this sense should be viewed as a strategic activity involving, wherever necessary, structural changes. The future prospects for industrialization should be viewed keeping in mind the new dimensions and perceptions that are required in the context of the technological advances. Such perceptions are required in regard to the development of transfer of technology and to the concept of technological dependence itself. A fresh look at human resources development is also required. A new type of technological capability appears to be evolving on the basis of new products, processes and matters of organization of production and other economic activities.

19. The new instrumentalities in this changing situation will be a technology-oriented industrial policy and the systematic incorporation of information, based on socio-economic assessments about technology trends in policy and decision-making. Special attention has to be paid to education bringing it to the level demanded by modern science and technology, In this respect it is appropriate that UNIDO organizes a special symposium on this issue.

20. New mechanisms of international co-operation are also called for. These could take various forms. Firstly, it is recommended that co-operation among developing countries should increasingly incorporate activities relating to acquiring self-determination and technological capability in the field of new technologies. Since the manner in which such new technologies are applied in one developing country will be relevant to other developing countries, the need for co-operation in the exchange of information, consultancy, training, technology transfer, etc. is paramount. Collective negotiation strategies and policy responses could also be considered. The emergence of new technologies and their potentials and implications for developing countries and the challenging task of creating unique developing country applications, require consideration and attention at the highest policy-making levels in developing countries.

21. New ways of strengthening co-operation between developed and developing countries should also be considered. The diffusion of the benefits of the technological advances should be available to and shared by all. Developed countries are asked to give special attention in their programmes of co-operation with developing countries in providing educational and training facilities, research co-operation etc. Technologies must be made available at fair and equitable terms and conditions and they should be adapted to the needs of developing countries. Research on adaptation, application, improvement and further innovation should be encouraged by developed country enterprises functioning in developing countries.

22. It is proposed that a new form of international co-operation be considered with the designation of a limited number of new advanced technologies to meet particular needs of a clear and urgent character to the human community as "Technologies for Humanity". These technologies should be developed and disseminated in the public domain. "Technologies for Humanity" should be clearly and precisely defined so that international efforts can be focused on specific problems until appropriate solutions are found and effectively disseminated throughout the world, especially in developing countries. All nations able to contribute to developing these technologies should be encouraged to do so. The UNIDO Secretariat should work further on the concept of "Technologies for Humanity" and present it to UNIDO IV for consideration.

23. UNIDO should increasingly try to augment its monitoring of key advanced technologies to disseminate the information focused on specific needs of different countries. This will involve intensifying and extending contracts between appropriate agencies and institutions in developing countries, and scientific

and professional societies, universities and non-governmental organizations that are concerned with the developing countries and are based in developed countries. Additional channels of technological information should be tapped including the patent offices and plant variety registries and open proprietary sources of information on new technologies through consulting firms and business information services. Above all else, developing countries may sharpen their requests for technological information through technology planning and industrial strategy groups.

24. It is recommended that the UNIDO programme on technological advances should be expanded and diversified on the lines indicated in the reports of the expert meeting in Moscow and the Tbilisi Forum. In addition, the UNIDO Secretariat should identify and promote new mechanisms of international co-operation in particular for strengthening the technological capability of developing countries and for the development of new technologies of unique interest to developing countries. It is also recommended that UNIDO continue, together with UNESCO and other international organizations, to mobilise the co-operation of high-level scientists and technologists in the world for harnessing the new technologies for the benefit of the developing countries in particular in the field of industrial development and bring the considered views of such experts to the attention of UNIDO IV and other relevant fora.

25. In undertaking such activities in this field, the UNIDO Secretariat is requested to continue to maintain close co-operation with other concerned international organizations in the UN system and outside it.

26. It is considered that the conclusions and recommendations of the expert meeting in Moscow and the Tbilisi Forum provide a sound basis for developing further the activities of UNIDO in this field. It is recommended that the results of the Forum be brought to the attention of the appropriate bodies of UNIDO in the preparations for UNIDO IV.

II. REVIEW OF SELECTED TECHNOLOGICAL ADVANCES

27. The Forum reviewed selected technological advances in the fields indicated in para. 11 above. It noted that those advances had been selected for detailed review as being important to most, if not all, developing countries and as those which illustrated the mutual interrelationship among technologies. Such a discussion was intended to help provide a general framework of consideration on the basis of which the general issues of technological advances could be considered.

28. The Forum noted that the selected technological advances had been reviewed in depth by the preparatory expert meeting in Moscow in working groups. It took note of the observations of the report of the expert meeting and its recommendations. Limitation of time did not permit the Forum to discuss fully all the aspects involved. It was considered that the general approach adopted by the expert meeting in Moscow and its recommendations provided a sound basis for further action. Special attention was however given by the Forum to the overall policy issues arising from the review of the technological advances. The Forum also heard statements from a number of participants on the experiences of their countries and the attempts made by them to strengthen their technological capabilities in the technologies under review.

A. Genetic Engineering and Biotechnology

29. The Forum noted that though fermentation technology was known to mankind for hundreds of years, it was now possible, thanks to advances in microbiology and genetic engineering, to tailor microorganisms to specific tasks. The resultant versatility and efficiency achieved will enable the production of a wide variety of new or significantly improved products in a variety of fields such as pharmaceuticals, energy production, agriculture, mining, etc. It would provide new solutions to the basic problems of food, fodder, fuel and fertilizers. It was therefore important for developing countries to understand and acquire this technology, utilize the processes and revitalize their economies. If appropriately utilized, genetic engineering and biotechnology could open up a new pathway for industrialization. The technology would also be energy-saving, of relatively low capital intensity and easy to apply and lend itself to decentralised applications. It could enable rural industrialization and improve the quality of life. With the adoption of appropriate safety regulations, the technology was not dangerous as was sometimes believed. Thus, it looked as though the new technology was particularly tailored to the needs of the developing countries where the turnover of organic material is high.

