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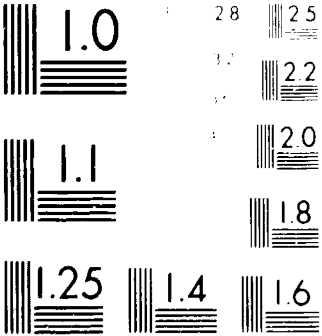

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Workshop on Institutional and Structural Responses of Developing Countries to Technological Advances

Dubrovnik, Yugoslavia, 31 May - 4 June 1983

REPORT.*

(Workshop on responses of DC's to technological advances).

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INTRODUCTION

1. The Workshop on Institutional and Structural Responses of Developing Countries to Technological Advances was held in Dubrovnik, Yugoslavia, from 31 May to 4 June 1983. It was organized by UNIDO in co-operation with the Science and Technology Policy Research Centre, Mihailo Pupin Institute, Belgrade, Yugoslavia. The list of participants is attached as Annex II and the list of documents as Annex III.

2. The objectives of the Workshop kept in mind, as follows, the ongoing and anticipated technoloigcal advances, the relevance of those advances to developing countries and the preconditions for utilizing them:

(a) To review the institutional trends in developed and developing countries in the transfer development and application of technological advances in specific fields (microelectronics, genetic engineering and biotechnology, new materials and technology, petrochemicals, energy from biomass and solar photovoltaic cells);

(b) To review the existing situation of industrial and technological institutions and structures in developing countries and their strengths and weaknesses;

(c) To identify policies, means and mechanisms by which those institutions in developing countries could be strengthened and reoriented to meet the challenge of the technological advances;

(d) To make recommendations and evolve guidelines for policy actions, integrating them with the overall industrial and technological policies of developing countries.

3. The opening session was addressed by Mr. K. Venkataraman on behalf of the UNIDO Secretariat, Mr. Geršković on behalf of the Socialist Federal Republic of Yugoslavia and Mr. Radoman, Director, Mihailo Pupin Institute. Mr. Radoman was elected as the President of the Meeting.

I. BACKGROUND OF THE WORKSHOP

4. As an important milestone in the UNIDO programme on technological advances and as part of the preparations for the Fourth General Conference of UNIDO, an International Forum on Technological Advances and Development was held at Tbilisi from 12 - 16 April 1983. It concluded that those advances have a potential and relevance for developing countries and would be feasible of application. The opportunity cost for developing countries of overlooking the technological advances was high, both in terms of acquisition of inappropriate technologies and the aggravation of their technological dependence.

5. The Forum recommended, inter alia, that developing countries, individually and collectively, examine their existing state of technological capabilities and take steps to reorient their institutions and structures as necessary and appropriate to respond to technological change in accordance with their own objectives and conditions. The Workshop was designed as a follow-up to the Forum in this respect and also to provide further inputs for eventual consideration by UNIDO IV.

6. The intensity, wide-ranging impact and convergence of technological advances, such as microelectronics and genetic engineering and biotechnology, was such that they can be expected to have implications for the future rate and pattern of industrial production and to accentuate the technological dependence of developing countries. In an interdependent world economy the developing countries cannot avoid the impact of those advances. They would have to come up with a timely and orderly response, if they were to avoid adverse consequences and exploit the potentials of the technologies. These technologies exhibit basic features, which if harnessed and applied to the unique conditions of a developing country, would be of considerable benefit and could revitalize their development process. An important element in the actions of developing countries would be to redesign their institutions and structures to meet the challenge of technological advances. Otherwise, the conditions of rapid application of the technological advances in a beneficial manner would not exist.

7. The problem would have to be reviewed as something more than the stimulation and diffusion of innovations. The developing countries should keep their development objectives firmly in view and consider the societal developmental impacts of possible specific applications. The creation of the necessary infrastructure should not imply indiscriminate applications.

8. In drawing up a strategy for this purpose, it should be remembered that conditions vary between developing countries and that a number of them were at present to overcome certain problems and shortcomings in their technological development. The Tbilisi Forum suggested that since developing countries were at different levels of development each country would have to decide for itself the point of entry, the degree of penetration, sources of inputs, linkages, vehicles of implementation etc., but whatever the level of development, there would always be a need for a minimum level of competence to deal with emerging technologies.

9. In addressing the question of the differences in levels of competence, the Tbilisi Forum identified three broad levels that obviously span a wide spectrum of situations. Entry points for each level were suggested as follows:[1/]

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

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

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

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

1/ ID/WG.389/6, p. 26

10. At each of the above-mentioned levels a variety of activities would have to be considered.[2/] In general, industrial and technological development involved several types of activities such as monitoring, assessment, selection and acquisition, R+D, financing, training, production and marketing. For each activity various relevant elements would have to be considered e.g.

Technology Development

11. (a) For imported technologies: selection; acquisition; adaptation and further R+D; absorption.

(b) For endogenous technologies: basic research; applied research; commercialization; extension; supporting services; newer types of research institutions.

Industrial Production

12. Awareness; decision-making; size of firm; level of integration; sub-contracting; new entrepreneurs; infrastructural services like testing, quality control, standardization; consultancy and design engineering.

Human Resource Development

13. Greater number or qualified personnel; interdisciplinarity; change of curricula; expatriate manpower; utilization of foreign experts; short-term training; retraining.

Structuring Demand

14. Structuring and volume of demand; public purchases, life styles and value systems.

2/ See the diagrammatic presentation in Annex I.

Financing

15. Resources for R+D; venture capital; capital for requipment; funds for education and training; resources for building new infrastructures. These activities were performed in a variety of institutions and structures and the main actors involved were the government, the business community and the general public.

16. Even the cursory and illustrative enumeration made above shows the variety of activities, elements and actors involved. Depending on the level of competence desired, a developing country may wish to identify the elements in each activity which it regards as key-result areas. Considering the variety of activities involved, selectivity and concentration of effort were needed. Obviously, links would have to be established between the various elements and coherence and consistency ensured within clear time frames. Fragmentation of effort would not achieve the desired results.

17. Within the above framework, the introduction of advanced technologies raised several considerations, such as:

(a) What were the distinguishing characteristics of the new technologies and how do they affect the various elements and sub-systems?

(b) What were the key result areas from the point of view of the developing countries?

(c) What guidelines could be given for practical action programmes?

(d) How could the actors be influenced?

18. The Workshop addressed those and related questions within the limits of the time available. It started with a review of the present situation in industrial and technological institutions in developing countries and moved on to a discussion of the required lines of action in selected technological advances.

II. STATUS OF INDUSTRIAL AND TECHNOLOGICAL INSTITUTIONS IN DEVELOPING COUNTRIES

19. In order to achieve full and effective utilization of the technological advances, the need existed to transfer information, know-how, understanding, so as to apply the technological advances in a manner appropriate to the needs, conditions, and constraints of the country. The technology system in a country was comprised of a number of institutional and structural elements, none of which could succeed fully in transferring or adapting technology in isolation from the other elements. A co-ordinated strategy and development plan was needed to bring together the unique capabilities of each element to carry out the transfer process.

