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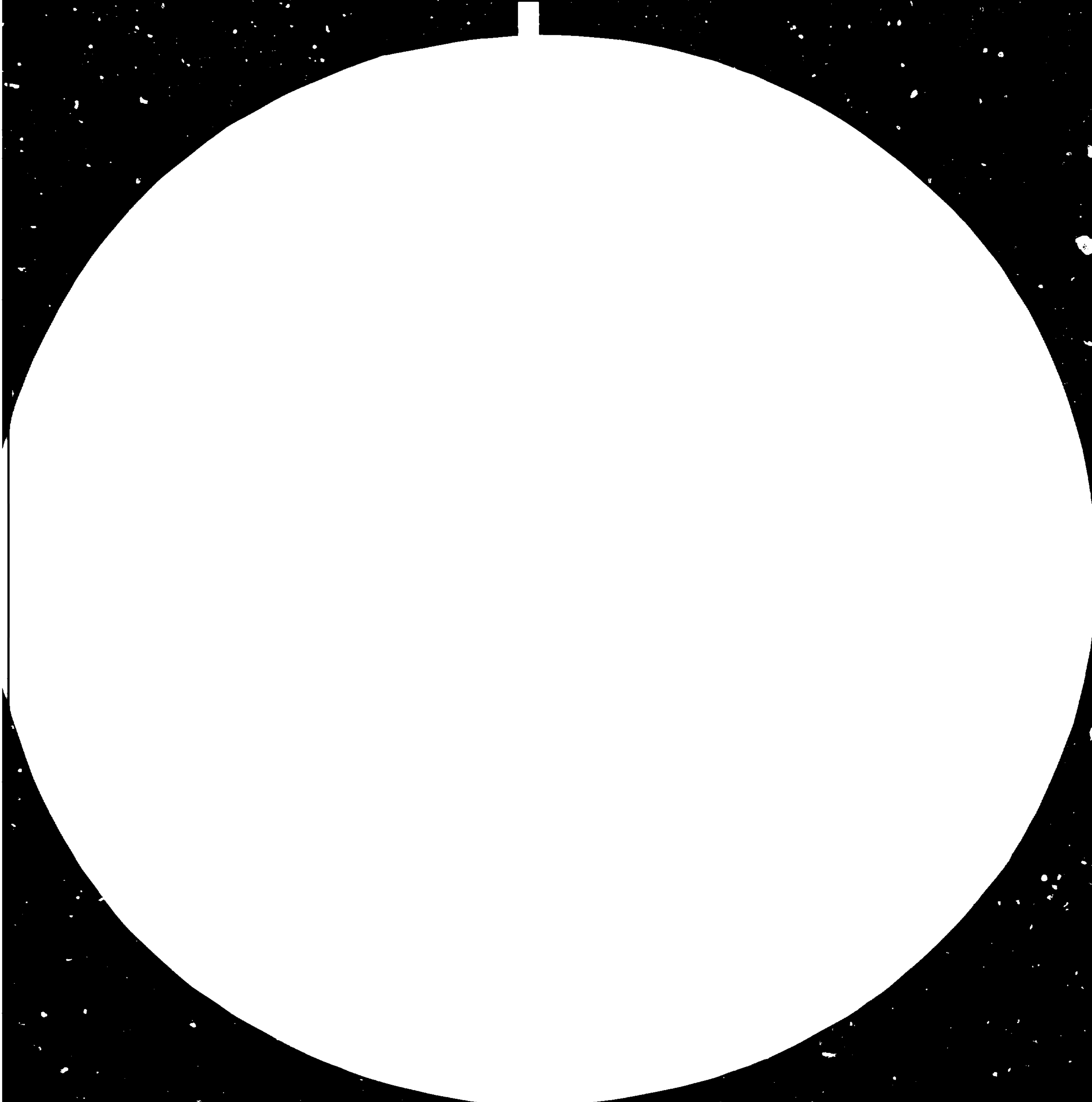

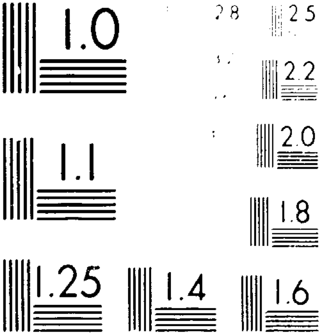
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INDUSTRIAL TECHNOLOGY MANPOWER IN AFRICA *

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CONTENTS

INTRODUCTION

1. This paper deals essentially with industrial technology manpower rather than the wider issues of manpower development in Africa. There is a wide range of functions to be performed by industrial technology manpower. Broadly speaking, these cover:

(a) Technology selection: including scanning for available technologies, evaluation and assessment, feasibility studies etc.;

(b) Technology acquisition: mechanisms, legal and contractual conditions, negotiating skills, regulation of flow of technologies, monitoring of implementation etc.;

(c) Financing and investment in technology projects and project evaluation: financial analysis, market surveys and projections, mobilization of internal and external finance;

(d) Assimilation and adaptation: management, production engineering, maintenance, manpower development, modification and adaptation of soft and hardware;

(e) Development of technology: technological R and D, engineering, commercial production and distribution;

(f) Technological services: standards, metrology, consultancy, design and testing.