30. In the discussion, attention was drawn to the present asymmetry in technological development efforts in this area as between developed and developing countries. For example, from 1977 to June 1980 the patents in various product categories in biotechnology registered by the USSR, USA and Japan amounted to 121, 244 and 1,427 respectively, whereas hardly any patents were registered by developing countries.

31. The Forum agreed that developing countries could not be passive consumers in this area and that they should monitor what is going on and develop their own expertise and establish centres of excellence. Indigenous competence was essential to enable the developing countries to exploit their natural resources and microorganisms, specific to each country. Unless local institutional capabilities are available within the country, there is the danger that the personnel sent for training abroad might continue to stay there and as such no real local expertise could be built. The importance of setting up national groups to work in this area was stressed.

32. The point was made in this connection that the commercialization of R&D was expensive. But the traditional thinking of cost structure has to change, e.g. the new phenomenon is that the development time from basic research to commercial production is much shortened. Similarly, several changes in economic and industrial structures are occurring, e.g. sugar is being replaced by fructose in sweeteners. Furthermore, the production processes do not necessarily demand high cost equipment. It was noted, however, that genetic engineering involved essentially scientific research and the capital investment for genetic engineering as such was not high. Besides, in applications such as in agriculture, the production of a new seed for example will not be an expensive proposition once the basic research is done. Capabilities of countries and the scales of production required and the cost of research personnel also varied from country to country. Development times from basic research to commercial production are getting shorter and the pilot plant production processes do not necessarily demand expensive equipment. The traditional thinking on the cost structure on R&D had to change, particularly when widespread benefits to a large number of people are to be realized. The alternative of transfer of technology also entailed high costs which may be more than the costs of development. The option of transfer of technology also entailed problems of access and suitability of technology. Further industrialized countries may not be interested in developing or using some of the biotechnologies. In any event, the opportunity cost of not developing and applying this technology is very high for developing countries.

33. At the same time, the problems involved in terms of the prerequisites for the introduction of the technology in terms of the infrastructure required should not be oversimplified. Besides, a measure of selectivity is required and each country has to decide at what point of technology development or application it wanted to enter. The matching of education and emerging technologies and the problems of scaling up and types of equipment needed were also necessary.

34. Several experts reported to the Forum on the steps taken by their countries in promoting the development and application of genetic engineering and biotechnology. The Forum noted in this connection that even a small country had a good chance of enhancing its capabilities in this field in selected aspects of technology. (The Hungarian experience cited in the meeting was a case in point).

35. The Forum agreed that ways and means of possible co-operation between developed and developing countries in this field should be identified. There were already instances where some of the developed countries were co-operating with the developing countries in this area. It was suggested that such co-operation be intensified, that interaction between scientists and technologists be promoted and that developed countries should provide to the maximum extent possible the necessary financial resources and education and training facilities for developing countries in this field.

36. A suggestion was made to devise suitable guidelines for technology transfer in this field. Attention was also drawn to the role of payments and the costs involved in the exploitation of the patents. The question had to be considered whether the existing system of patent laws needed to be adjusted to utilize technological advances and to improve access to technologies. There was also a need for improving the terms and conditions of technology transfer.

37. Specific recommendations were made at the expert meeting in Moscow in regard to national and international actions and UNIDO's role (ID/WG.384/16, paras. 114-116)and other suggestions were contained in ID/WG.389/3, paras. 13 and ID/WG.384/4/Rev.1. There was a need to sensitise countries on the potentialities as well as the problems involved in the development and utilization of the technology and the time frames for achieving specific objectives. The Forum noted with appreciation the initiatives already taken by UNIDO in this regard and its efforts to establish the International Centre for Genetic Engineering and Biotechnology and the publishing of the Genetic Engineering and Biotechnology Monitor. UNIDO should continue to assist all countries at their request and also undertake promotional activities, it should pay particular attention to assisting newcomers, particularly the smaller ones in acquiring a greater awareness of the potentialities of the technology and the ways and means of developing a capability in this field. UNIDO should also make an effort to demonstrate that a systematic utilization of the potential of genetic engineering and biotechnology could serve as a powerful introduction to rural industrialization carried through high technology. UNIDO may also take advantage of an offer

made in the Forum to prepare feasibility studies and project reports on processes that have promise for commercialization.

B. Microelectronics

38. The Forum was of the view that the importance and relevance of microelectronics was such that the question was not whether microelectronics should be introduced in the developing countries but how. It is relevant to developing countries in many respects because of its far reaching effects on the productivity of industries, its capacity for simplification of, and imparting flexibility to, manufacturing and industrial operations, its contribution to improvement of the quality and cost-effectiveness of goods for the export market and its strategic value in terms of strategic industries like oil, power, etc. At the same time, a major factor is the direct impact of microelectronics on the quality of life through applications which could improve, for example public health, medical and educational levels in a country. The technology is complex in regard to the manufacture of chips but its application is relatively simple.

39. Currently, there is increasing infiltration of microelectronics-based products into the daily life in developing countries and much of the imported capital goods and other equipment has microelectronics circuitry built into it. Costs of microelectronics components and systems are declining. At the same time, the technology gap between the developed and developing countries in this field is growing. Unless the developing countries take appropriate measures to build up an endogenous capacity, there may be a never ending cycle of imported technologies and dependence on the developed countries, the products and systems as presently developed may not necessarily be relevant to the needs of the developing countries.

40. While microelectronics applications might lead to a reduction in employment in some sectors and cause hardship at micro levels, the benefits to be gained from them are such that the loss of some employment should not stand in the way of their introduction. New employment will also be created in the medium and long-term by the development of microelectronics industry as well as better environment and working conditions.