20. The elements of such an infrastructure included:

<u>Institutions:</u>

industrial research and service institutes;
universities;
bureaus of standards or metrology;
testing laboratories;
development/finance banks;
technical libraries and information dissemination systems;
national technology/innovation centres.

<u>Organizational structures:</u>

national S+T councils;
ministry of industry;
ministry of planning;
ministry of finance;
parastatal entities;
production sector;
societal sector;
regional and international organizations.

21. It would be desirable, although perhaps not possible, to undertake a rigorous survey of technological institutions, organizational structures and policies in developing countries. Such information would be useful in suggesting changes for strengthening the ability of such institutions to respond to technological advances. Information was needed in the areas of interest of each institution, on interaction between them and the end-users, on the modes and content of co-operation amongst them, on their real versus imagined institutional capabilities, as well as on attitudes of governments towards inclusion of new technological advances in national development strategies and plans.

22. The requirement exists for information on the national technology policy and technology development strategy which related the scientific and technology potential (STP) to the objectives of science and technology development (STD) in terms of the needs of the productive and service sectors and society at large. Investigation would also cover the manner in which decisions were made on the technology balance between domestic and imported technologies, financing, human resources, and other factors.

Status of IRSIs:

23. Many multi-branch, multi-pupose industrial research and service institutes (IRSIs) have been established recently in developing countries. Usually, these have been organized along traditional lines, embracing several specializations. Single branch IRSIs had also been created, in some cases, to serve a particular industrial sector, such as food technology, textiles etc. Generally, these IRSIs were more effective since they responded to well-defined needs and demands for services.

24. In most cases, IRSIs were confronted with a number of constraints which frequently impede their ability to provide effective service and solve problems. These included:

(a) Absence of a well-defined government policy for the role of technology in development. The science and technology councils in many developing countries were often more science than technology-oriented, and would not always have the stature necessary to impact on development policies ;

(b) Lack of industrial experience of their staff. This constrained their ability to identify, understand and solve industrial problems;

(c) Absence of strong industrial liaison and industrial extension activity. This was part of the marketing function, which was absent in most IRSIs;

(d) Lack of adequate technological information, particularly know-how information, and an industrial information dissemination system ;

(e) Limited operation between them and other national technological institutions (universities, bureau of standards, commercial testing laboratories) or regional IRSIs;

(f) Absence of active demand for their research services, as a result of massive technology transfer from foreign sources;

(g) The tendency of their staff to continue research initiated during postgraduate study, or undertaken on the unjustified promise that the concept, if successfully developed, would be of interest to the productive sector or important to the national development process (that related, of course, to either inadequate management direction, government policy, lack of information, industrial liaison, or all of these).

25. Admittedly, the above were generalizations and would not apply across the board to all IRSIs. The Joint UNDP/UNIDO IRSI Evaluation Study,[3/] however, showed clearly that in many cases, IRSIs did not interact effectively with the productive sector. Their research activity was not always relevant to national development needs, except as a form of long-term institution building and staff development.

26. However, where the IRSI enjoyed autonomy in management and operational procedures, and where an IRSI was required to earn a sizeable portion of its annual operational expenditure through contracted services, performance was greatly improved. In such cases, the IRSIs were better informed about the needs of the productive sector and adjusted more easily to client's needs.

27. Such IRSIs frequently had close working relationships with universities and other technological institutions in their countries or regions, and entered jointly into projects which involved scientific as well as technological development aspects of the new technologies. A significant number of more established IRSIs had co-operative agreements with universities and technological organizations in Europe, the United States and Japan.

3/ Joint UNDP/UNIDO Evaluation of IRSIs, ID/B/C.3/86, 28. August 19,9

These co-operative agreements could be an excellent mechanism for acquiring information about new technologies, for training in such technologies, and for joint projects that could utilize the combined resources of the co-operating institutions. The opportunities inherent in such co-operative agreements or twinning arrangements between technological institutions in developing countries were of paramount importance to transfer of new technological advances.

Status of Universities

28. Universities in developing countries are a valuable resource in the transfer of new technologies, but that resource base was not always used effectively. The first principle for faculty promotion in a university involved the publication of scientific papers in refereed journals. Thus, the faculty research efforts were usually directed towards projects which would yield a paper acceptable to international journals. Consideration was seldom given to relevance of the research results to development needs. In the majority of cases, the universities were short of modern laboratory facilities. Consequently, university research tended to be theorectical rather than experimental.

29. Universities were the main source of the qualified manpower that would deal with the technological advances. However, current curricula and syllabi did not reflect particular emphasis on technological advances. Faculties were not particularly well-informed and rather slow in carrying out the considerable changes involved in mobilizing them to face the challenge of these advances and to prepare their students for facing them.

30. Faculties in the universities frequently obtained information on technological advances from journals, international seminars, and correspondence with colleagues. It seemed clear that with appropriate co-ordination, universities could contribute significantly to collaborative projects with IRSIs, where experimental equipment may be available, and where better information usually existed on the needs of potential end-users.

31. Governments did not often seem to recognize the potential contributions of universities to the development process and hence did not emphasize to universities the need to focus on excellence in teaching and research dedicated to national development needs.

Status of Development/Finance Banks

32. National development banks which played an important role in technology transfer were not usually active partners with research centres in the transfer process. In deciding on the provision of financing, they seemed to concentrate on market surveys, economic and financial analyses and profitability and seldom scrutinized licensing and other technical service agreements.

Technology Development, Transfer and Regulation Policies and Instruments

33. Most developing countries had a national body responsible for S+T policy in the country. This was either a separate agency or a section within the appropriate ministry. The crucial question was how effective these bodies were in linking their activities with those of national development planning. As a broad, but valid, generalisation it would be fair to say that in the larger more developed and newly industrializing countries, and a few of the smaller and less industrialized countries, the S+T policy bodies had left a marked impact. At the lower income levels stress had been on basic human needs and self-reliance with particular concern for rural development. In the middle income countries priority was given to accelerated and sustained economic growth which usually implied massive technological imports and less attention to encouraging endogenous technological development. At the top level there were several examples of an explicit and coherent technological policy covering both imported technology regulation and encouragement of the development and application of indigenous technologies.

34. Although the majority of developing countries still adopted "laissez-faire" policies in technology transfer, more and more were beginning to play an active role in regulating the flow of foreign technology. A recent survey had indicated that nine countries currently had legislation for this purpose, three had issued guidelines, eight had instituted administrative controls and another eight were planning to introduce them.

35. Governments promoted indigenous technologies through a variety of incentives, such as tax concessions, liberalised licensing procedures, financial incentives and special funds for supporting indigenous creativity and the application of indigenous useful innovations. Sometimes approval of foreign investments was conditional on the establishment of R+D units to absorb the imported technologies. In some countries patent laws had been changed to better advantage. However, the impression was that action so far had been unco-ordinated and poorly linked to the technology import policy, the development incentives and to S+T plans. Governments seemed to be placing more attention on the evolution of an integrated strategy of technological development with the role of imports more clearly defined.

