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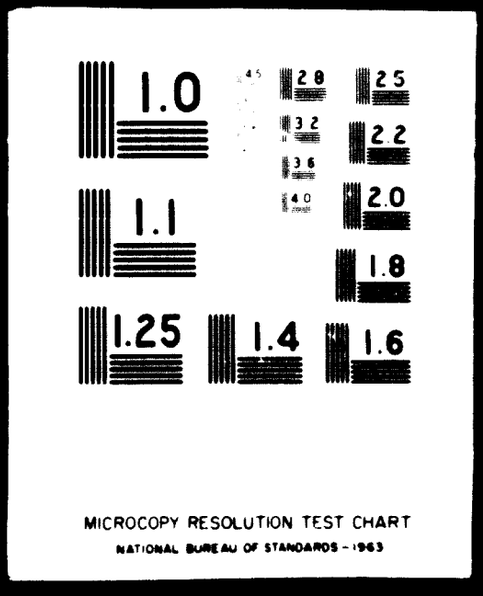
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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Background paper

EDUCATION AND TRAINING PROGRAMMES FOR INDUSTRIALIZATION

Presented by the
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and Cultural Organization

67-14615

Contents

I. DESIGN OF EDUCATIONAL AND TRAINING STRATEGIES FOR INDUSTRIAL DEVELOPMENT

1. Industrial development and technical education for the preparation of specialists are interdependent. The mere transfer of technology is not sufficient for the industrialization of the less developed countries although very important. There are two kinds of activities which play a dominant role in the creation of new economic structures: first, education and the training of local scientific and technical staff; second, the organization (including planning) of scientific work with a view to utilizing the particular scientific and technical potential.(1)

2. It has been noted that much time and effort will be required to secure "recognition of the need to build up in the developing countries the infrastructure of educational, training and research institutions required for the introduction of science and the equally important need to create among the general public, and especially young people, a greater understanding of the socio-intellectual aspects of science.

3. "The reason for these difficulties is obvious: at these fundamental and general levels, action is not likely to lead directly to tangible results which can easily be measured. Nevertheless, the United Nations Educational, Social and Cultural Organization (UNESCO) has never ceased to maintain that it is at those levels, and there alone, that decisive changes can be achieved. Indeed, it is only on these conditions that science, by ceasing to be regarded ..... as imported magic, the import of which at once proclaims and perpetuates the dependency of the under-developed countries, can become an integral part of the economic, social and cultural life of the community, and capable of spontaneous development."(2)

4. Industrial development of a country certainly depends on the natural resources to be found there, and it is therefore possible to forecast development in general terms for a period of several years. Manpower planning should go hand in hand with the very first industrial development plans. Some elasticity is of course required here, as industrialization is a process which does not depend only on local conditions. There are often many external factors which have to be taken into account, and it is therefore impossible to draw up hard-and-fast manpower plans. The manpower planners who calculate personnel requirements on the basis of over-all economic growth (planned over a number of years) and who go into the pattern of employment to determine production output, cannot see clearly the changes likely to be brought about in this pattern by rapid technological advances in various fields. Lack of precise information is another factor which makes it impossible to forecast exact requirements in every branch of study over the next twenty years. Requirements therefore need to be revised as time goes on. (3)

5. In spite of this, a balanced plan for development (including education and training) should be drawn up irrespective of the local situation.

6. Since technological and social changes may well influence the existing pattern of economic growth and development over a period of several years, detailed planning should not cover a period longer than five years. However, long-range general plans may usefully be prepared to cover a longer period. It has been stated:

> "Because of the rapid advances occurring in technology, there appears to be a clear need for all countries 'developed' or 'developing' to have some kind of national agency to investigate and co-ordinate the manpower needs and the training requirements for these needs. Such planning is essential for future economic and social development and should take place at all levels -

/...

regional, national and local -- and should be carried out by both the government and private sectors. It should be the result of close liaison between industry and educational authorities".(4)

7. Technical manpower planning with regard to human resources, and in conjunction with the entire economic development of a country, must be carried out, taking into consideration the fundamental branches of the economy at a given time and the natural resources of the country.

8. Planning for technical and vocational education should be carried out in close liaison with interested parties in industry, agriculture and commerce. Manpower planning should be carried out within the cadres of the same branch and be based on an evaluation of the knowledge possessed by the technical personnel. (The kind of technical hierarchy and the percentage of technical manpower within this hierarchy should also be taken into account in the general assessment). The time factor in preparing technical personnel should also be considered, as well as the possibility of disturbances affecting the planning (which can be quite considerable in developing countries).