41. Microelectronics is a multidisciplinary, multi-institutional technology and developing countries have options of several entry points and the degree of penetration, depending on their objectives, needs, resources and capabilities. The options are in terms of applications, manufacture of components and production of software. Applications pave the way for a better understanding of the use of microelectronics and build up the local market. Selective applications could

thus be introduced in the nature of "spot light"applications. Some countries have encouraged such applications in industry through incentives. It is however necessary that applications should be developed and designed locally. Software development is an integral part of the introduction of microelectronics and of particular relevance to developing countries where, with a minimum of effort, considerable capabilities could be built up. As regards manufacture of components, chip design facilities could be developed locally so that custom designed chips for special applications could be developed. The silicon foundry concept should be considered so that even though there may not be large-scale production, a basic understanding of large-scale integrated (LSI) circuitry could be developed and custom designed chips could be produced. The co-operative efforts on a regional basis between developing countries could also lead to the setting up of production.

42. The development of the foregoing capabilities would enable special applications of unique relevance to developing countries aimed at the improvement in the quality of life in fields such as agriculture, health and education. While the developed countries are essentially concentrating on developing applications relating to productivity, instrumentation, applications in steel, cement, power and oil, they may not always be interested in special applications by conscious, positive and deliberate actions within the developing countries themselves. The user involvement is essential in such applications because if the user understood the application, he could indicate what exactly needs to be done, and could help the microelectronics specialist to develop various products and systems. In the interfacing of microelectronics components with the applications, sensors are of particular importance and the developing countries should undertake the necessary development effort for appropriate sensors. Reference was also made to the concept of flexible automation using welding robots with minimum sophistication as being particularly relevant to small and medium-sized enterprises.

43. Attention was drawn to the need for manpower development and innovative measures of training for specialisation in different aspects of microelectronics. Also sensitisation training in microelectronics of specialists in other fields should be considered. Innovative ways of exposing the country at large to the potentialities of microelectronics should be considered, for example by the introduction of microprocessors at schools and through awareness programmes, such that people may accept microelectronics as they do the telephone and the automobile. For this purpose, the flow of information on microelectronics

and its applications could be considerably accelerated and it was recommended that UNIDO, as part of its activities in this field, should promote the free flow of technical information in this subject and also information designed for the public at large.

44. In this context, the importance of the cultural aspects of the introduction of microelectronics should be considered. For example, the ability to handle systems in national or local languages was important and the absence of such a possibility could have important cultural implications.

45. Conclusions and recommendations for action in the field of microelectronics were made at the expert meeting in Moscow (ID/WG.384/16, paras. 107 to 113), and further suggestions were contained in ID/WG.384/5/Rev.1 and ID/WG.389/3, paras. 19 to 36). The Forum considered it necessary for developing countries to set up very quickly mechanisms for monitoring trends in microelectronics technology so that the selection and acquisition could be done in a meaningful manner. Otherwise there could be a never ending spiral of acquisiton of products based on advanced technologies where a minor advance in technology would lead to further imports and continuous clamour by local users for imports. Government purchase policies, fiscal policies, import policies and tariffs must be utilized in an optimal manner to ensure a meaningful acquisition of technology and products. A standardization approach could be used so that further know-how might be built up and efforts could be made for increasing local content. A "menu" approach where such special standard products and chips are given special preference could be used as an incentive for standardisation. Particular emphasis should be placed for co-ordinating microelectronics activities with telecommunications programmes in view of their close interrelation. A nodal co-ordinating agency should be set up in the country in view of the diverse aspects of the micro-electronics industry and its applications and the need for a coherent strategy in the introduction and use of microelectronics.

46. With regard to the impact on employment, it was noted that no satisfactory method of estimating such an impact exists. Work is being initiated by ILO on this matter and other studies on specific applications are being undertaken. It was suggested that studies should take into account the compatibility of the structure of production in the developing countries and the microprocessor applications. But in areas of agriculture, transport, power generation and distribution and health the potentialities and benefits of such applications are substantial. To facilitate this task and to develop necessary software, it was suggested that

a centre on microprocessor applications should be established to serve national and regional needs. UNIDO should initiate steps to explore the possibility of such a centre, taking into account the needs of the developing countries.

47. The Forum underlined the need for co-operation between North and South and particularly among developing countries to promote the establishment of a micro-electronics base for the production and trade of both software and selected hardware, peripherals, etc. in the developing countries and also for training, research, consultancy, maintenance and other activities that are significantly manpower-oriented. In several of these aspects, technical co-operation among developing countries could be regarded as the first option.

48. In view of the importance of this technology, it was suggested that UNIDO expand its current work and evolve a well structured programme taking into account the recommendations of the expert meeting in Moscow. Its Microelectronics Monitor was appreciated and it should increasingly incorporate activities of the developing countries and policy measures suited for developing country situations. The information base on microelectronics applications should be systemised and expanded. The effects on developing countries of the use of some technologies in this field by developed countries (in particualr automation) should be examined by UNIDO.

C. Materials and Related Technologies

49. The Forum noted that it was almost axiomatic that the economic growth of the developing countries required positive programmes of materials development and utilization. The materials discussed by the expert meeting in Moscow, namely high-strength low-alloy steels, fibre reinforced structural composites, powder metallurgy and fillers in plastic materials were clear examples of materials which were characterized by conservation of materials and energy, require inter-action between designers and materials engineers and could be produced on a fully integrated or a partial basis. Reference was also made to newly developed basalt fibres with properties comparable to glass fibres and amenable to processing in several desired forms. These were also inexpensive and had an abundant raw material base. It was however noted that the above categories were intended to serve as examples of a much wider spectrum.