36. Systematic technology assessment was at an even more embryonic stage and was attempted in very few countries. Such countries were still groping for appropriate methodologies and impact criteria whose application would bring significant results for optimum policy and planning. Assessments seemed to be based mainly on economic calcualtions and prospects of profitability rather than on the variety of long-term trade-offs and social impacts.

37. In all these efforts there was an obvious need for steady and reliable scientific technological information. National technological information centres existed in many countries. Their capabilities and scope of information coverage varied considerably. Their competence in information analysis, assessment and intelligence would have a long way to go in the majority of developing countries. However, in certain regions technical information networks had been established and seemed to be improving with time.

38. Finally, very few developing countries had as yet formulated explicit policy responses to the new technological advances. For example, Mexico had started systematic prospective studies with the aim of incorporating the results in national strategic decision making. Furthermore, plans existed or were being elaborated for technological development of specific sectors. Brazil, had set a special secretariat for formulating an informatics strategy and was formulating a plan for micro-electronics development. The Electronics Commission in India was assessing trends in developing countries and formulating appropriate national strategies for benefiting from advances in microelectronics. Singapore was undertaking, in co-operation with Japan, an extensive national programme for the development and application of microelectronics on a wide scale.

III. REVIEW OF SELECTED TECHNOLOGICAL ADVANCES

39. Aware of the different nature, characteristics, history and future of each of the technological advances, the Workshop considered, as concrete examples, three of these advances and suggested desirable actions for each at the variety of competence levels.

Microelectronics

40. Even in the less developed of the developing countries, there would be extensive use of microelectronics-based equipment for the power and communication industry and for many other industrial and service activities. This called for a technical capacity for repair, maintenance and, more importantly, for appropriate integration of the equipment used. Thus, even in such countries, a programme should be set up to enhance its microelectronic capabilities through increased awareness of key people, training of personnel in handling electronic equipment and in software, establishment of minimum infrastructure for testing, repair and maintenance.

41. In several developing countries there were already some groups working in the design of electronic equipment, many of them operating within a very limited infrastructure and with poor support. In general, these groups suffered from lack of components, problems in designing and manufacturing good quality printed circuits and insufficient understanding of the engineering of the systems where a microelectronic application would be carried out. In these cases, it was important to heighten the awareness of decision makers the big potential of these groups, with better engineering focused on the applications and with the necessary support in components, printed circuits, mechanical design, capacity to transfer results obtained in industry etc. It was at that stage that a "centre" devoted to providing such electronic infrastructure support was justified.[4/] Furthermore, the Workshop recommended that UNIDO undertake a study to analyze in detail the infrastructure needed for the establishment and operation of this type of centre.

4/ 'Some Considerations About a Practical Approach to the Development of Technical Infrastructure for Microelectronics' by Guillermo Fernandez de la Garza, ID/WG.401/6.

42. In some developing countries there were already local industries successfully manufacturing microelectronic-based equipment designed locally. In such cases, the potential already existed for the design of custom or semi-custom micro-circuits that could be manufactured locally or abroad. The support required by industries at this stage was mainly in the area of computer-aided design and, where relevant, in the different aspects of micro-circuits manufacturing. The level of support that local governments and industries would give to the development of the technical infrastructure required at this stage, would depend on the possibilities of the market, the level of sophistication of the applications and the availability of complementing facilities from abroad.

43. It was recognized that the development of the technical capacity required to support the microelectronics industry as suggested above was costly (in order of tens of millions of dollars) and that it would take at least 3 to 5 years to train the initial personnel for many of the technical support activities suggested.

44. The Workshop emphasized that the above suggestions should be complemented by a national programme for microelectronics development in the country following the recommendations of previous UNIDO meetings, namely public awareness campaigns; concentrated programmes for education and training; support for the manufacture of electronic components and the application of microelectronics in production and services; public procurement policies; R+D subsidies; research contracts; low-interest loans; investment grants etc. However, without careful attention to the technical details, all such measur would be ineffective.

45. With respect to the application of microelectronics to rural problems and their integration with traditional technologies, the Workshop noted suggestions for such integration and its feasibility in some cases. While acknowledging the decisive importance of that type of application of microelectronics, it was felt that the available information on that aspect was scarce and suggested that UNIDO commission a study to analyze specific cases of success or failure and provide reliable guidelines for ensuring success in the application of microelectronics in rural areas or in merging them with traditional technologies.

46. In order to improve communications and possibilities of collaboration among developing countries, it was suggested that the "Microelectronics Monitor" published by UNIDO place particular emphasis on reporting the activities and results for groups working in developing countries and also of co-operative activities among them. 5/

Genetic Engineering and Biotechnology

47. In most developing countries, an adequate scientific-technological infrastructure in this field did not exist. In fact, the number of competent people in developed countries was still relatively small. Consequently, the basic requirement was to acquire a minimum capability as soon as possible. Genetic engineering and modern biotechnology were science-intensive and called for highly competent scientists in a number of disciplines. Having invested in the education and training of a number of scientists and technologists in these disciplines, the most rational approach for maximising their potential and impact would be to set up inter-disciplinary core groups composed both of academics and industrialists and located preferably in academia. This would facilitate manpower development and expose the students to practical applications. The core group should be supplemented,whenever possible, by expatriate nationals working abroad in the fields of genetic engineering and biotechnology.

48. Genetic engineering was perhaps the most recent of the technological advances. Consequently, it was developing and would continue to develop for some years to come at a very rapid pace and in many directions that were not always predictable. One essential task of the core group will thus be to monitor closely developments in the field, assess them carefully in order to identify in good time the most appropriate applications for the country and to suggest sound strategies for their implementation. However, only actively working scientists and engineers could provide a realistic perspective of tendencies and alternative paths in which genetic engineering and biotechnology were likely to develop.

5/ For example ACSTD ad-hoc Panel Meeting held in Los Baños, the Philippines, December 1982.

49. Because of this exceptionally rapid pace of development, the Workshop felt that patent laws in the developed countries would not be a limiting factor for applications in developing countries, once a minimum capability had been achieved. The rapid pace of development renders innovations obsolete before they are patented.

50. The interdisciplinary nature of genetic engineering and biotechnology makes traditional mono-science education unsuitable. The developing countries need to bring about drastic changes in curricula and syllabi in biology, both at the school and university levels.

51. The Workshop recognized the potential impacts in a number of fields that were of particular importance to developing countries, e.g. health, food production and processing, and renewable sources of energy and raw materials. It was noted that the cost of bringing about such benefits was not too high and the time span to commercialization was rather short. In this respect, their integration with traditional technologies, particularly in rural areas, promises substantial and rapid benefits that will improve the living standards and conditions of large sections of the population in many developing countries.

52. The far-reaching impacts of developments in this field necessitated that the complete chain of effects of particular applications be studied by the policy formulating and planning authorities, particularly when cash or export crops were affected by such applications.

53. The possible benefits and threats mentioned above emphasized the need for such assessment being carried out by interdisciplinary groups involving scientists, economists and sociologists.