2. Although accurate statistics on African technology manpower are not available,[1] it seems obvious that in almost all African countries today there are serious gaps in most of these functions. In particular, the functions of technology acquisition, assimilation and development may be cited.

3. The technological manpower needs are part of the overall manpower needs in Africa. Manpower is particularly critical in the context of African industrial development as a whole. Although many African countries are endowed with abundant natural resources, most of them lack comparable reserves of qualified human resources. This is partly due to to underpopulation (table 1 shows that there are several countries

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1/ See document Action in the Field of Industrial and Technological Information in Africa (ID/WG.332/1) prepared for the Symposium.

in Africa with a population of less than five million). It is also attributable to the fact that the existing population is still not equipped to provide all the skills needed in the necessary numbers. There is no assessment of the present manpower needs for industrialization and technological development;2/ but there is no doubt that these will be considerable for the whole of the next decade if Africa is to increase its rate of industrial expansion to the 11 per cent per annum required for meeting the Lima target.

4. In the fifties, with very few exceptions, relatively high proportions, ranging from 30 per cent to over 80 per cent, of the limited high-level manpower requirements in Africa were met from foreign resources.3/ For example in Zambia at the time of independence, there were only 1,200 Africans with secondary school certificates and only 108 Zambian graduates. Similarly, the first manpower survey in the United Republic of Tanzania in 1962/63 showed that over 80 per cent of all jobs that required a university education were occupied by non-Africans. Faced with this situation, the African Ministers of Education, at their first conference in May 1961 in Addis Ababa adopted the Outline Plan of Education for Africa. This set out a twenty-year programme (1961-1980) of mass education. Although the African countries have made enormous progress in meeting the targets, if a random sample of 100 school-age children is taken it will be found that about 90 receive only primary education or less.4/ Traditional educational and institutional facilities cannot provide enough places for all those who are willing to learn because school organization, material requirements, curricula structure and courses offered still cling to inherited patterns, notwithstanding some promising educational innovations in Ethiopia, the United Republic of Tanzania etc. over the past two decades. Hence, many African countries find themselves faced with manpower shortages as their economies grow.

2/ In 1968, ECA estimated that Africa needed to train about 30,000 management and supervisory personnel, 52,000 scientists, engineers and technologists, 112,000 technicians and foremen and 1,722,000 skilled and semi-skilled workers (E/CN.14/WP.6/18, p. 13)

3/ ECA (1978), Manpower development and utilization policies and strategies with special reference to indigenization of African economies, C/CN.14/CAP.7/10, Economic Commission for Africa, Addis Ababa, 16 November 1978.

4/ See Education in a Rural Environment, UNESCO, Paris, 1974.

Table 1

Population of African Least Developed Countries around 1975

Total population in 1975 by sex and country (Unit: thousands)				5-24 years age groups by sex and country		
Country	Male	Female	Total	Male	Female	Total
Benin	1,514	1,560	3,074	690	701	1,391
Botswana	320	371	691	162	173	335
Burundi	1,859	1,906	3,765	825	830	1,655
Central Africa Empire	861	929	1,790	392	403	795
Chad	1,925	2,098	4,023	863	918	1,781
Ethiopia	14,111	13,864	27,975	6,371	5,994	12,365
Gambia	256	253	509	109	109	218
Guinea	2,187	2,228	4,415	961	977	1,938
Lesotho	566	582	1,148	234	237	471
Malawi	2,341	2,576	4,917	1,086	1,123	2,209
Mali	2,834	2,863	5,697	1,271	1,255	2,525
Niger	2,282	2,309	4,591	1,038	1,041	2,079
Rwanda	2,024	2,176	4,200	917	978	1,895
Somalia	1,567	1,603	3,170	754	761	1,515
Sudan	9,229	9,039	18,268	4,269	4,137	8,406
United Republic of Tanzania	7,577	7,861	15,438	3,658	3,510	7,168
Uganda	5,692	5,661	11,353	2,593	2,529	5,122
Upper Volta	3,003	3,029	6,032	1,343	1,318	2,661
Total	60,148	60,908	121,056	27,536	26,994	54,530

Source: Population by sex and age for regions and countries 1950 - 2000 as assessed in 1973. Medium Variant - Prepared by United Nations Population Division.

5. The absolute size of a country's population influences the number of nationals in the 5-24 years school age population and, consequently, the local potential for the production of trainable nationals, assuming that there are adequate physical facilities and financial resources, as well as the socio-political will to enable all to go to school. Educational and training facilities are still limited in Africa. School enrolment indicates that not all eligible school-age populations are going to school or find facilities to do so, especially at the secondary level. There is also gross imbalance in the distribution and use of available places in secondary level institutions. This is particularly significant since this is the level that produces the skilled manpower at the routine executive level. It is largely due to the bias at the secondary level, accentuated by social values and wage structures for different types of jobs and qualifications, and perpetuated by the former colonial premium set on clerical work, that African countries experience recurrent shortages of middle and lower-level technical personnel and skilled operatives needed in industry and agriculture.