50. While the development of new materials could be the result of "demand pull" or "technology push", the question was raised as to how far developing countries pursue such technological developments. Their concern was on the one hand to

utilize local resources and those materials for which capacity has been established and on the other that the difficulties of their economic situation rendered allocation of resources extremely difficult. It was noted, however, that each developing country, in the light of its own conditions, would be interested in one or more major material groups from the point of view of exports and/or imports or from energy saving considerations. It was therefore necessary for them to be fully informed on the technological developments in the materials field, though the actual manufacture or even the use of specific materials depended on a variety of considerations such as the raw material position, the availability of the necessary quantity and type of energy, existing industry and infrastructure, domestic and export markets etc. In welcoming the preparation by UNIDO of a Materials Monitor as a periodical bulletin, it was stressed that processed information and careful assessments were necessary so as to facilitate decision-making and to form the basis of a materials policy. Attention was required for traditional materials where there are new and better technologies and new materials and related technologies.

51. While stressing that the industrial development policy of developing countries should reflect a "materials consciousness" and take note of technological and other developments in the field of materials, it was recognized that the formulation and implementation of a materials policy as such was marked by considerable difficulties. In general, national material policies are seldom explicitly stated but depend indirectly on an aggregate of various policies, statutes and regulations established for other purposes but, put together, they provide a "shadow" national materials policy. The elements of such a policy would include mining and mineral laws, land use regulations, environmental regulations, import/export regulations including tariffs, investment and tax laws, patent laws, national programme of technical education and training and research and development.

52. In spite of the difficulties mentioned above, it was considered necessary that developing countries follow a selective materials policy based on their own material resources, economic conditions and other factors. Such policies could be implemented at least in the field of public sector purchases and through decisions on use of materials in large-scale national projects. Materials science laboratories and techno-economic assessments and design capabilities related to materials could be strengthened. R&D programmes could pay specific attention to the development or use of materials. In considering the use of various materials particularly arising from new technologies, special attention should be given to relevance and compatibility and the integration of the use of such materials

within a conscious plan. While the recommendations of the expert meeting in Moscow (ID/WG.384/16, para. 117 and suggestions contained in documents ID/WG.384/1/Rev.1 and ID/WG.389/3 paras. 37 to 49) are useful, the question of helping developing countries to develop appropriate materials policy and information systems in accordance with their actual needs, priorities and conditions required further examination. To help developing countries in this respect and provide them with the necessary technological intelligence, UNIDO might examine the feasibility of establishing an international mechanism and promote, where possible, regional co-operation in the field of selected materials.

D. Petrochemicals

53. Petrochemicals were important as they were major and effective contributors to the material-mix of most countries in the form of polymeric materials (plastics, fibres, synthetic rubber and fertilizers). Major shifts in hydrocarbon prices and markets since 1970 have affected the products of petrochemicals. Most of the hydrocarbon deficient countries, and particularly developing countries thus need to examine strategies by which new feedstocks can be introduced to supplement conventional materials.

54. It was noted that assessments of some new technologies, which were in the nascent stage of development in the advanced countries, indicated that they may be vitally important to the hydrocarbon-deficient developing countries. These new technologies were capable of using non-conventional raw materials, such as coal liquids, petroleum residues, synthesis gas and methanol to produce the 6-8 basic hydrocarbon intermediates from which practically all commercially important polymers were made. A major breakthrough in polyethylene production has been achieved through using gas-phase process in producing linear low-density polyethylene (LLDPE). This breakthrough has enabled the production of LDPE with improved quality at lower cost. The cost/performance improvement is now revolutionizing the applications in plastic industries.

55. The chemical industry has changed its feedstocks several times, from ethanol to coal-tar liquids, to coal (during the Second World War) to calcium carbide and later to naphtha and heavy oil fractions. Change of feedstocks have been characteristic of the industry and new materials were considered unlikely to have a traumatic effect.

56. The key "upstream" technologies relevant to developing countries, in a 15-20 year time-frame were: (a) the catalytic cracking of heavy oils and petroleum residues

with metal-tolerant catalysts; (b) the gasification of residues; (c) the production of synthetic gas at low temperatures and pressures; and (d) the production of petrochemicals and polymers from methanol and synthesis gas through zeolite and other chemistries.

57. It was important to recognize that in terms of syngas and methanol technologies every developing country had directly at its disposal, or in a proximate regional context, one or more resources as biomass or natural gas or petroleum residues with which it can have strategic self-sufficiency in petrochemical raw materials.

58. It was noted that ammonia could be produced most economically using natural gas (methane) reforming to CO, CO_2 and H_2. Methane and the reforming gas were also natural products of biomass degradation to biogas. However, the quantities of biogas required for a conventional economic scale ammonia plant (1000 tons/day) would need enormous biogas facilities (including the farming and transport infrastructure) that would not be possible. Therefore, the improvement in the efficiency of smaller scale ammonia production through innovative and process engineering would result in the infrastructural requirement for biogas facilities being kept at a manageable level and thus enable domestic production of ammonia from local biomass resources. This particular aspect is vital to most developing countries since they are primarily agriculture based, therefore producing agricultural byproducts (wastes) as biomass and at the same time require input of fertilizers to sustain agricultural output. Alongside the development of conventional fertilizer products via non-conventional raw material sources, it was also considered necessary to be aware of the development in nitrogen fixation through biotechnology.

59. Recommendations for action were made at the expert meeting in Moscow (ID/WG.384/16, paras. 118 and 119), and suggestions are contained in documents ID/WG.389/2 and ID/WG.389/3, paras 50 to 52. Developing countries may undertake the development of the necessary technologies, depending on their resources or national economic strategies at the national, regional and/or international levels, involving, where feasible, R&D collaboration with advanced countries, particularly in the form of development consortia. For such effort it was considered necessary that organizations such as UNIDO should sensitize developing countries, render consultative services to them and sustain interest through periodic appraisal of emerging technologies.