Energy from Biomass and Photovoltaics

54. Biomass and photovoltaics were in sharp contrast with their historical antecedents. While biomass resources have been the main source of energy for the majority of the world population for millenia, photovoltaics were a very young, if not embryonic, method of converting solar radiation into electricity.

55. One basic problem with biomass as a source of energy was that it was also the source of other vital human needs, particularly food and basic chemicals. Recent technological developments in chemistry and biotechnology were revealing a very wide vista of other forms of utilization of biomass.

56. Consequently, an essential need when dealing with biomass was to analyze carefully, within each national or regional context, the merits and demerits of one particular path of processes as against others. This has not been made any easier by the fact that the processes or the technologies were changing and developing in all directions, or by what was known about the negative energy balance in certain applications. However, the most important consideration for developing countries, and may be worldwide in a small interdependent world,was the issue of food/energy balance.

57. One distinguishing feature of biomass was that most resources existed in developing countries. Yet very little attention had so far been given to the development of the resource base of biomass in developing countries, perhaps with the exception of Brazil. Recent developments in genetic engineering point to great opportunities in increasing resources considerably.

58. Conversion systems to produce energy from biomass follow one of two paths: the termochemical or the biological. It should be remembered that energy from biomass was not a complete substitute for other conventional sources. It was, however, particularly significant for decentralised applications related to rural development - notwithstanding the impressive development of Gasohol in Brazil mainly through national effort. In fact one feature was the very wide coverage of applications from the simpler low cost, low energy output to the very complex and large scale.

- As mentioned already, other technological advances, particularly genetic engineering, and perhaps microelectronics to a lesser extent, could impact dramatically on the resource based and conversion methods. The ad-hoc Panel Meeting organized by UNCSTD in the Philippines in 1982 [6/] emphasized this aspect and felt that developments here needed to be integrated with overall rural development efforts.

6/ op. cit

- It has been noted also, that equipment used in most conversion technologies was relatively simple to fabricate, even though the design and process know-how were sophisticated. The nurturing of local design and construction capability was advocated perhaps more realistically for small decentralized applications.

- Development of this technology impinged directly and dramatically on the way of life and the social fabric. This feature needed particular attention. However, widespread use in India and China indicated that this was a manageable problem, at least in the decentralized applications. The social problems brought about in Brazil by the large scale development of the resource base for alcohol production was also mentioned.

- Because of the continuing and dispersed paths of development of the technology, there was an urgent need in developing countries for information and knowledge of future developments in resource base management and the conversion technologies through effective monitoring and assessment mechanisms.

59. It was noted that there were presently 60 institutes in developing countries involved in biomass research and spending around US$ 20,000,000 per year.Expenditure had ranged between a record high of US$5,000,000 in one case and US$ 5,000 in another. Only in 17 cases has expenditure reached or exeeded US$ 100,000. The range of interests of these institutes was widely dispersed. Little work was done at present on the development of the biomass resource base. There were no reports of a national biomass policy in a developing country. Apart from the case of three large countries (Brazil, India and China) no significant achievements were reported in the upgrading of the production of energy from biomass. This indicated the need for establishing links between these institutes in a networking arrangement that would ensure the easy flow of information between them and encourage the formulation and implementation of joint projects addressing priority problems in similar national situations.

60. In the field of photovoltaics it was noted that production of the raw material and the cell and modules was in a highly fluid state with claims and counterclaims being made almost every day. Huge investments were involved and it was far from clear who would be the winner. This underscored the decisive

importance of monitoring and selection of the right time and point of entry. A proposal for establishing a consultative group to fulfil this role was thought to be worth implementing.

61. Given the cell modules, the problem was to integrate them into a workable system and to investigate applications in detail in order to obtain first-hand experience of performance and to evaluate it. This would mean besides the technical problems and consideration, acquiring insights into the economic and social problems involved in application. What was most needed was an energy system model (or better still a series of such models) serving a specified community of particular characteristics in which could be fed parameters such as results of performance monitoring cost and availability of other sources, social benefits and constraints. Changes in such parameters would yield through operation of the models, reliable answers that indicated the feasibility or otherwise of photovoltaics systems, at any moment in time or set of circumstances.

62. This review of the present situation emphasized a number of particularly important issues relating to institutional and structural changes in developing countries in the face of the new technologies. Firstly, there was a need for a clear national policy on biomass utilization. That would take into consideration the nature and quantity of biomass resources, possible impacts of other technological advances on their development, the matching of the priority needs of the country with the potential of biomass to their satisfaction and the complex spectrum of implications, particularly social, in following this policy. That highlighted also the need for upgrading capabilities in technology assessment and forecasting, as well as the necessity of integrating socio-economic investigations with scientific-technological research and the development of an interdisciplinary culture in decision-making circles and R+D institutions. Finally there was a need to bridging the gap between R+D and application on an economic scale, particularly where equipment manufacture or system integration was relatively straightforward and not prohibitively costly.

IV. AN APPROACH TO CHANGES IN INSTITUTIONS AND STRUCTURES

63. Having reviewed the existing situation in the technological and industrial institutions and some of the particular actions needed for specific technological advances, it was necessary to summarize clearly the general character and commonalties of these advances and the challenges posed by them without in any way ignoring that each had a special character of its own. This would help in identifying the changes that were needed in the existing structures or in creating new structures and institutions.

The General Character of Technological Advances and the Challenges Posed

64. The technological advances were more and more science-based. The research was at the structural and molecular level indicating the importance of basic research and the interdisciplinary character of research. Further, there was a convergence or confluence of one emerging technology with another producing a synergistic effect. Their combined impact brought about vast and radical changes in social, economic and industrial structures. The total innovation chain from basic research to production and commercialization had become considerably shorter and rapid changes were occuring in processes, products, equipment, machinery and materials of construction etc. Around 65% of existing industry was affected, with a likely uprooting of well-established industries (e.g. fructose taking over 60% of the sugar market for sweeteners).

65. Fortunately, they did not conflict basically with existing technologies. In fact, they permitted decentralized production, improved quality of life of the rural people and appeared to be specially suited to the needs of the developing countries in utilizing the sunbelt resources fully.

66. However, they demanded new or higher skills in several cases, though some might even reduce the need for skills, as well as new orientations in education, training and research and new attitudes on the part of labour

management and government. They called for changes in the existing structures and institutions and a reorientation towards interdisciplinary approaches whether in R+D, education or government, an integrated system approach emphasizing backward and forward linkages, and an environment conducive to continuous innovation flow. The modified structures should respond quickly to rapid changes in innovation in venture-oriented, flexible management structures with risk-taking ability and the availability of venture-oriented capital. Education, research and production formed a trinity having a common culture and strong links between them, with particular emphasis on excellence and quality standards, guaranteed by upgrading skills and acquiring new ones at all levels, ranging from the worker to the manager. It was imperative that both the government and the people were kept aware of the impact of the technological advances. Therefore, information, awareness, intelligence, assessment, forecasting etc. became urgent needs.