6. While the increase in the primary enrolment ratio since 1960 is smaller than that envisaged in the Outline Plan of Education for Africa, the expansion of enrolment ratios at the secondary and tertiary levels has exceeded the targets set in the plan. This would not be a cause for concern had not the proportion of enrolment in technical and vocational courses appeared to have dropped and the attempts to increase substantially the proportion of science and technology students in higher education fallen short of requirements.

7. One disturbing fact is that engineering and agriculture are the smallest groups of study in most African countries.[5/] This has serious consequences for the building up of an adequate potential for technological development, particularly in industrialization, the mechanization of agriculture and for economic growth and national development as a whole.

5/ Tables 14 and 15, UNESCO, National Science Policies in Africa, No.31, Science Policy Studies and Documents 1974, Paris, France.

Similarly, the low percentage of students in agriculture (with the exception of Mauritius) is obviously undesirable for countries seeking self-sufficiency in food as top priority. Furthermore, the tendency has been to concentrate only on basic and applied sciences rather than on developing the practical ability to perform through sensitization to the importance of the multidisciplinary approach in solving real life problems. This has led to recurrent complaints by the business community that African educational systems fail to give sufficient attention to the practical problems of the world of work.

8. Furthermore, African countries have not only to increase their skilled manpower as rapidly as possible but also to use it efficiently and effectively as it becomes available. More specifically, it is necessary for each African country to give particular attention to the following problems:

(a) The salary structure and social status of skilled manpower, including promotional prospects. The appropriate levels of differentials between skills of various types; relating remuneration to job specification rather than to paper qualifications. Linked with this is the problem of incentive schemes that would encourage the strengthening of national technological capabilities;

(b) On-the-job training and prospects for vertical mobility for semi-skilled manpower as well as high-level personnel;

(c) Motivating, training and upgrading unskilled labour;

(d) The question of adult illiteracy;

(e) The problems of "school-leavers" and brain drain".

9. Focusing on the African stock of manpower for technological development, the following general remarks can be made:

(a) Africa lags far behind the world figures for scientists, engineers and technicians (see table 2). The figures for Africa are one fourth to one third those for Asia and almost one tenth of those for Latin America. They are two whole orders of magnitude below those of developed countries;

(b) The distribution of scientists, engineers and technicians in Africa is very uneven (see table 3). It ranges from over half a million to as little as a few hundred;

(c) There are still considerable numbers of non-nationals in many African countries (see notes for table 3);

(d) The number of scientists, engineers and technicians engaged in research and experimental development is limited (see table 4). Their percentage distribution over the various fields varies considerably (table 5), with natural sciences and agriculture predominating in many countries and engineering and social sciences far behind in most African countries.

Table 2

Technological capacity, selected indicators[a]

(Averages expressed as medians for 1970 or latest year available)

Per 10,000 population	Developed market economy countries	Developing countries and territories		
		Africa	Asia	Latin America
Science and technology				
Ratio of total stock of scientists and engineers	112	5.8	22.0	69
Ratio of technicians	142.3	8.3	23.4	72.2
Scientists and engineers engaged in R and D	10.4	0.35	1.6	1.15
Technicians engaged in R and D	8.2	0.4	0.6	1.4

a/ The size of the sample countries vary by indicator.

Source: UNIDO, 1979, International flows of technology, (Vol.3, UNIDO/IOD/326).

Table 3

Number of scientists, engineers and technicians in African and selected non-African countries

Country	Year	Definition of data	Total (SET)	Scientists and Engineers	Technicians
			(1)	(2)	(3)
African countries					
Botswana 1/	1972	ST	1 527	786	741
Egypt	1973	ST	...	593 254	...
Djibouti	1973	ST	35	35	
Ghana 2/	1970	EA	21 993	6 897	15 096
Kenya 3/	1975	EA	11 009	5 130	5 879
Libya 4/	1973	EA	+18 921	+8 319	+10 602
Nigeria 5/, 6/	1970	ST	35 126	19 885	25 241
Seychelles 7/	1973	ST	...	+300	...
Sudan 8/	1971	ST	+16 431	+13 792	+2 639
Togo	1971	EA	672	461	211
Tunisia 9/	1974	EA	11 135	3 421	7 714
United Republic of Cameroon 10/	1970	ST	+3 500	...	...
Zambia	1973	ST	37 000	11 000	26 000
Non-African countries					
Brazil	1970	ST	1 718 822	541 328	1 177 494
Canada 11/	1971	ST	...	621 645	...
Federal Republic of Germany	1970	ST	1 189 000	1 083 000	106 000
India	1971	ST	+1 174 500	...	...
Netherlands	1971	ST	+742 000	+442 000	+300 000
Pakistan 6/, 12/	1973	ST	...	111 000	...
Switzerland	1970	ST	...	175 090	...
USA 6/	1976	EA	2 605 000	1 647 000	958 000
USSR 13/	1975	ST	22 796 300	9 477 000	13 319 300

Key

ST = Stock of scientists, engineers and technicians;

EA = Number of economically active scientists, engineers and technicians;

SET = Scientists, engineers and technicians.