9. An important influence on planning is exercised by the presence of foreign capital and loans from abroad, as well as by manpower immigration and emigration which often result from economic and political factors at play in the country itself or in neighbouring countries. The General Conference of UNESCO stated in 1962: "Although methods of prediction should take account of local circumstances, the planning and statistical authorities should, in making their forecasts, follow certain broad principles, adapted where necessary to different national needs."(5) For instance, in accordance with the pattern which has emerged in industrialized countries, one could say that there should be, roughly, one university for

every million persons, and this should be the target aimed at. Again, the experience of the industrialized countries shows that about 5,000 to 10,000 engineers and qualified technicians are needed per one million persons. Only in Africa, Asia and Latin America is it necessary to produce about five million engineers and technicians in order to reach the level of the industrialized countries of Europe and of America.(6)

10. The necessity for preserving some kind of equilibrium between the number of technical personnel produced and their absorption into industry must be borne in mind. This point was clearly made in a recommendation adopted by the twelfth session of the General Conference of UNESCO: "It is essential that efforts be made to obtain employment for all students who have completed their studies. The competent authorities should be concerned to see that the graduates of the schools obtain employment in the occupations for which they have received an education, taking into account their personal wishes."(5)

11. The criteria for assessing the optimum size of the various branches of technical education should be based on a country's needs and the ability to produce technical personnel. Once the requirements with regard to technpersonnel at all levels have been established, the problem of human resources should be considered.

12. Technical education does not usually begin at the same time as general education. If one takes it that between the ages of 22 and 24, people have become fully productive and useful members of society, one can say that the education pyramid is composed of a period of ten to twelve years covering primary and secondary education, and of a period of about four to five years covering university education. It is possible for men to go into production after the first five, six or seven years but if this is

done later, they will be better qualified for industry or public works. It is difficult to give any general rules in this case. There are many developing and developed countries in which engineering education, for instance, is carried out over a period of more than four years. There are others where the period is shorter. The length of the period of training depends on the amount of ground-work which has been done beforehand. It has been pointed out: "The number of years involved in technical and scientific training schemes will vary according to the conditions prevailing in the country concerned; plans should be sufficiently flexible to permit modifications in the light of experience."(7)

13. It is well known that technical education is expensive. Therefore, it is all the more necessary to co-ordinate the activities of the different sectors of technical education with a view to making the best use of available resources. In this case, too, one should aim at planned investment and recurrent expenditure. A recommendation has been made, as follows:

> "In determining the amounts to be allocated to technical and scientific training, increased requirements should be taken into account, particularly in the following fields:
>
> (a) New institutions based upon numbers of pupils and on new forms of technical and scientific specialization;
>
> (b) The recruitment, training, appointment and remuneration of teachers, laboratory technicians and workshop staff;
>
> (c) A sufficient number of buildings, including the necessary classrooms, laboratories and workshops;
>
> (d) Essential technical and scientific equipment for teaching and research;
>
> (e) The maintenance and running cost of the various installations;
>
> (f) Social assistance for students etc.

> Where the economic system of the country permits, industry, which would be the first to benefit from an increase in the numbers of technical and scientific staff, should be encouraged to contribute to the expenditure involved...The following types of contribution from private sources should be noted: the establishment by large firms of institutions for technical training or scientific research; the creation of a special fund by a group of firms, or contributions by private initiative to more general funds set up by the government; direct subsidies to certain institutions; a special contribution for the promotion of staff training; special scholarships to encourage certain studies or research work etc."(7)

14. Expenditure for teaching staff depends on the ratio between teachers and pupils and also on the ratio between junior and senior staff. It has also been stated that:

> "The shortage of technical and scientific staff has an adverse effect upon the recruitment of teachers for training such staff; serious steps must be taken to draw into and retain in the teaching profession technicians, engineers and scientists, who might be tempted by the better conditions of employment offered to them in industry, and to attract a sufficient proportion of the best secondary school pupils and university students of both sexes into teaching and research."(7)

15. The teaching staff for the education of technicians should possess higher qualifications than general teachers and should have had experience in their particular discipline. The training of technical teachers should be a continuing process. Arrangements should be made in order that they may keep abreast of modern processes and methods of production and management. Expenditure incurred by the non-academic staff (administration, laboratory and workshop services, cleaning staff etc.) depends very largely on the number of students in a school. The larger the school, the smaller the ratio between the non-academic staff and the students.