67. Against this background, the Workshop considered in some detail the several activities, actors and institutions involved in the development and dissemination of the new technological advances, while keeping in mind the variety of levels of development in developing countries.

A. Technology Development

68. A wide spectrum of institutions and structures was involved.[7/] Apart from their shortcomings and the necessary changes that had aready been identified on several occasions for the more mature technologies, the following new factors were highlighted by the Workshop:

69. The interdisciplinary culture and practitces had to be nurtured actively. This could start by identifying national priority projects and assigning them to interdisciplinary tasks forces under competent leadership with adequate authority and funds commensurate with their responsibilities. Control of funding was an elegant way of nurturing the interdisciplinary culture in R+D institutes. Of particular importance in instilling the interdisciplinary culture was the bringing together of the social and physical and biological sciences. Because of the far-reaching implications

7/ See Industrial Technology Institutions, ID/WG.332/4.

of the technological advances, the overall integrated systems view should be taken, embracing the full spectrum from value systems, across economic and social consequences to technical considerations.

70. Technology development also needed to be trans-sectoral and trans-organizational if the full benefits of synergy of the technological advances were to be exploited. For example, a textile technology institute might join hands with an electronics research institute and industrial firms in both fields to develop microprocessor applications in the textile industry.

71. Mobility of personnel between education, research and production would facilitate free and continuous flow of innovative ideas, as well as better understanding of each other's problems and the emergence of a common culture. Administrative procedures would need to be instituted for permitting and encouraging that mobility Furthermore, employment of greater numbers of scientists and technologists in industry would facilitate the flow of information and experiences.

72. The professional and academic institutions would have a major role to play in propagating awareness and in acquiring the higher levels of skill, excellence and discipline called for by the technological advances and the value systems that go with them.

73. Developmental research, which was more focused than applied research and closely associated with the operational function, needed considerable strengthening due to the fact that the new technological advances were often amenable to rapid translation into production processes, particularly in applications in rural development that merged those with the traditional technologies. That called for particular attention to design, prototype and product evaluation activities.

74. Many developing countries did not currently have the full range of institutions for technology development. In some cases where there was a well-developed institutional structure there might still be need for new institutions. For

example, in one country possessing an adequate infrastructure it was necessary to set up a national biotechnology board to create a critical mass of the individuals working in that new field, to co-ordinate their activities and to prompt them to cover the whole area. That board would cut across several academic and R+D organizations.

75. The least developed countries might have different entry levels for both education and research. Some useful steps would be:

(a) to set up a goal setting body that would identify a few priority areas;

(b) to set up a small core group, say of 10-14 people, for each priority area with linkages to similar groups internationally. Such a group would keep the country informed about the state-of-the-art in that area and provide information and awareness intelligence;

(c) two or three such groups, e.g. biotechnology, genetic engineering, microelectronics, might be brought together and provided with common facilities like library, testing, etc. This conglomerate of groups might be allowed to grow into a centre of excellence or an advanced institute;

(d) similarly, for technology assessment, technological forecasting, technology choices and technology import negotiations, a separate group should be formed of economists, scientists, social scientists, systems analysts, bankers, industrialists, management experts etc. to analyze information, assess and offer alternatives for the decision-maker to make autonomous and rational decisions;

(e) engineering and consultancy groups might be set up with local experts or in association with foreign experts and/or firms to prepare feasibility reports covering the total spectrum including production and utilization;

(f) new and appropriate technology delivery systems needed to be thought of to support government initiatives in propagating technological advances. S/T institutes and development banks could adopt a district, an area or a cluster of villages for development through their application. Voluntary agencies might also be involved. Similarly, technology transfer centres might be set up in the rural areas. Youth organizations might be brought in to disseminate new technologies in rural areas with a sense of participation and pride of achievement.

B. Human Resources Development

76. Universities in developing countries could be an important repository of knowledge on technological advances if their structure and methodologies for teaching and research were changed from traditional practices to more appropriate ones. Too many universities in developing countries were overwhelmed by their teaching load to be able to undertake those changes or to relate more strongly to the developmental needs of their societies.

77. New approaches to the process of teaching were required making full use of modern teaching aids and kits and technological data banks. Textbooks, teaching material and laboratory equipment would have to be up-graded and staff retrained to reflect the impact of the technological advances. Universities should provide courses in design, production, management and related topics addressing the realistic needs of industry in the country.

78. Universities had three main functions, teaching, research and community service. University faculties in developing countries occasionally engaged in original research relevant to the needs of the country and had seldom become involved in the third important function of offering extension services. That latter function was particularly important in developing countries where skilled human resources were scarce and the country could not afford anything but full-time devotion of all competent human resources to its development needs.

79. The practice of peer review was not common in developing countries. Yet peer reviews were a powerful tool for ensuring the achievement of desirable standards by a university. The review process usually involved scrutiny of curricula, academic standards and professional experience of faculty, extra-mural activities, as well as management practices.

80. The traditional emphasis on publications as the criterion for promotion hindered increased involvement of faculty in applied research. Promotion criteria should take into consideration involvement in applied research in developmental problems. Basic research should be assessed within the framework of its contribution to the development needs of the country. Unsatisfactory or marginal research should be terminated.

81. A triad of university, R+D and industry would bring about the full capabilities of the S+T community and focus them more effectively on development problems.

82. Where the qualified staff was not at hand, the involvement of expatriates, particularly expatriate nationals, was entirely appropriate. The practices of making the services of expatriate nationals available at conditions that accommodate their professional ambitions and responsibilities in their new home countries would have to be instituted. Universities needed also to establish working relations with sister institutions abroad that provided access to state-of-the-art information and advice on technological advances. The compilation of rosters of individuals and institutions facilitated access to such sources of valuable inputs and linkages.

83. The intensive training and retraining effort necessary to ensure the quantity and quality of human skills in dealing with the technological advances could not, and should not, be the responsibility of academia alone. Professional societies and trade unions, in particular industrial enterprises and government bodies needed to be involved in a nation-wide effort covering the full spectrum of human resources from worker, middle and top management cadres to decision makers, and also to potential end users in industrial service sectors, administration and the public at large. Continuing education acquired a new urgency and significance when people had to switch over to the new jobs that needed new skills and knowledge.

84. At a more fundamental and basic level there was also the upgrading and re-orientation of education at the school level. The widespread use of microcomputers, the restructuring of courses in biology, the emphasis on an integrated approach to scientific subjects, cultivating awareness of global environmental considerations and concern for the social implications of recent technological

advances called for a true revolution in the educational system. The major problem was the retraining of the teaching corps so that it could perform these momentous tasks.

85. The curricula of primary and secondary schools should be strengthened, through the mechanism of teachers possessing a better understanding of the emerging technologies and their applicability to the development process. Similarly, science clubs, science centres etc., might be established for that purpose. It was imperative that computer education be inserted into such programmes at the earliest posssible level.

86. It was reiterated that an interdisciplinary approach to education, training and research was required. It was no longer feasible to educate or train people in a single discipline without an adequate understanding of related disciplines. That referred to research fields also and was reflected in the emergence of such new fields as life sciences, environmental sciences etc.