60. The Forum noted that the development of upstream technologies should be consistent with the industrial strategies of individual developing countries

and this may require different "points of entry" by the developing countries. Thus, the importance of developing important raw materials such as ethylene, or of its expanded application, should be sustained. Overt emphasis on technologies based on methanol or residues may vitiate otherwise desirable development. In promoting new technologies developing countries should not lose sight of the need for fully evaluating the advantages of developing fully new technologies over the established ones.

E. Energy from Biomass and Solar Photovoltaic Cells

61. The Forum noted that there was growing awareness of the need to develop new and renewable forms of energy in addition to conventional fuels. This was particularly important for countries without indigenous supplies of oil, gas and coal. Biomass energy technologies and solar photovoltaic cells are only two of the wide range of renewable energy technologies available but they are very good examples in relation to the situation and needs of many developing countries. At present, developments in energy from solar and biomass sources permit only small-scale decentralised applications for industrial operations. However, they have considerable relevance if an integrated approach to industrial development and energy planning is undertaken.

Biomass

62. Biomass in one form or another already provides the major source of energy in developing countries especially in the rural areas. This is primarily in the form of fuelwood which is burnt in simple stoves. In fact, there are many different types of biomass resources and a wide variety of energy conversion technologies, from the very simple, which have wide application, to the very sophisticated, which are still at the research stage.

63. Improvements in the simple systems such as wood burning stoves and charcoal kilns will lead to immediate and beneficial results for millions in the developing countries. Modern science should be applied to improve the traditional conversion technologies. The Forum noted that efforts in this direction were being undertaken. In the longer term, the major advances taking place in genetic engineering and biotechnology may be very significant. One of the most important advances is the research and development work being undertaken on the efficient conversion of cellulose and hemicellulose to ethanol by using genetically manipulated micro-organisms and by using recombinant DNA technology. Lignocellulosic material is probably the largest source of biomass available and therefore the quantities of ethanol that could be produced could really provide an addition to conventional

energy forms.

64. In addition to the availability of biomass energy technologies, it was important to remember that an integrated approach to their adoption is necessary. Firstly, the food, energy and raw material potential of biomass resources should be assessed in an integrated systems approach in line with particular needs and resources of developing countries. Secondly, the alternative conversion technologies should be considered in accordance with socio-economic conditions.

65. It was pointed out that advances in biomass energy technology provide a number of opportunities for developing countries. For full advantage to be gained from these opportunities, it was essential that developing countries acquired up-to-date information and knowledge on biomass energy. This has to cover all aspects of the subject including improved biomass resource management as well as new and improved conversion technologies. Reference was made to the improved version of wood gasifiers and it was suggested that their use could be promoted. International and regional monitoring and information systems related to biomass energy would have to be developed and those existing strengthened.

66. An important aspect of most biomass conversion technologies is that they are not very complex or costly. The result is that it is possible for much of the equipment needed to be fabricated locally in developing countries. The problem is that the design and processes for these advanced technologies are usually the property of enterprises in the developed countries and are not adapted to the needs of the users in developing countries. It is therefore essential that the developing countries with biomass energy potential, and that includes the vast majority, develop a local design and construction capability for the various biomass technologies.

67. Several recommendations for action were made by the expert meeting in Moscow (ID/WG.384/16, paras. 120 to 123). Suggestions are also contained in document ID/WG.384/6/Rev.1 and ID/WG.389/3, paras 53 to 61. A number of steps have to be taken up in developing countries. Information collected by UNIDO has shown that R&D in this area is not confined to the industrialized countries. From a limited survey it is found that in 1982 there were 60 research institutes in 31 developing countries engaged in R&D on industrial conversion of biomass. The 1981 budget for this R&D in the developing countries was reported to be $12 million and the professional staff working in this field is over 500. The Forum agreed that there is great potential benefit to be gained by providing a network of these institutions so as to synergise R&D activities, to permit testing and field experiments and in particular the scaling-up of the technology as necessary.

Solar Photovoltaic Cells

68. It was noted that the widespread applications of photovoltaics either in developed or developing countries depended on improving their conversion efficiency and on the expansion of the world market that would lead to an increase in solar cells production and a reduction in costs. It is evident that when the market becomes large enough to justify automated mass production of cells, costs will fall sharply which will open up new markets, accelerate sales and drive prices even lower.

69. Solar cells can be fabricated on a laboratory scale in most of the developing countries. The first few trials may yield low conversion efficiency but will have the sociological impact that this device is no longer a "black box". Improvements in efficiency can be achieved by further activities and co-operation with experts. Also, prototype photovoltaic solar modules can be assembled from cells locally fabricated or imported and in this way considerable added value would be achieved. This will also allow field testing of modules under local environmental conditions in developing countries. The question arises, whether considering the trend towards declining costs, the developing countries should not refrain from making major long-term commitments for the acquisition of technology at present. They have to make several crucial decisions based on a careful assessment of the technology trends and the reduction in costs, such as:

(a) At what stage of the declining cost curve should they enter applications and/or manufacture;
(b) To build up capabilities for production of systems which permit considerable added value;
(c) To assess the experience gained so far in pilot applications, including the technical, economic and social aspects;
(d) In view of the fact that they provide large markets and that competition exists in this technology, adopt collective negotiation strategies for acquisition of technology, components and equipment;
(e) Develop capabilities not only in research and development but also selection, negotiation and acquisition on the one hand and systems design, application, marketing and servicing on the other.

70. There were divergent views on how soon and how fast the costs of the solar cells would go down. Two points were clear. In regard to non-competing uses, solar cells could still provide energy to perform specific functions for which no energy is otherwise available. Such uses might include for example use in health clinics and educational television where the social pay-off will substantially outweigh the costs of solar cells. Solar energy driers needing small amounts of

electric power for blowers could substantially reduce post-harvest losses. Secondly, developing countries could use the intervening period till the costs come down to build up their capabilities, particularly in the peripherals, carefully assessing alternative technologies and executing pilot projects and achieving a measure of technological self-reliance in this area. In this respect, the 1980s and particularly the next five years may be crucial for the developing countries.