16. The quantity of technical personnel required in each country depends on the ratio between the different kinds of specialists (the managerial staff, management engineers in production or research departments, production technicians, maintenance technicians, skilled workers etc.). In spite of various recommendations, the ratio between the number of technicians and the number of engineers in developing countries is not altogether satisfactory (this is true of developed countries as well). It is only too well known that there is an insufficient number of good technicians in industry and public works. It has been said:

> "In the majority of the industries in the private sector, the supervisory personnel and technicians are recruited through promotion from the ranks of artisans. The choice by the employers of such personnel is influenced by the fact that the employers have been able to observe them for a longer period of time and thus evaluate their qualities of initiative, sense of responsibility and ability to lead their fellowmen. It is not unusual for such supervisors to be of mature age. These supervisors or technicians are able to carry out the limited nature of their assignments. However, with the expansion of the plant and with the introduction of new processes and handling techniques, the supervisors are handicapped by their lack of theoretical knowledge of the technology...."(8)

17. An important factor here concerns the choice of techniques adopted in different branches of industry. As has been pointed out:

> "The solution generally advocated consists of utilizing techniques which are not highly mechanized and which therefore require a greater number of manpower. It has been suggested, consequently, that developing countries should examine the possibility, when setting up industry, of using machinery no longer utilized in highly industrialized countries on account of the rise in manpower costs. This suggestion results from the fact that countries whose economic conditions, as far as cost of labour and amount of manpower are concerned, differ completely from those prevailing in under-developed countries produce machinery tending to eliminate, more and more, the manpower element."(9)

This idea is not generally upheld, however, as employers tend to profit from the cheapness of labour when capital is scarce. Nevertheless, when it is economically necessary and desirable from a social point of view to employ as many workers as possible, they should not be replaced by machines.(10)

18. The different kinds of specialists in each branch should also be taken into consideration. In this respect, natural resources play an important role, as well as a country's over-all development plan. However, there are several branches in which specialists are required regardless of a country's natural resources. Public works is one such branch. This is the reason why a country's first technical school is devoted to public works and the reason why the first engineering faculty is very often that of civil engineering.

19. Collaboration and co-operation between industry and technical education is very important in developing as well as in developed countries; without this collaboration, it is well-nigh impossible to train even middle-level technical personnel efficiently. Industry affords the opportunity of training on the spot, and technical teachers can maintain liaison with industry in solution of a specific problem. Co-operation between the school and industry would therefore be possible. The school could offer, for instance, training courses open to industrial workers, thus giving the workers a way of improving their knowledge and techniques. It has been stated:

> "Most important in these considerations are the attitudes of employers towards technical education. The larger firms, it is true, often look for some formal technical education in their recruits and when this is not forthcoming, they may even set up their own training courses in one form or another. However, many firms in developing countries, and indeed some in developed countries, do not yet place a high value on technical education,

particularly at the technician and trade level. To some extent, this is because the technical education which is being given is not very closely suited to their needs. Seldom are adequate occupational analyses available on which to base curricula suited to local circumstances; and this is of particular importance in developing countries where, because of the great diversity of industrial techniques, the occupational terminologies, again usually borrowed from the developed countries, give only a most approximate indication of the work actually to be performed in many jobs."(4)

20. The strategy which should be followed in order to assist industrial development by means of technical education would have three phases: the phase before execution of the programme for the teaching and training of technical staff, the execution of the actual programme, and the phase coming afterwards.

21. Before executing the programme it is necessary to know the potential of the teaching establishments and to assess the needs of industry. Decisions must be made as to the new measures to be adopted. The new operations can then begin. This programme presupposes the existence of planning as well as co-ordination in the field of education.

22. Since it has been noted that frequent alterations are made in the economic development plans of developing countries, the technical education system must take these changes into account. Those responsible in the field of technical education should point out to the economic authorities the difficulties which will be encountered when trying to meet the needs of industry.

23. After establishment of an educational system and after the preparation of a certain number of specialists, the results will then have to be analysed. This analysis cannot take place immediately after the first few technicians or engineers have been produced, but only after several years

of their absorption into the economy; it will then be possible to determine whether technical education is running along the right lines.