NOTES:

1/ 557 of the scientists and engineers in column 2 and 171 of the technicians in column 3 are non-nationals.

2/ 1,761 of the scientists and engineers in column 2 and 317 of the technicians in column 3 are non-nationals. The figures in column 3 do not include social sciences and humanities.

3/ Data refer to persons in gainful employment.

4/ Approximately 79 per cent of the scientists and engineers in column 2 and 34 per cent of the technicians in column 3 are non-nationals.

5/ Data relate to the year 1970/1971.

6/ Not including data for social sciences and humanities.

7/ Approximately 150 of the scientists and engineers in column 2 are non-nationals.

8/ Data relate to the year 1971/1972.

9/ Data are underestimated.

10/ Approximately 1,000 of the total in column 1 are non-nationals.

11/ Data for scientists and engineers refer to university degree holders only.

12/ Data relate to the year 1973/1974.

13/ Refers to specialists in the national economy (that is to say, persons having completed education at the third level for scientists and engineers and secondary specialized education for technicians). Figures relating to the Byelorussian SSR and the Ukrainian SSR are already included with those of the USSR.

Source: UNESCO Yearbook of Statistics, 1977.

Table 4 Total number of scientists, engineers and technicians engaged in research and experimental development, 1970

Tableau 4 Nombre total de scientifiques, ingénieurs et techniciens employés à des activités de recherche et de développement expérimental, 1970

Country / Pays	Total	R & D scientists and engineers[1] / Scientifiques et ingénieurs employés à la R & D[1]: Total	of which percentage of part-time / dont pourcentage à temps partiel	R & D technicians / Techniciens employés à la R & D	Number of R & D technicians per R & D scientists and engineer[1] / Nombre de techniciens (R & D) par scientifique et ingénieur (R & D)[1]	R & D scientists and engineers per million inhabitants[1] / Scientifiques et ingénieurs R & D par million d'habitants[1]
Algeria/Algérie	1 121	587	58	534	0.9	41
Burundi	61	23	17	38	1.7	6
Cameroon, United Rep. of / Cameroun, Rép. unie de	269	184	34	85	0.5	31
Central African Republic / République Centrafricaine	101	39	–	62	1.6	24
Chad/Tchad	129	87	12	42	0.5	23
Congo, People's Republic of / Congo, Rép. populaire du	113	57	30	56	1.0	60
Dahomey	76	29	14	47	1.6	11
Egypt, Arab. Republic of / Egypte, Rép. arabe d'	4 869	2 796	60	2 073	0.7	84
Ethiopia/Ethiopie	662	267	44	395	1.5	11
Gabon	77	41	–	36	0.9	81

Table 4 (continued) / Tableau 4 (suite)

Country / Pays	Total	R & D scientists and engineers[1] / Scientifiques et ingénieurs employés à la R & D[1] — Total	of which percentage of part-time / dont pourcentage à temps partiel	R & D technicians / Techniciens employés à la R & D	Number of R & D technicians per R & D scientist and engineer[1] / Nombre de techniciens (R & D) par scientifique et ingénieur (R & D)[1]	R & D scientists and engineers per million inhabitants[1] / Scientifiques et ingénieurs R & D par million d'habitants[1]
Ghana	1 431	519	58	912	1.8	60
Guinea/Guinée	209	171	81	38	0.2	44
Ivory Coast/Côte d'Ivoire	586	335	27	251	0.7	78
Kenya	2 031	730	39	1 301	1.8	65
Lesotho	32	26	80	6	0.2	28
Liberia	156	80	31	76	0.9	53
Libyan Arab Republic République arabe libyenne	174	77	73	97	1.2	40
Madagascar	627	340	40	287	0.8	50
Malawi	251	137	45	114	0.8	31
Mali	285	117	6	168	1.4	23
Mauritania/Mauritanie	28	18	–	10	0.6	15
Mauritius and deps. Maurice et dép.	150	111	29	39	0.4	137
Morocco/Maroc	643	253	10	390	1.5	16
Niger	57	31	–	26	0.8	8
Nigeria	1 630	1 030	54	600	0.6	19
Rwanda	64	20	35	44	2.2	6
Senegal/Sénégal	518	304	47	214	0.7	77
Sierra Leone	232	82	77	150	1.8	32
Somalia/Somalie	37	24	–	13	0.5	9
Sudan/Soudan	995	470	53	525	1.1	30
Tanzania, United Republic of Tanzanie, Rép. unie de	828	338	16	490	1.4	25
Togo	297	100	5	197	2.0	51
Tunisia/Tunisie	742	318	4	424	1.3	62
Uganda/Ouganda	757	422	42	335	0.8	43
Upper Volta/Haute Volta	171	87	20	84	1.0	16
Zaire	606	354	69	252	0.7	16

Note : 1. Data on scientists and engineers are the total of full-time and part-time personnel.
Les chiffres concernant les scientifiques et ingenieurs représentent la totalité du personnel employé à temps plein et à temps partiel.