71. In view of the fact that several R&D institutions were engaged in solar energy research, the establishment of a consultative group for solar energy research and application was considered beneficial to promote co-operation among the R&D institutions and strengthen the capabilities of the concerned developing countries.

72. It was noted that in regard to energy from both biomass and solar cells, developing countries constituted major markets for the use of the technologies and this gave them a potential bargaining counter in the acquisition of technologies. It was also noted that in the use of such technologies regional and socio-economic considerations would be of significance. In reviewing some energy technologies, the Forum noted that conventional sources of energy will remain the basic source of energy supply. Much still needs to be done in this area in terms of prospecting, processing and economical methods of production and utilization.

73. Recommendations for action were made by the expert meeting in Moscow (ID/WG.384/16, para. 124). Suggestions are also contained in ID/WG.384/2 and ID/WG.389/3, paras. 62 to 65.

III. OVERALL POLICY CONSIDERATIONS

74. The Forum welcomed the initiative taken by UNIDO in focusing attention on the subject of technological advances and development and expressed appreciation for the preparatory work done by the Secretariat and the documentation submitted to it. It further expressed its appreciation for the work done by the expert meeting held in Moscow. The documentation provided considerable material on the basis of which the further lines of action could be discussed. Several participants presented their country experiences which provided yet another source of information which facilitated the definition of issues and the identification of lines of action.

General considerations

75. In considering the combined influence of the several technological advances

it had reviewed, the Forum noted their several common distinguishing characteristics. They are more and more based on science and on transdisciplinary basic research at molecular and structural levels but amenable to rapid translation into production processes. Several of them have relevance to a wide range of industries and applications in various sectors. The technology development may be sophisticated but the applications in several cases are relatively simple. There is a convergence of technologies bringing about a new stream of production processes, equipment, services and information systems. They could, over a period, change the very structure of industrial, economic, educational and cultural systems. They provide alternative routes to industrialization or means for revitalizing that process. Some of the technologies appear to be especially tailored or designed to suit developing countries. At the same time, the combined impact of the technologies would have implications for a very substantial part of the existing industrial structures in developing countries. These considerations make it urgent for developing countries to assess their own positions and the possible policy responses to the ongoing technological change.

76. In an interdependent world economy with technology-dependent developing countries, the influx of the new technologies into them is an inevitable process. The developing countries could either follow a path of simply reacting to events and changes and keep rectifying their own positions in a changing world, or gain an insight into the new technologies and develop their capacity to use them purposefully for their own requirements. It may be that both options may have to be followed. However, if the technological advances could be approached as new opportunities for revitalizing the development process and improving the quality of life, the challenge could be converted into an opportunity.
The Forum noted that this would, however, call for new perceptions and instrumentalities of action both at the national and international levels and in particular the will and commitment of the policy-makers at the highest levels. The process of getting such a pay-off from the technological advances is by no means easy and has to be pursued without unconditional optimism.

77. The Forum considered that actions to be taken in this field would have to go far beyond the sensitization of policy-makers to the preparation of guidelines and methodologies to facilitate the utilization of technological advances; formulation of new policies and the forging of new mechanisms of international co-operation.

78. The Forum, however, cautioned against any oversimplified approach to the problem and in particular drew attention to certain constraints in the process of the developing countries harnessing the technological advances for their develop-

ment. One of them is the integration of these advances into the industrial, productive and social structures of the developing countries, keeping in mind the backward and forward linkages. The technology options have to be placed within the range of available options of developing countries and will have to be implemented in a context of "technological pluralism". It is therefore important that such advances do not function as technological enclaves but help to raise the general level of industrial productivity and social well-being and mesh in with and upgrade traditional technologies and small-scale industries. This calls for the development of basic scientific and technological capabilities including the capability for technology forecasting and assessment, careful choice of technologies and the determination of the manner of their absorption into the productive and social structure. The acquisition of inappropriate technologies could considerably distort the industrial and social structure of the society and affect the cultural patterns. Structural adjustments should, however, be made where necessary but they should stem from development objectives.

79. Another consideration examined by the Forum was the need for appropriate institutions and structures which could match the new technologies and maximise the potential benefits to be derived from them. New types of institutions and structures may have to be evolved while the existing ones will have to be re-oriented. A typical case in point would be R&D management in developing countries and their capacity to commercialize technologies.

Levels of competence

80. The Forum emphasized that any approach to the question of technological advances and development would be unrealistic if it did not take into account the different levels of development in developing countries and the different goals, priorities and resource endowments. There were perhaps a dozen developing countries which could absorb technological advances to a greater extent than the others. The situation of all types of developing countries has to be considered. Countries may have to follow selective and differential approaches and each country may have to decide for itself the point of entry, the degree of penetration, source of inputs, linkages, vehicles of implementation etc. But whatever the level of development, there is a need for a minimum level of competence to deal with emerging technologies within realistic time horizons and for establishing effective national groups for this purpose.

81. It was suggested in this connection that various levels of competence and needs of the developing countries should be taken into account, It should, however, be understood that a country should strive to reach a high level of competence

in the longer term, while in the short run it may aim to attain a given level of competence in particular technologies and productive sectors. Within the country itself, the level of entry point may vary for different areas.

Entry points

Minimum level: awareness, continuous monitoring, critical and relevant technological intelligence; identification of needs and relevance, ability to assess, select, negotiate and utilise technology; autonomous decision-making.

Medium level: the above and in addition ability to adapt or generate technology;

High level: all the above as well as capacity for commercialization, design, manufacture of equipment, and participation in competitive international markets.

The foregoing levels and elements should be viewed in a dynamic framework, with each country selecting its entry point and advancing its level.