24. In many cases, it is necessary for technicians to work for a probationary period in industry. During this period, both technical educators and industry have a great responsibility towards the technicians. Special legislation should be enacted to cover this period.

25. The new curricula should also be worked out in close collaboration with industry. There should also be collaboration between the two sectors dealing, respectively, with technical education and the training of skilled workers.

II. IMPLEMENTATION OF EDUCATION AND TRAINING PROGRAMMES FOR INDUSTRIAL DEVELOPMENT

26. There should be a harmonious interplay between general and technical education. It has been recommended that:

> "Technical and vocational education should be an integral part of an overall system of education and, as such, due consideration should be given to its cultural content. It should do more than train an individual for a given occupation by providing the persons concerned with the necessary skills and theoretical knowledge; it should also, in conjunction with general education, provide for the development of personality and character."(5)

In many developing countries, general education, from a structural point of view, runs along the same lines as prevail in the industrialized countries that once had, or still have, a great deal of influence in the developing countries.

27. In a great number of less-developed countries, a very small proportion of pupils in primary schools go on to secondary school, and a still smaller percentage proceed from secondary school to some higher form of education. The majority of young people, therefore, do not progress beyond primary education. That is why it is necessary to introduce the fundamentals of technical and agricultural education in the early school years. This must be done very carefully. It has been further recommended that:

> "Premature specialization should be avoided, and in all programmes of study the proper balance between general, scientific and specialized subjects should be maintained without increasing the amount of subject matter taught....Any system of primary education which is mainly general and non-vocational should include some means of giving children a liking and respect for manual work, accustoming them to observation and creative effort and encouraging in them an intelligent approach to the practical problems arising at home and in the community. However, work not likely to contribute towards general education should be avoided."(5)

28. Secondary education plays a very important role in developing countries and should be regarded as complete in itself. It should prepare and train pupils for a career even in cases where secondary education remains extremely general. All levels of the administration are increasing in number, and the majority of its members have enjoyed general secondary education. In developing countries, therefore, it should be concluded that secondary education also should have a practical bias, certainly more practical than in the developed countries.

29. It has been mentioned that "the trend to include certain technical subjects in general secondary education should be encouraged. In the later stages, all pupils should be offered a choice between various special subjects in order that they may be better prepared to select a suitable career."(5)

In addition to full-time education, the following types of technical and vocational education should be considered: theoretical education, while part of the practical training is obtained through periods of work; the day-release system, providing for workers to attend school for one day a week; the sandwich system; the block release system, with courses for one or two short periods a year; evening courses; correspondence courses; and last but not least, refresher courses.

30. In some countries, whether they be developing or developed, education between the primary and university levels is divided into two cycles.

31. Regardless of the duration of these two cycles, it would be most useful, in the case of each country, to know at what point, in their school career, the pupils graduate from general secondary education to technical school education.

32. There are various possibilities in this connexion. After completion of their general education, technicians can be trained in some two-year courses. As a result, such technicians will be quite well-trained with their general technical knowledge of a rather high standard. However, this method is rather costly, as the technician goes into industry somewhat later. Another possibility is for the pupils to go directly to the technical school after completion of primary school education. This is a good method of training technicians, especially for industry. However, if those pupils wish to enter a university afterwards, they do not generally make the best engineers since their level of general education is not sufficiently high. The third possibility is for pupils to begin their technical education without having completed their general secondary education. This method is often adopted, and the results are best when this transfer is made about two years before completion of general sscondary education.

33. From the educational point of view, it is desirable to refer to the system which "consists in fully integrating theoretical instruction in technical education establishments with practical work in industry; this system normally provides for equal periods spent alternately in recognized practical training in industry and in academic study, both training and study being carefully co-ordinated and supervised; a common arrangement is for students to be employed throughout their courses by the industrial organizations which provide their practical training."(7)

34. It is most important for pupils, whatever form of education they may have chosen, to be able to continue their training and thus reach a more advanced level until their potentiality has been developed to the full.

35. Access to all levels of technical, vocational and general education should open to everyone, and transfer from one type of technical education to another should be made possible.