Source: UNESCO, National Science Policies in Africa, Science Policy Studies and Documents 1974, Paris, France.

Table 5 Percentage distribution by field of science of total scientists and engineers engaged in R & D and ratio of part-time (PT) to full-time within each field, 1970

Tableau 5 Répartition en pourcentage par domaine d'étude du nombre total de scientifiques et d'ingénieurs employés à des activités de R & D et rapport temps partiel (TP) - plein temps dans chaque secteur, 1970

Country / Pays	All fields / Ensemble des secteurs	Field of science / Domaine d'étude: Natural sciences / Sciences exactes et naturelles		Engineering / Ingénierie		Medical sciences / Sciences médicales		Agriculture		Social sciences and humanities / Sciences sociales et humaines	
		Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP
	%	%	%	%	%	%	%	%	%	%	%
Algeria/Algérie	100	54	58	1	-	26	80	19	27	1	100
Burundi	100	43	40	–	–	–	–	57	–	–	–
Cameroon, United Rep. of / Cameroun, Rép. unie de	100	40	57	–	–	6	50	50	15	4	–
Central African Republic / Rép. Centrafricaine	100	30	–	–	–	10	–	60	–	–	–
Chad/Tchad	100	21	–	–	–	–	–	46	25	33	–
Congo, People's Republic of / Congo, Rép. populaire du	100	77	40	2	–	4	–	9	–	8	–
Dahomey	100	24	–	–	–	–	–	45	8	31	33
Egypt, Arab Republic of / Egypte, Rép. arabe d'	100	40	41	15	59	28	75	17	84	–	–
Ethiopia/Ethiopie	100	26	60	16	69	18	49	22	27	18	–
Gabon	100	73	–	2	–	–	–	20	--	5	–
Ghana	100	32	67	21	78	4	87	39	37	4	50
Guinea/Guinée	100	65	81	22	100	5	22	8	71	–	–
Ivory Coast/Côte d'Ivoire	100	53	34	1	25	6	100	37	5	3	50
Kenya	100	13	59	11	83	10	72	57	22	9	32
Lesotho	100	88	91	–	–	–	–	12	–	–	–
Liberia	100	51	5	–	–	3	–	41	57	5	100
Libyan Arab Republic / Rép. arabe libyenne	100	49	45	6	100	–	–	45	100	–	–
Madagascar	100	35	50	14	76	6	62	38	15	7	30
Malawi	100	25	59	–	–	–	–	56	20	19	70
Mali	100	71	–	2	–	8	87	15	–	4	–
Mauritania/Mauritanie	100	28	–	–	–	–	–	72	–	–	–
Mauritius and deps. / Maurice et dép.	100	1	100	14	75	–	–	71	11	14	67
Morocco/Maroc	100	25	19	8	–	9	–	50	–	8	70
Niger	100	52	–	–	–	–	–	35	–	13	–
Nigeria	100	29	74	6	63	16	84	47	30	2	96
Rwanda	100	30	50	–	–	5	100	50	–	15	100
Senegal/Sénégal	100	23	47	2	60	37	90	32	2	6	21
Sierra Leone	100	60	88	–	–	–	–	38	63	2	–
Somalia/Somalie	100	62	–	–	–	–	–	38	–	–	–
Sudan/Soudan	100	52	57	–	–	14	100	34	27	–	–

Table 5 (continued) / Tableau 5 (suite)

Country / Pays	All fields / Ensemble des secteurs	Field of science / Domaine d'étude: Natural sciences / Sciences exactes et naturelles		Engineering / Ingénierie		Medical sciences / Sciences médicales		Agriculture		Social sciences[1] and humanities / Sciences sociales[1] et humaines	
		Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP	Total	PT/TP
	%	%	%	%	%	%	%	%	%	%	%
Tanzania, United Rep. of / Tanzanie, Rép. unie de	100	25	35	1	–	7	–	65	11	2	–
Togo	100	10	–	–	–	6	33	19	16	61	–
Tunisia/Tunisie	100	23	–	6	–	13	34	40	–	18	–
Uganda/Ouganda	100	26	42	–	–	27	75	43	19	4	66
Upper Volta/Haute Volta	100	13	–	–	–	61	34	16	–	10	–
Zaire	100	64	72	14	80	11	66	11	42	–	–

PT - Part-time personnel expressed as a percentage of total scientists and engineers in each field of science.
Note : 1. See corresponding note on Table 4.