87. For countries where educational structures were still to be built, the same steps as those suggested earlier might be taken, starting with a core group to be trained abroad or by inviting foreign experts who in turn would train nationals.

88. Centres for innovation needed to be established to provide facilities for the free play of innovative ideas. Finally, the ability to exploit fully technological innovations was closely related to the ability of educational systems to instigate changes in good time and to provide the necessary skills and trained personnel for bringing them about. Education for tomorrow's needs would be essential.

C. Industrial Production

89. First there was a need for developing awareness programmes aimed at highlighting the relevance, potential and pitfalls of introducing the new technologies in the industrial structure of the developing countries. Those programmes should address three main groups:

(a) The possible producers of goods and services based on these technologies;

(b) The potential users in industrial enterprises that stand to gain from the application of the new technologies;

(c) The general public who, together with the government, were the consumers and who would create the demand for their application.

90. Concentrating on the first two groups, the Workshop proposed that:

(a) Large industrial firms established advisory groups to identify optimum ways and means of benefiting from the technology advances. At least half the membership of such groups needed to be experts in the relevant technologies from outside the firms themselves;

(b) A main role for the Chambers of Commerce and Industry currently and in the immediate future should be to conduct awareness campaigns highlighting the potentialities of the new technologies for each sector;

(c) National awareness campaigns addressed specifically to the industrial community should be organized, covering a variety of levels and industrial sectors and providing concrete examples and feasible approaches to the advantageous adoption of the new technologies.

91. At the national level, the industrial structure had to be modified and stimulated in new ways in order to benefit from the technology advances. The Workshop felt that this could be achieved through one or more of the following actions:

(a) Development of a more coherent and interactive industrial structure facilitating the interchange of technologies and their vertical and horizontal diffusion across the established, relatively isolated sectors. Recent examples were the impact of microelectronics on machine tools, production control techniques and those of genetic engineering on the primary sector (agriculture and mining);

(b) Emphasis should be placed on the comparative advantage of the country or the region, in identifying the relevant technological advances.

That had to keep in mind the changing pattern of such comparative advantages with time and the changes in the relevant technologies to meet future situations;

(c) Exploitation of the technological advances, in order that they would be cost-effective called for closer interlinkages with other relevant non-industrial sectors, particularly education, R+D, banking, marketing and distribution;

(d) The strategy of exploiting the technological advances should be integrated with the national industrial and technological development strategy into a new synthesis of technological development based on a "niche" strategy that built on the comparative advantages of the national economy;

(e) Attention should be paid to strengthening the related traditional technologies.

92. At the level of the firm, the technological advances called for:

(a) A minimum in-house R+D capability to be established in the larger industrial units;

(b) International reorganization in inter-disciplinary task forces charged with specific development or production targets;

(c) Stricter quality control and higher levels of workmanship and emphasis on full and detailed documentation;

(d) Good, flexible and responsive information systems within the firm and with the outside;

(e) Emphasis by management on the encouragement and easy flow of innovative ideas ;

(f) Interest, support and financial participation in the exploitation of prototype useful applications developed in academic or R+D circles;

(g) Encouraging firms to formulate and implement long-term corporate strategies and plans for exploiting the technology advances, based on current and expected states and directions of development of these technologies.

93. The technological advances seemed to offer unprecedented opportunities for economic production at a wide range of scales of production. That highlighted the role of the knowledge-based specialized small firm feeding larger ones, even in lesser developed countries, in a new synergism based on parity between the big firm and the subcontractor, unlike the traditional asymmetry between the two. That underscored the role of a new type of entrepreneur whose main asset was scientific knowledge rather than business acumen and who needs new mechanisms and incentives for integration in the industrial structure.

D. Structuring Demand Patterns

94. The "technology push" of the technological advances in developing countries placed upon governments the responsibility of watching out for undesirable impacts on the national value system and way of life and to see to it that it was a useful and orderly "demand pull" that was shaping the national market for those technologies. The business community needed to be protected from making unwise investments at the wrong time, as well as dissuaded from the temptation of easy profit through importation of inapproriate or even harmful products that could cause social upheaval. Already the state in some developing countries had barred certain undesirable applications of microelectronics. That emphasized the need for building a much more competent, though not bureaucratic, regulatory capability backed by expert and up-to-date monitoring and assessment mechanisms.

95. In many developing countries, the State was the major consumer and source of national demand. That provided opportunities for controlled and orderly diffusion in society of the technological advances, through their introduction in public administration, social services and public utilities in harmony with national values and life styles.

96. Furthermore, public procurement - usually involving large-scale contracts - should stipulate participation and development of national capabilities to the maximum possible extent. That would accelerate the process of upgrading national institutional and individual capabilities and facilitate their mastery of the technological advances.

E. Financing

97. It was realised that financing was a serious problem in many developing countries. However, the technological advances were essentially high risk ventures that the developing countries had to undertake. Waiting for a period of reduced risk had been shown to mean losing the battle in trying to exploit them in the most favourable and least damaging manner. In that respect, traditional aid and technical assistance programmes could be reoriented to provide some of the extra financial resources required.

98. Taking advantage of the technology advances along the lines indicated above would require new financial resources, particularly to cover:

(a) Financing of R+D. This could be done jointly by the government, public and private enterprises;

(b) Financing of training and retraining of personnel in the new skills, ranging from monitoring, assessment and selection, through R+D and new production methods;

(c) Upgrading and substitution of obsolete plant and equipment;

(d) Venture capital directed to carefully selected applications.

99. Apart from government funds, private investors and the banking system would need to be involved, either through new technology investment companies or existing industrial development banks offering venture capital cost-free or at very low interest rates, or as grants with participation in returns from successful ventures.

100. Coupled with that there was a need for new incentives specifically directed to encouraging the development of the new technologies, such as:

(a) tax holidays and incentives for exports;
(b) national financing of training and re-equipment programmes;
(c) national financing of technological information servies;
(d) provision of grants for R+D in specific high priority applications.

F. Labour

101. The introduction of technological advances in developing countries would have important social impacts on the labour force. The age and skill profile of the labour force was a determining factor of the speed at which any new technology would be absorbed. That determined the scope and nature of the effort required for retraining and recruitment of new personnel. In general, the technological advances required higher intellectual standards, more team work and less physical labour. Those new requirements would make it difficult for present-day workers to adapt and retrain independently. Industrialists and governments should be aware that new technologies would cause unemployment at the micro-level. That might mean social tensions calling for improvements in social security schemes. That would need to be combined with special efforts by government, industry technical schools and labour unions to develop new motivations for retraining and establishing the required retraining programmes and facilities necessary to develop the new skills and attitudes required.

102. However, it should also be remembered that on the macro level, and on a broader national level, assimilation of technological advances would boost the national economy and thus provide better opportunities for employment, particularly through decentralization of production and accelerated rural development.