36. With regard to the education of engineers, the developing countries have adopted the educational system followed by developed countries. There has been more and more talk recently in many industrialized countries of reforming engineering education with a view to producing engineers of a more general type, rather than engineers specializing in a very narrow field. Once, technical education covered a wide field but in recent times, there has been such diversity of technical knowledge in all its various fields of application that specialization has tended to become narrower and narrower in many different engineering fields. It is preferable that the engineering students at a university should have a more general basic technical training and that specialization should follow graduation. If this is true for industrialized countries, it is even more applicable to developing countries where mistakes in development planning are more likely and where it is harder to ensure work opportunities for many different engineering branches.

37. At the Latin American Conference for the Application of Science and Technology to Development, held at Santiago in 1965, mention was made of the insufficient recognition of technical careers, particularly at the intermediate level, and of the inefficient utilization of skills. Higher prestige, better utilization of skills and more attractive prospects would encourage young people to pursue technical careers. For this reason, the fourteenth General Conference of UNESCO, held in November 1966, agreed that upon the request of member States, studies regarding technical careers would be carried out and advice would be provided with a view to increasing the attractiveness of technical careers and to ensuring sufficient utilization of technical personnel.

III. SOME SUGGESTIONS CONCERNING INTERNATIONAL ACTION

38. All that has been stated earlier shows how much can be done by international organizations, which act as catalytic agents, in the economic and cultural fields of developing countries. Co-ordination of effort is the key to action on the part of international organizations. Co-ordination is essential from the moment that development plans for those countries are conceived. It is essential in order to lay proper stress on the importance of developing technical education and to convince those responsible — the parents and society at large -- of the vital role which technical education is called upon to play in the life of the community.

39. The UNESCO was co-author of the recommendations of the 1959 International Conference on Public Education which proposed intensification within the framework of the United Nations of the training of technical and scientific staff, by means of aid in opening new institutions, the enlargement of existing ones etc. UNESCO is acting upon this proposal. The General Conference of UNESCO, at its fourteenth Session, authorized

the Director-General of the organization to encourage international co-operation in the development of technical and technological education and training in member States, and in particular:

> To continue to provide advisory services to member States towards improvement of technical and technological education and training;
>
> To continue to assist member States in the education and training of technicians and engineers.(11)

40. During the 1967-1968 biennium, 45 projects which have been entrusted to UNESCO by the United Nations Development Programme (Special Fund Component) for execution, are primarily for the education of engineers and the training of technicians in developing areas. The amount allocated for this purpose totals $15,672,500.

41. Co-ordination of activities among the United Nations specialized agencies would result in a better deployment of work with regard to the teaching of different categories of technical personnel. "In some cases, several countries would be well-advised to pool their resources in order to set up regional technical or scientific institutions, and possibly technical teacher training schools also, on a regional basis", it has been stated.(7)

42. At the 1965 Conference on the Application of Science and Technology to the Development of Latin America, organized by UNESCO with the co-operation of the Economic Commission for Latin America, it was recommended that a centre be organized, with the professional staff necessary, and "that the centre deal with problems involved in the application of science and technology to the development of the region. In its activity, it should not overlook the repercussions of its recommendations in the social and economic field and should therefore co-ordinate its action with

other specialized organs in the region."(12)

43. Among other activities, it has been proposed, the functions of the centre should include studies such as the identification of the major technological problems that hamper development, in accordance with the need to find technical solutions to fit the specific characteristics of the area, and the analysis of the existing technical education systems in the light of local conditions; and the formulation of recommendations for the improvement of educational systems in Latin American countries. The functions of the centre should also include the furtherance of applied scientific and technological research projects of a regional nature, the organization of regional courses for graduates in the various fields of technology and the applied sciences, the organization of the exchange of research workers and teachers, both among the countries of the region and with other countries, the organization of regional courses on subjects which, though new to the region, are important for it, and the encouragement of constant contacts between universities, technical institutes and other technical training institutes, and between them and industry in the region.(15)

44. In order to continue in other regions the activity begun in Latin America, a regional conference to consider the same range of subjects will be convened in Asia in late 1967 in co-operation with the Economic Commission for Asia and the Far East.