TP - Pourcentage de l'effectif total des scientifiques et des ingénieurs travaillant à temps partiel dans chaque secteur.
Note : 1. Voir note correspondante du Tableau 4.

Source: UNESCO, National Science Policies in Africa, Science Policy Studies and Documents 1974, Paris, France.

A FRAMEWORK FOR ACTION

(a) Long-Term Technology Manpower Development Policy and Plans.

10. A characteristic feature of manpower development is that it cannot be hurried beyond certain limits. The captains of industry, the technologists, the scientists, the technicians etc. of the future are today still within the educational system. The way in which they are educated and trained today should equip them to meet the challenges of one or two decades from now. Thus manpower development has to work on long-term projects, as well as short-term ones facing imminent, if not actually present, needs. The main elements of planned technology manpower development for Africa are:

(a) An estimation of the various kinds of skilled personnel needed, namely:

(i) Top managers and industrial and technological policy planners;

(ii) Managers, engineers, scientists, technologists, economists, accountants, sociologists etc.;

(iii) Vocational, trade and skilled personnel;

(b) Establishing an appropriate institutional infrastructure for meeting these needs over a specific time horizon. This will clearly indicate the order of priorities for the respective roles of the various institutions,[6/] which could be broadly grouped as:

(i) Educational institutions

Universities and other institutions of higher learning
Secondary schools
Technical, vocational and trade schools

(ii) Technical institutes

Management and technology institutes
Research and development (R and D) institutes
Training institutes for the priority industrial sectors

6/ The document on Industrial Technology Institutions discusses this matter is detail.

(iii) Other training programmes
In-service training
In-plant training
National training workshops, training associations etc.;

(c) A definite decision is usually made on the proportion of the government revenue or the GDP which should be spent on the development of the educational and technical infrastructure and on the educational and training establishments themselves;

(d) The general education system is the foundation on which programmes for developing technology manpower rest. It is from amongst the men and women conditioned by this system that technology manpower will be built up. Improvement in the educational system at all its levels and the general enlightenment of society affect technology manpower development in a direct manner. Thus it is important to reform the educational system and the content of the education and training programmes at each level, so that the technological development needs are best met;

(e) Working out suitable programmes for the promotion of adult literacy and the development of a scientific and technological awareness in the population as a whole. The role of the media, that is to say, radio, television, the press, is decisive in this process;

(f) Having assessed, even tentatively, the technological manpower requirements, a manpower development plan with a clear perspective, method, schedule of implementation and financing can then be drawn up making use of existing capabilities and providing for new institutions and modes of education and training.

11. Assessment of manpower needs is a difficult exercise for which there are, as yet, no generally accepted methodologies, especially for developing countries. It should always be remembered, however, that manpower development is a key factor in overall development. If carried out in an appropriate manner, it is a good investment, for any country, at any time. However, trained manpower should not be confined to the needs of ongoing or future projects; but should aim at upgrading the general level of the population in all the basic skills needed for technology development. Such qualified manpower generates self-employment and the spread of entrepreneurial spirit in all walks of life.

12. It is also important in planning to meet the needs to make full use of innovative methods of manpower development in various parts of the world, rather than adhering always to classical forms and modes of education and training.

(b) Short-Term Actions

13. The actions outlined above are of a long- and medium-term nature. In the meantime, industrial and technological contracts will continue to be signed and factories set up. Therefore it will be necessary also for certain immediate actions to be taken for the solution of the industrial and technological manpower problems being faced. Such short-term actions would predominantly consist of short-term training programmes aimed at augmenting the skills and experiences of various industrial and technological personnel in dealing with the immediate problems confronting them.

14. So far, manpower development does not seem to have received the full attention it deserves in the contracting and implementing of foreign technology projects. Training of nationals usually has been confined to mastering the drill of operation of plant and equipment purchased, and a certain amount of maintenance and repair. It is unusual to find a systematic approach to the training of nationals during the processes of design, fabrication, testing, erection and commissioning. Even if this were to be carried out, it is usually at the expense of more expenditure or some delay in implementation. It is not unusual to rely on expatriates to carry out most of the more sophisticated technological tasks across the whole technology spectrum from investment opportunity identification, feasibility study, technology choices, consultancy, design, erection up to maintenance and marketing.

15. Furthermore, the full potential of a variety of existing institutions and possible modes of training does not seem to have been fully realized particularly on the short-term type of action to meet an urgent need. Considerable progress could be made in upgrading and reorienting manpower in relatively short periods of time with some flexibility in modes of operation and *ad hoc* measures in existing institutions to meet a pressing and clearly defined need and without establishing new institutions or departments in existing ones.

16. The importance of a multi-disciplinary approach has been stressed on several occasions in the working documents of the Symposium. Technological development has been viewed from a systems approach in which a variety of sub-systems staffed by people trained in different disciplines have to work together and interact effectively. It is important that the emphasis on multi-disciplinarity be reflected also during the education and training processes, in course work and in curriculum design. The actions proposed here are built on the preceding ideas and involve actions in the short-term particularly. They do not address the issues of manpower development or education in their totality; but bear in mind that immediate action is a subset of the more comprehensive and long-term plans of educational reform and manpower development.