103. As mentioned earlier, the educational system should take into account the new labour requirements and should provide better basic education and better understanding and ability to deal with those more science-intensive technologies. The ethos of "learning" and continuous education should be instilled in the population who should be prepared to be retrained several times throughout their lives and to learn more about new scientific developments related to their new jobs. That will require special attention to skills such as reading, note-taking, memorizing, problem solving, etc.

104. In the long run, developments might bring about more leisure time for the working force. Properly managed, that would be beneficial for self-improvement in many respects: retraining, further education, artistic activities,

sports, hobbies, improved family life, more participation in community affairs, as well as better living, in general. However, some doubts were expressed about the benefits of more leisure time, given that it could also cause boredom, unrest, or even crime. It was a major responsibility of government, industry and labour unions to see to it that leisure time proved to be beneficial both for workers and for society.

105. New technologies would bring about changes in industry and, in many respects, create strains in the relations between management and labour. Industrial relations should be reoriented to cope with those new problems on the basis of a proper appreciation of the resulting benefits. Incentives and mechanisms that allow workers to prepare themselves for the new requirements in skills and attitudes needed to be devised.

G. Role of Government

106. Formulating and implementing an integrated strategy to respond to technological advances should be regarded as one of the major responsibilities of governments in developing countries. A strategy of scientific and technological development had to be formulated. To the extent such a policy existed, it had to be specifically re-oriented to take note of the features and implications of the technology advances. The starting point of such an integrated strategy would be a clear understanding of the potentials and implications of the technologies and how they would contribute to or affect the development objectives of the country. Such an understanding was urgent, particularly to decide on short run imports of new technologies, since inappropriate imports could result in significant and enduring distortions whose effects might outweight or nullify the benefits of long-run endogenous technological development.

107. Regardless of the level of development of a country, it was necessary for each country to establish mechanisms for awareness, intelligence, forecasting and assessment of the technological advances. The scope of the mechanism might vary with the size of the country and its conditions. As a minimum, an interdisciplinary unit of, say 6 to 12 professionals,could be established, close to a high policy-making level. Such a unit would perform monitoring and assessment functions drawing upon the expertise

of individuals and institutions within the country and where necessary outside it. Such units could be assisted in their establishment and operation through information and advice by UNIDO.

108. In view of the effort involved and to facilitate exchange of experience and adoption of possible collective strategies, a "Forecasting and Assessment Network" of developing countries could be created. UNIDO could service as the clearing house for the network. It could also contribute studies for the network and identify or promote centres in developing countries which could specialize in specific fields. This was meant to complement and facilitate, not substitute, national actions. The Workshop called upon UNIDO to elaborate that concept and put it into operation at an early date.

109. The results of forecasting and assessment of technological advances should be incorporated in the development plans of the country. Before a development plan could be drawn up, a comprehensive technological perspective for the country should be prepared and utilized in its formulation. Likewise, the results should be fed into the process of industrial policy formulation. Industrial and technological policies should be viewed as two sides of the same coin, together constituting an innovation policy. Public debates involving industry, the scientific and technological community, professional associations and users should be encouraged to facilitate the formulation and implementation of realistic and workable long-term strategies.

110. The incentive policies for R+D which already existed in developing countries should not be construed as complying only to the need for an innovation policy that concerned itself both with the development and commercialization of technology as well as the related structuring of industry. Additional resources and possibly new mechanisms for R+D were needed. The target of one percent of GNP as R+D expenditure was recommended several years ago. Taking into account the knowledge-intensive nature of the technology advances and the substantial R+D expenditures in that field incurred or planned by several developed countries, it was recommended that the developing countries should aim at devoting 1.5% of GNP for R+D by 1990 and to reach a minimum level of 2% by 2000. Developed countries, through appropriate provisions and reorientation of their aid programmes, could help to attain this level.

111. In view of the shortages of trained manpower in the technology advances, developing countries might adopt appropriate policies and mechanisms to enable national expatriates to assist their development. Such mechanisms could be linked to an "International Roster of Scientists and Technologists" in selected technological advances who were willing to assist developing countries through communication, training, field visits or a period of stay in those countries. The Workshop recommended that a computerized and updated roster of this kind be developed by UNIDO in implementation of the recommendation of the Tbilisi Forum calling upon UNIDO to mobilize the co-operation of scientists and technologists in the world to apply technological advances for development. The roster could contain information on the name, qualification and affiliation of the scientists or technologist, his fields of interest and competence, the countries he would be prepared to assist, the period of availability, financial remuneration required etc. Developing countries requiring specific expertise could approach the clearing house for information on the basis of which they could contact the concerned expert directly. UNIDO was requested to establish such a clearing house initially in the fields of microelectronics, genetic engineering and biotechnology, and solar and biomass energy. In that effort, it should co-operate closely with the United Nations Educational, Scientific and Cultural Organization (UNESCO),International Council of Scientific Unions (ICSU), Committee of Science and Technology in Developing Countries (COSTED), World Association of Industrial and Technological Research Organizations (WAITRO) and other relevant organizations. This roster could also be used to mobilize the co-operation of scientists and technologists in the development of applications unique to developing country conditions and in particular the development of "Technologies for Humanity" as recommended by the Tbilisi Forum.

112. The role of government in various other respects had been highlighted in the preceding discussion of the various activities and actors. In particular, public procurement should be used as an effective tool for the controlled induction of new technologies, to improve the productivity of public services and utilities, to create a demand for the production of goods and services and to familiarize the users with the technology advances and their benefits. Governments would also have to adopt appropriate laws, regulations and guidelines for standardization, quality control, public health safeguard etc.

113. The systematic popularization of science and technology in general and the technological advances in particular was an essential task of governments. It should be carried out with the objective of sensitising the public to the need for change; facilitating the acceptance of change; and above all in mobilizing the inventive and creative capacities of the population at large. Hence, in addition to popularization attempts through the media, museums etc., promotion of applications in every day life and those which improve traditional occupations would be of particular value. The scientific and technological community should be encouraged to devote some time to the popularization of the potentials of technology advances - "Invention Development Centres" could be created by government and/or services could be provided for inventors at nominal charges.

114. The public at large, and in fact the policy-makers themselves would be considerably assisted in their perceptions of the potentialities of technological advances if actual examples, case-studies and demonstrations were provided. The Workshop felt that UNIDO could perform a useful function in the collection and dissemination of such examples,and in the promotion of pioneer projects in that respect.

V. CONCLUDING REMARKS

115. The problems discussed by the Workshop were wide-ranging and complex, involving several actors and activities. Several elements in each and possible lines of action had been examined by the Workshop in a preliminary fashion and by no means exhaustively. Some of the changes proposed could not be introduced by a simple change of law or regulation but have to be effected or induced over a period of time. In that sense what had been discussed was a broad checklist of potentially important elements.