45. The 49th Recommendation adopted by UNESCO and the International Bureau of Education (IBE) at the International Conference on Public Education in 1959 states that "the initiative taken by various international, regional or national organizations, both public and private, in increasing the number of scholarships for young technicians or scientists to study or take further

training abroad or else to go abroad for practical work relevant to their training, should be encouraged."(7) A good example of international co-operation in this connexion is the post-graduate training courses which UNESCO is sponsoring in the field of engineering. This activity conforms to the recommendation concerning technical and vocational education adopted by the UNESCO General Conference in December 1962. It stated: "Post-graduate study should be encouraged as a means of attracting the most capable candidates for teaching and scientific research. Announcements of vacancies and of competitive examinations should be made public, and financial aid should be given to post-graduate students in the form of fellowships, grants etc."(5)

46. UNESCO has launched an appeal to member States with long-established scientific traditions, to collaborate in organizing a network of UNESCO-sponsored international scientific and technological training programmes for the benefit of staff members of universities and scientific institutions located primarily, but not exclusively, in developing countries. This programme aims at upgrading the quality of science-teaching and research staff by giving them the opportunity to strengthen their research competence and to introduce a strong laboratory orientation to their teaching.

47. The programme is a joint endeavour of UNESCO and those of its member States which agree to share their experience with other countries. Training programmes, including theoretical and practical teaching as well as initiation in individual research work, are offered in selected fields of the pure and applied sciences. These programmes are organized in the various participating member States at universities and scientific institutions where higher education and research are of a recognized high level in the particular field considered. Courses may be organized both in developing and

developed countries to meet the needs in all of the main basic subjects in science and technology.(13) At present, post-graduate courses in chemical engineering are in operation in the Federal Republic of Germany and Japan; courses in the field of petroleum technology are under way in Italy and Romania; and courses in automation and metallurgy are being given, respectively, in Spain and Argentina.

48. International exchange of educational administrators, technicians and teachers of technical and scientific subjects also contributes to the improvement of the training of future staff.

49. At its fourteenth session, the UNESCO General Conference agreed that missions should be carried out in member States to advise on the means of creating the structure for technical and technological education and also to meet the requirements of their national development plans.

50. Mention should be made of the normal activities of UNESCO in the field of technical education and training related to the question of economic development. The recommendation on technical education and training, adopted at the eleventh session of the General Conference (1962), stated that: member States should co-operate in the field of technical and vocational education with, where desirable, the help of international organizations. Member States should take continuous action in the preparation of programmes of international co-operation in the field of technical and vocational education. For this purpose, the recommendation continued, they should create within their own territory a climate of opinion favourable to international co-operation.

51. Despite all of the recommendations and the work which had been carried out, the diversity of opinion and the variety of approaches among participants at the Regional Seminar on Technical Education held at Tripoli in

April 1966, showed that the UNESCO recommendation on technical and vocational education had not yet penetrated all appropriate circles concerned with this field in member States, "The difficulties experienced by the majority of the countries in attracting sufficient numbers of candidates for the technicians' category was shown to be mainly due to the persistence of traditional discrimination against manual or practical work by the section of the population having achieved a certain level of education", the report of the Tripoli Seminar stated.(14) This shows that there is still much to be accomplished in this field.

52. International co-operation in the field of industrial development will clearly be required in the proposed "World Plan of Action for the Application of Science and Technology to Development". 1/

1/ Proposed by the United Nations Advisory Committee on the Application of Science and Technology to Development, and endorsed by the Economic and Social Council in August 1966 (resolution 1155 (XLI)). The objectives of the World Plan would be, among other things, to promote the more effective application of existing scientific knowledge and technology to the development of less developed countries; to assist such countries to build the necessary institutions and to train skilled personnel; and to mobilize the efforts of scientists and research organizations to find solutions which will be of special benefit to developing countries.

During discussion of this proposal in the Co-ordination Committee of the Economic and Social Council, Rene Maheu, Director-General of UNESCO, stated:

> "The very idea is likely to give a new stimulus to the efforts of member States and international organizations in what is unanimously regarded as a key sector of development, and it is particularly timely at the present juncture, when a survey of the situation reveals a dangerous slackening in the progress of the developing countries..... The very existence of the plan is likely to lead to a more systematic approach and to a better organized solidarity in the planning and execution of these efforts, which are likely to be considerably more effective as a result. The activities of international organizations, in particular, are bound to gain in effectiveness if, without losing their individual character, they take place within a general framework which strengthens their natural ties and ensures that they converge along lines leading towards common objectives." (2)

53. In order to have a true world plan which can be converted into action, the Director-General said, three conditions must be met. These concerned:

(a) The availability of adequate funds;

(b) Precise programming by organizations, particularly those of the United Nations family, which will assist in the execution of the plan;

(c) Incorporation of the objectives and guide-lines of the plan in the national plans of the States concerned."(2)

54. The resolutions adopted at the fourteenth session of the General Conference of UNESCO in 1966 on the general aspects of technological progress (requirements, potential, structure), technical and technological education and training, and the promotion of the technological sciences and applied research -- demonstrate the importance accorded by the organization to technical education and to questions requiring international co-operation with a view to assisting in the economic and cultural development of member States.