Optimum utilization of existing educational and training facilities

17. (i) Universities

a. Their role in providing basic training for technical, professional and managerial personnel is well known. However, university courses are generally lacking in a variety of important areas of technological development of a country, for example, production engineering, financial management, industrial economics, business management, areas that are particularly important for the training of technology manpower.

b. In all these functions, the multi-disciplinary approach is essential. Universities are an obvious choice for drawing on expertise in various disciplines. The establishment of technology or development centres or institutes, that provide special courses and carry out mission-oriented research, can accelerate the training of technology manpower.

c. Training, research, consultancy and extension work constitute four principal functional areas in which universities can play a key role in developing an industrial technology institutional infrastructure. At the request of the bodies concerned with stimulating industrial technology, universities could undertake research and provide consultancy services to such bodies or enterprises.

They could undertake, for example, pre-feasibility studies, market and manpower surveys, cost analysis etc. for financial institutions interested in promoting indigenous entrepreneurship. One important aspect which has been overlooked is the direct involvement of universities in industrial extension work, similar to the agricultural extension work already common in some universities. African governments have been slow in calling upon universities to get involved in extension work and in providing them with the funds for research oriented to the needs of industrial extension services.

(ii) Post-secondary technical institutes

These include polytechnics, colleges of technology, management development centres and technical institutions at the upper secondary and post-secondary levels. Their training programmes provide the main source for the staffing of executive, supervisory, operational and field service posts as well as the accounting and clerical services of various industrial promotion institutions. Being less pre-occupied with academic refinements, and more oriented to developing a capability for getting work done, developing research and consultancy services is likely to be directly relevant to the needs of African industrial technology today. African governments have yet to provide these training institutions with the means and encouragement to engage in more extension work in order to promote industrial technology.

(iii) Vocational training institutions

Vocational training centres, trade schools and commercial schools are all concerned with training junior technicians, skilled operatives, craftsmen and other semi-skilled workers. At the operational level, national vocational training centres are also active in some countries. As industrial and business activities in the developing countries increase progressively there would be a definite need to establish more vocational training schools, and to provide advanced training in more sophisticated trades such as toolmaking, electronics and data processing, which are becoming more widespread in technology packages.

(iv) In-plant training institutions

In-plant training workshops or schools providing institutionalized in-house training programmes such as the East African Railway Training Workshop in Nairobi, and the Ethiopian Airlines Training School for Pilots have gained continental reputation. Sometimes several firms in a given industry pool resources to establish their own training school or workshop (for example, the East African Management Institute, Arusha, established to cater to management training needs of the various public enterprises formerly owned by what was formerly the East African Community).

(v) Management training institutes

Institutes of public administration, management development centres, centres for entrepreneurship etc. are principally concerned with developing managerial capability and supervisory skills. In addition to personnel training, they also carry out research directly related to production, finance, marketing and personnel management problems and provide management consulting services to industries and industrial promotion institutions. Their increased involvement in the screening of new technology contracts and diagnostic field research in existing enterprises would provide invaluable training opportunities for a variety of specialists.

(vi) Polytechnic institutes

There is an urgent need for a variety of specializations. Designing of industrial products, tools, fixtures and other production aids, pre-planning methods, engineering, production technology, quality control, material management and value engineering, are some of the essential skills needed in the industrial technology spectrum. To provide training facilities for persons to handle these specialized tasks, polytechnical institutes on the national or regional level could meet some immediate needs, but as time goes on and technological activities grow, more polytechnic institutes may become necessary.

The important consideration is that these institutions must have close links with all organizations performing technological functions. Consideration might be given by industry to the funding of training programmes and the award of fellowships for specific tasks in these institutes.

18. Some of the African countries have sufficient talents which could be reoriented to meet the immediate needs, at any rate as far as manpower of the required skill mix is concerned. The high standards of technical and scientific education in the universities and technical colleges of these countries, has generated intelligent and resourceful scientists and engineers. The technical institutions could normally provide the manpower for the training of managers, higher technical personnel, designers and research staff needed in industry and business. Daring and innovative approaches in all these institutions could enhance African stocks of qualified technology manpower effectively and quickly.

19. While substantial effort has gone into the training of teachers and professors in the educational system, only a few attempts have been made so far to train those professionals responsible for the training and manpower development function in an organization. These professionals (co-ordinators, administrators, managers and directors of training) lack the opportunities for systematically developing their skills. Joining together in an "association for training and manpower development" is a way in which these specialists can develop their profession. Such an association would, inter alia, upgrade knowledge and skills of training specialists, work out new and appropriate methodologies based on original research and actual experience, build a data bank for training opportunities and organize group training programmes for people from other countries.