116. It was necessary to emphasize that action in any particular situation had to be selective and addressed to the key result areas, if it was to be effective in realisation of the objectives in the conditions of the country. However, the need for action, both short- and long-term was urgent. Given the scarce resources of developing countries, the penalty for inappropriate action was high, while fragmentary action might give the illusion of a response without the desired results. For example, a young developing country with a large rural population might choose to apply the advances in genetic engineering and biotechnology to such areas as food processing, agricultural development and energy from biomass, while another developing country with a sizable industrial base might see in the application of microelectronics,in upgrading traditional industrial processes,and better quality control and management practices the optimum application. National actions in each case would reflect the stage of development, the state of national institutions, the specific character of the technological advance to be applied and the availability of resources.

117. The Tbilisi Forum had already made a series of recommendations for action. The Workshop had developed some of these further and made some additional recommendations. It was not intended to enumerate those recommendations again, considering particularly that each country had to exercise a measure of selectivity. However, it might be useful to conclude by indicating some of the salient results of the Workshop:

(a) The problem of reorientation of institutions and structures had been approached in terms of activities and actors and the possible elements in each relevant to the technology advances identified preliminarily.

(b) The idea of core groups, whether for monitoring or for technological development in specific technologies, had been highlighted for all countries, particularly for countries at the earlier level of development. UNIDO should assist the setting up of such groups through technical assistance, advisory services and promotional measures.

(c) The relation between technological development and industrial structure had been emphasized, highlighting the need for an integrated approach to industrial and technological policies.

(d) It had been recommended that developing countries increase their R+D expenditure to 1.5 percent of GNP by 1990 and 2 percent by 2000.

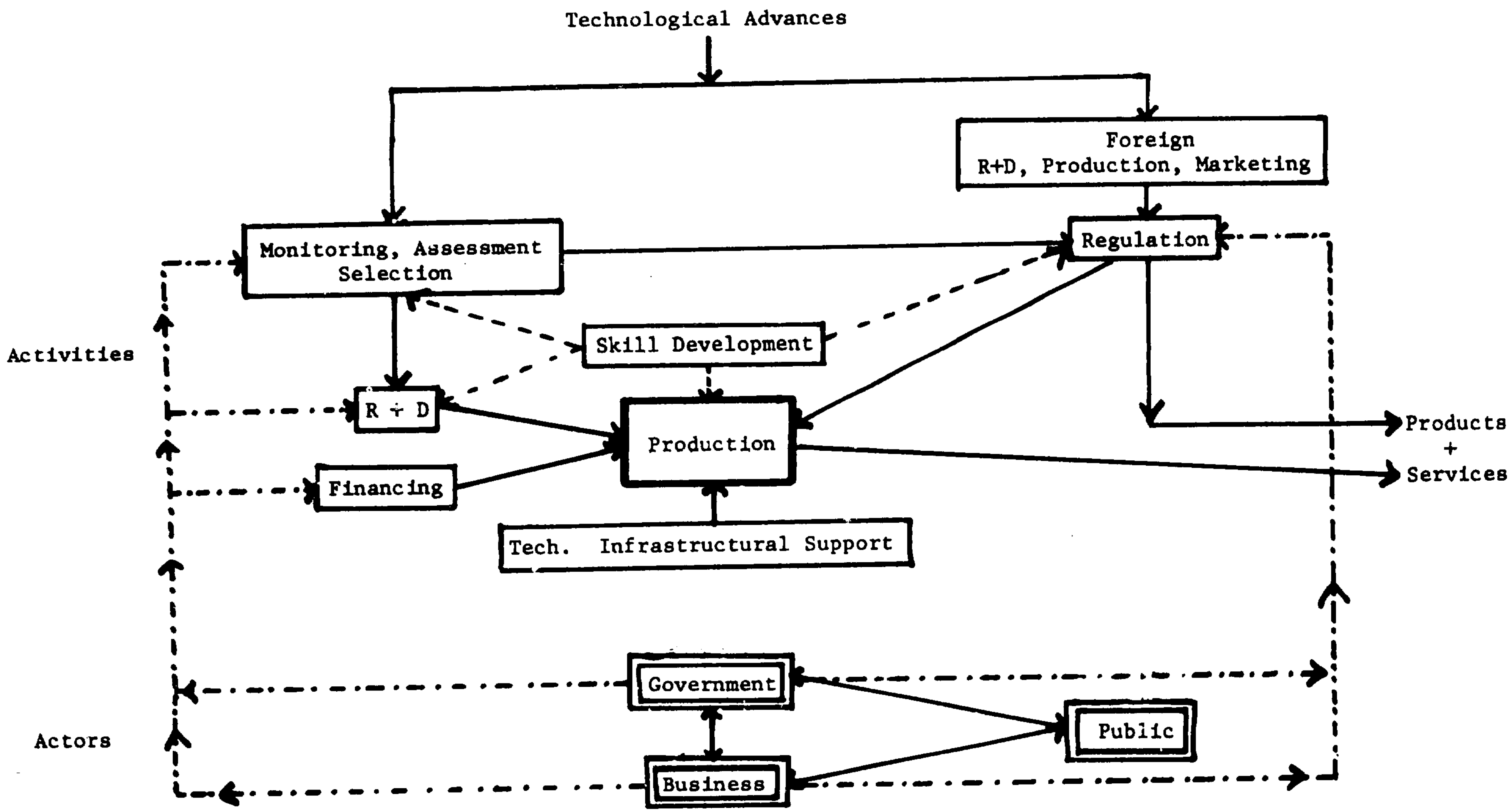
(e) An international roster of scientists and technologists, under the auspices of UNIDO had been recommended.

(f) A co-operative programme among developing countries in forecasting and assessment of technological advances had been spelt out.

(g) UNIDO should continue and expand its programme of technological advances. A study group should be established under its auspices to monitor the responses of developing countries to technological advances.

(h) Several possibilities of co-operation in that field among developing countries existed and should be promoted actively.

(i) Co-operation of developed countries was called for in regard to assisting developing countries in strengthening their technological capabilities in the field of technology advances.


Technological Advances
Foreign
R+D, Production, Marketing
Monitoring, Assessment
Selection
Regulation
Activities
Skill Development
R + D
Production
Products
+
Services
Financing
Tech. Infrastructural Support
Government
Actors
Public
Business

ANNEX I

ANNEX II

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ANNEX III

LIST OF DOCUMENTS

ID/WG.401/1	Status of Technological Institutions and Structures in Developing Countries by J.P. Blackledge
ID/WG.401/2	Types of Necessary and Desirable Changes in Institutions and Structures in Developing Countries in Order to Accept the Challenges of New Technologies and Appropriate Policies and Measures, with Special Reference to Yugoslavia by V. Matejić
ID/WG.401/3	Institutional and Structural Changes: Means and Mechanisms by Y. Nayudamma
ID/WG.401/4	Conditions and Justifications for Acceptance or Rejection of New Technologies with Special Reference to Yugoslavia by A. Ferencić and V. Kraljeta
ID/WG.401/5	Responses of Developing Countries to Technological Advances: Some Basic Considerations with Reference to Biomass and Photovoltaics by. O.A. El-Kholy
ID/WG.401/6	Some Considerations About a Practical Approach to the Development of Technical Infrastructure for Microelectronics by G. Fernandez de la Garza