ANNEX

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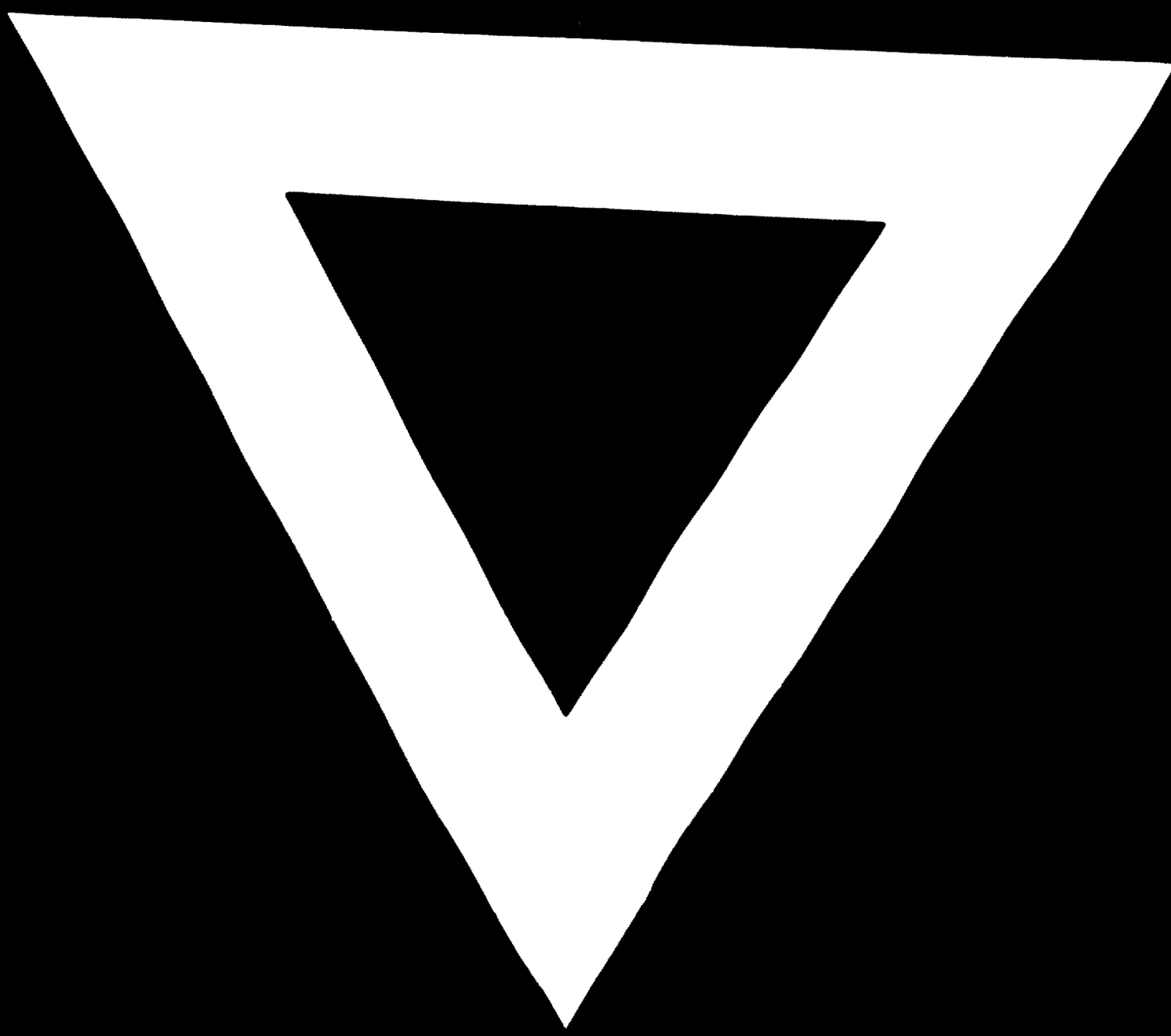

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