20. With suitable training and practical experience in more sophisticated technologies, personnel could be trained abroad to become capable of acquiring the necessary knowledge in technology. In so far as in-service and in-plant training is concerned, it may become necessary, and in fact advantageous, to obtain the service of experts from abroad, preferably from collaborating firms engaged in transferring a particular product or process technology and to place local personnel as counterparts to the foreign experts on short deputations so that, after the initial

period and a planned time horizon, the local personnel would take over from the foreign experts. It ay also become necessary to intensify the training abroad of key personnel in foreign enterprises and institutions, particularly in other developing countries, to learn the intricacies involved in the product and process technologies.

Specific training for selection, acquisition, adaptation and development of technology

21. Specific training in the skills required for the functions of technology policy, planning and implementation cannot be provided by the formal educational sectors alone. However, research work conducted in the universities to collect information on African and other experiences in this domain and to analyse it in an attempt to point out pitfalls and highlight successes would provide basic material for training in these areas. Exchange of experiences within Africa and with other developing regions, particularly India, the Republic of Korea and Latin America[7/] would further facilitate training in these crucial skills. Multi-diciplinary teams could be formed to attend specially designed group training courses, workshops or seminars organized nationally or by United Nations agencies analysing African case studies of the problems involved in the selection, acquisition, adaptation and development of technology. It is important that such teams continue to work together, close to the decision-makers in technology matters.[8/]

Establishment of inter-institutional linkages

22. In their central function of providing technical manpower for industrial and economic development, technological training institutions need to develop strong linkages if their contributions are to reflect a systems approach and be effective. The training technological institutions need to develop linkages with national industrial and economic planners; industrial enterprises and the business community, other relevant institutions in the country, as well as with technological institutions in other countries, particularly other third world countries.

7/ UNIDO has organized a number of training courses on these subjects.

8/ See Guidelines for the Evaluation of Transfer of Technology Agreements, Development and Transfer of Technology Series, No.12(ID/233).

(a) Linkage with governmental planning machinery

In their planning functions, national industrial planners require industrial and technological manpower inputs generally provided by institutions from more advanced countries. A close working relationship with the national industrial planning machinery is essential in order to provide an opportunity for the indigenous technological institutions and personnel to contribute by providing the required industrial and technological manpower inputs. Where the industrial technological manpower has not acquired the level of competence to make an effective contribution, a natural approach would be for such personnel to be linked with the appropriate more advanced ones. Decision-makers and national industrial and economic planners also need to encourage indigenous technological institutions and personnel, where these already exist, by making greater use of their services in the full spectrum of industrial and economic development;

(b) Linkages with the industrial and business communities

Although several efforts have been made at the national and international levels to close the gap that exists between technological expertise and industrial and business enterprises, the degree of success so far achieved is disappointing. Concerted efforts at the national level, with international assistance if necessary, would be required to develop suitable approaches; for example, research contracts to promote greater use of indigenous technological expertise by the industrial and business community. Professional societies and productivity councils could play a decisive role in bridging this gap and creating effective working relations between industry, universities and research centres;

(c) Linkages with other national institutions

Linkages between training institutions and other relevant national institutions are directly related to the development of a national machinery and programme for technological manpower development. With a suitable policy framework and national machinery which clearly defines the functions of each institution, linkages between the various technological and training institutions in a country, particularly between multipurpose and specialized training institutions, would be easier to establish and implement.

An action programme in this area would necessarily have to be within the framework of a programme for the establishment of a national policy, plan, programme, machinery and an institutional framework for industrial technology manpower development. However, there would be certain specific situations where action would be required to develop working arrangements between institutions, either on joint training programmes or for complementing and supplementing the other's activities;

(d) Linkages with institutions outside the country

With the rapid pace at which science and technology is changing and with the rapid rate of industrial development taking place in various countries, the establishment of close contact among technical personnel and organizations devoted to industrial and technological manpower development would need to break national boundaries and establish viable and dynamic international linkages. Such linkages would exist between personnel and institutions particularly within the developing countries themselves and also between developed and developing countries. Linkages between technological personnel institutions in developing countries and more advanced foreign ones would help to build more confidence in the local institution since it gains experience by working with more experienced experts and organizations. The linkages, if they involve consultants and technological institutions which already enjoy international recognition, would also help the efforts of industrial and technological personnel and institutions in Africa to win the confidence of the industrial and business communities.

The preceding framework for action within the long- and short-term time horizons closely relates to the institutions involved in technology manpower development. It is useful to remember that reorientation and upgrading of academically qualified personnel is perhaps one of the major tasks in the short run and that considerable progress could achieved in this endeavour over reasonably short periods through ad hoc measures at the national, and particularly at the regional level.

It is also important that the trainees do not drift later into other occupations or that the multi-disciplinary and task force approach are lost in exercising the skills acquired in training.

In the long run, effective technology manpower planning, balancing the supply and demand sides of the exercise over adequate time horizons will ensure the availability of qualified technology manpower in the right numbers, at the right time and with the right education and training.