82. The Forum noted that to achieve such levels of competence, developing countries should be able, should they so desire, to receive external assistance. The Forum considered that new mechanisms of international co-operation and the setting up of international centres as appropriate, would be necessary to strengthen the technological capabilities of the developing countries, in particular, of those which did not have at present a critical mass of infrastructure, to absorb and apply new technologies. The situation also calls for increased responsibilities on the part of UNIDO. It was requested to provide methodologies and guidelines for the consideration of countries at different levels of development in regard to the policy responses, methods of integrating the new technologies into the production structure and the realignment of the industrial and technological policies. It should, in addition, explore new means and mechanisms of international co-operation. Several possibilities of international institutional mechanisms were mentioned such as the International Centre for Genetic Engineering and Biotechnology being promoted by UNIDO, and possible international mechanisms in the field of microelectronics, energy from biomass, solar energy etc.

83. The Forum discussed other relevant considerations to be taken into account by developing countries. The policies for human resource development would need to be reviewed. The technological advances, particularly microelectronics, offered new possibilities in this regard. The education systems will have to be reoriented to match the requirements of new technologies which are multidisciplinary in

nature. The revision of curricula, introduction of new courses, and new types of technological institutions for education and training have to be considered. Existing educational and industrial training facilities have to be reviewed to take into account the changing profiles of skills required to operate industrial and other equipment.

84. For the development of human resources and in order to create a milieu in which the new technologies could be applied, sensitization programmes should extend beyond policy-makers to a variety of users and to the public at large. "Spotlight" applications can have an important demonstration effect. In this connection, it was suggested that an exhibition of the potentials of technological advances for development could be organized at the time of UNIDO IV and later repeated in other countries. Similar exhibitions at the national level in existing technical museums or other institutions in developing countries could also be considered.

85. Attention was drawn to the possible realignment of the international technology market structure on account of the emerging technological advances. This called for the strengthening of capabilities, for forecasting, assessment, negotiation and acquisition of technology, greater awareness and intelligence about technological trends and preparation of guidelines for acquisition of technology in areas such as computer software, genetic engineering etc. It was suggested in this connection that UNIDO should study, on a continuing basis, the changing technology market structure and disseminate the results to developing countries. This could be done under the auspices of UNIDO's Technological Information Exchange System (TIES), which will have to be strengthened and expanded for this purpose. Technology acquisition policies and decisions should increasingly incorporate socio-economic assessments of new technologies to be imported. Sometimes the introduction of a technology may have implications beyond the sector in which it is applied.

86. The foregoing requirements call for, as one of the first steps, an increasing flow of information about technological advances packaged in a manner suitable to different types of end-users such as the general public, students and trainees, policy and decision-makers, enterprises and government agencies acquiring technology etc. UNIDO was requested, as part of its information activities, to take steps to promote such flows of information. In this connection, UNIDO was also requested to co-operate closely with United Nations Educational,Scientific and Cultural Organization(UNESCO) and United Nations Centre for Science and Technology for Development (UNCSTD). Such information activities would form an important and

valuable part of the global exchange system on science and technology.

International Co-operation

87. The Forum considered that a new orientation to international co-operation was necessary both to enable the utilization of technological advances for the benefit of mankind as a whole and developing countries in particular, and to evolve new approaches to the halting and uneven development process. International security and peace are important pre-conditions for social, economic and technological progress. The co-operation between developed and developing countries should increasingly focus on the beneficial application of technological advances in accordance with the priorities and requirements of each developing country, enabling it to acquire a basic technological competence for the use of the new technologies. Exchanges between scientists, education and training programmes, links between universities and other means should be utilized to enhance the technological capabilities of developing countries. The transfer of technology should be on equitable terms and conditions involving national participation and development to the maximum possible extent. In transfering technology, adaptations of products and processes should be made, particularly since applications in biotechnology have a high specificity to local resource endowments and applications in microelectronics have to fit specific developing country requirements and their cultural and social context. Hence, a considerable degree of transfer process should not be considered as merely involving transfer of knowledge between enterprises but as contributing to and maximising the benefits of global interdependence. The knowledge and information available in the public domain in the developed countries should be widely accessible and be disseminated to the developing countries. Channels of communication and co-operation should be improved between developing countries and small and medium enterprises and educational and research organizations in developed countries pioneering applications of advanced technologies.

88. The emergence of technological advances would, in a sense, lead to a new phase of co-operation among developing countries. The problems faced by them in information collection, forecasting, assessment, selection, acquisition, adaptation and absorption of new technologies and endogenous development and application of such technologies, will have much in common and it is therefore necessary to exchange information on policies and experiences in this field. Co-operative programmes should extend beyond the exchange of information to collective negotiation and acquisition of technologies, setting up of common production facilities, technological institutions and programmes. More importantly, the

developing countries may have to consider together a collective strategy for their response to technological change. In this connection, attention was drawn to the relevance of the recommendations of the United Nations Conference on Technical Co-operation among Developing Countries (A/CONF.79/13/Rev.1, Buenos Aires, 30 August to 12 September 1978); the Vienna Programme of Action (A/CONF.81/16, Chap.VII, p.46, 20 - 31 August 1979); the Caracas Plan of Action (A/36/333, 13 - 19 May 1981) and the recommendations of the Meeting of Heads of Science and Technology Agencies held in New Delhi in May 1982. The last mentioned meeting had specifically given attention to the modalities of co-operation among developing countries in the field of advanced technologies. UNIDO was requested to take into account and contribute to these initiatives in implementing its programme on technological advances.

89. The true test of international co-operation would, however, lie in harnessing the new technological advances to unique developing country applications which would enhance the productivity and quality of their manpower and improve the quality of life. The fact that developing countries are at different levels of preparedness to take advantage of the new technologies, makes it essential that new mechanisms of international co-operation are devised. The possibility of setting up international centres for different advanced technologies should be explored and references were made illustratively to the International Centre for Theoretical Physics, the proposed International Centre for Genetic Engineering and Biotechnology and a possible international centre for microprocessor applications. Such international mechanisms would help to strengthen the technological capabilities of those developing countries in particular which do not, at present, have trained national groups to work on these technologies, by enabling them to create such groups.

90. Another important means of demonstrating a new spirit for international co-operation would be through considering the implications of technological advances for future world development at the highest policy levels, whether among developing countries or among all countries. A suggestion was made that UNIDO examine the possibility of convening a "technological summit". A limited number of important common problems of developing countries could also be addressed through common programmes to develop "technologies for humanity". Such programmes could be selected through the proposed summit or other international fora. Commonly funded programmes for such technologies for humanity could enable the dissemination of the fruits of modern science and technology to improve the quality of life of humanity at large. Such a move would reinforce the commonly held aspiration that the human being must be the centre of concern in technological development. UNIDO was requested to take steps for the further definition and implementation

of the concept of "technologies for humanity".

Role of UNIDO and other international organizations

91. The foregoing aspects of the problem of applying technological advances for development would place a much broader and heavier responsibility on UNIDO's programme on technological advances than at present. It was suggested that if the concept of application of the emerging technological advances for development should be taken to the point of implementation in a large number of countries, consideration may have to be given to ways and means of strengthening UNIDO's programme in this area. UNIDO will have to offer a varied programme of promotional, advisory and technical assistance services to help countries at different levels of development. Its efforts to identify new forms of instrumentalities of international co-operation should be continued. It was recommended that the UNIDO Secretariat take these aspects into consideration in addition to the recommendations made on its role by the expert meeting in Moscow.

92. Observers from UNCSTD, UNCTAD, ILO and the CMEA made statements explaining the activities of their organizations which are of relevance to the subject of technological advances and development. The observer from the UNCSTD referred to the plans of that Centre to establish an advanced technology alert system and the meetings under the auspices of the Advisory Committee on Science and Technology for Development concerning the merging of modern and traditional technologies and strengthening the capabilities of scientific and technological personnel in developing countries. UNIDO was requested to co-operate with all UN bodies and other concerned international organizations, so that the efforts of the international community are fully mobilized for this important task. In undertaking such efforts, it was suggested that the overall framework of the Vienna Programme of Action on Science and Technology for Development should be kept in mind.

93. It was agreed that the Forum had served a useful purpose in focusing attention on the subject and defining the issues involved and in identifying further lines of action. The technology trends as well as the development efforts in this field have to be kept under constant review and UNIDO was requested to convene another Forum at an appropriate later date to review the efforts made and the progress achieved in this regard so as to contribute to an acceleration of the process of harnessing technological advances for development.

IV. CLOSURE OF THE FORUM

94. Academician Gvishiani, in his closing speech noted that the participants came from 23 countries of various socio-economic systems and different levels of scientific and economic development who have candidly and objectively expressed their points of view, discussed the results of their studies, and adopted a common document aimed at raising the level of scientific and technical competence of the developing countries. The report deals with the problem of how best to introduce the latest advances in science and technology in the developing world. This has been a noble task and a meaningful step forward has been taken towards both the understanding and the solution of that task.

95. In reviewing the general conclusions of the Forum, Academician Gvishiani noted that the ways and means of using technological advances for the solution of specific problems in developing countries in areas such as education, health and food production had been identified. Technological advances would also have significant impact on many economic and social sectors such as employment, trade etc. and it is essential that these be taken into account in formulating national policies. It is clear that developing countries should not just imitate the industrially developed nations in their choice of new technologies, but need to take account of their specific economic and social conditions.

96. Academician Gvishiani stressed the fact that the Forum had focused attention not only on the basic lines of activity but also on the organizational efforts required for the successful utilization of technological advances for development purposes. This applies to the development of scientific, technical and economic co-operation between the industrially developed and developing countries, as well as to the increasing role played by organizations of the United Nations system.

97. The meeting expressed its appreciation and grateful thanks for the excellent facilities provided by the State Committee for Science and Technology of the Georgian Soviet Socialist Republic, as well as the Government of the USSR for its kind invitation to UNIDO to host the Forum.

ANNEX I

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ID/WG.384/1/Rev.1	Implications of New Materials and Technology for Developing Countries, prepared by UNIDO Secretariat
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ID/WG.384/6/Rev.1	Implications of Biomass Energy Technology for Developing Countries prepared by UNIDO Secretariat
ID/WG.384/15	Methodological Problems of a Comprehensive Programme of Scientific and Technological Progress in the Soviet Union, a Preliminary Note by Academician J.M. Gvishiani
ID/WG.384/16	Report - Expert Meeting Preparatory to International Forum on Technological Advances and Development, Moscow, Union of Soviet Socialist Republics, 29 November - 3 December 1982
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ID/WG.384/14	Reports of Working Groups on the Expert Meeting Preparatory to International Forum on Technological Advances and Development Moscow, Union of Soviet Socialist Republics 29 November - 3 December 1982

ID/WG.372/17	Report on the UNIDO/ECLA Expert Group Meeting on Implications of Microelectronics for the ECLA Region
UNIDO/IS.246 and Corr. 1	Implications of Micro-electronics for Developing Countries: A Preliminary Overview of Issues prepared by UNIDO Secretariat
UNIDO/IS.261	The Potential Impact of Microbiology on Developing Countries by Carl-Göran Hedén
UNIDO/IS.350	Emerging Petrochemicals Technology: Implications for Developing Countries by V.R.S. Arni
UNIDO/IS.351	Microprocessor Applications in Developing Countries by James. M. Oliphant

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CRP. 3	Biotechnology of Cellulose: A Key to Basic Human Needs (Food, Energy and Medicine) by A.A. Klesov and J.V. Berezin
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