Saeed Ahmad Rashed

NORTH AFRICA AND MIDDLE EAST:

Background for Manpower Programming and Choice of Technology*

I. Introduction

In the dialogue between North and South, Muslims of North Africa and Middle East are destined to play a critical role, a role which has to be played out in the 15th Century Hijra. The Muslims of these countries which are stringed along the tropic of Cancer, have a highly developed sense of identity, with a will to argue their point. They have survived in the harshest of environments and it is not easy to push them. It is interesting to know how are they equipped to face the challenges of the 15th Century Hirja.

What needs to be examined in this regard includes the primary factors, like land and labour, as well as others like technology and education. The latter have proved elusive and intractable, so that some economists have worked with the concept of the residual factor, which may include various influences not clearly identifiable. The students of social dynamics perhaps have a better awareness of the interaction of factors. We make an attempt to give the background of some of the factors as they operate today in a selection of the countries of North Africa and Middle East.

II. Population and Densities

Two of the primary factors which determine the shape of the economy and its potential for growth are land are labour. In the region chosen for the present study, it is relevant to observe the variety of the primary factor pattern. The countries listed in Table I display substantial variation in area as well as population. Areawise the smallest country is Bahrain with only 662 square kilometres. The

*The author gratefully acknowledges the assistance of Dr. Abdul Razzaque Rukanuddin, Mr. Khalid Hamid Sheikh, Mrs. Shama Rahman and Mr. Naseem Iqbal Farooqui in revising the data of his earlier paper on the same subject.

largest is Sudan with 2,505,813 square kilometres. In terms of population the largest is Turkey with 36,162,000 persons and the smallest is United Arab Emirates with 197,000. The last column of the table brings out the relationship more clearly, between the human factor and the environment.

TABLE I

Country	Area sq. km.	Population 1979 (Estimated)	Density ⩽
Algeria	2,381,741	19,100,000	8
Bahrain	622	300,000	482
Egypt	1,001,449	40,600,000	41
Iran	1,648,000	36,300,000	22
Iraq	434,924	12,900,000	30
Jordan	97,740	3,000,000	31
Kuwait	17,818	1,300,000	73
Lebanon	10,400	3,100,000	298
Libya	1,759,000	2,800,000	2
Mauritania	1,030,700	1,600,000	2
Morocco	445,050	19,400,000	44
Saudi Arabia	2,149,690	8,100,000	4
Senegal	196,192	5,500,000	28
Somalia	637,657	3,500,000	5
Sudan	2,505,813	17,900,000	7
Syria	185,180	8,400,000	45
Tunisia*	163,610	6,400,000	39
Turkey	780,576	44,300,000	57
United Arab Emirates	83,600	900,000	11

**Note*—The data are from United Nations Demographic Year Book 1971 except for Tunisia.

The population densities have been arranged in descending order in Table II to show the range. The highest is Bahrain with a density of 482 per sq. km. and the lowest is Mauritania with a density of 2 only. The mean density is about 65 per sq. km., while median is 30. The distribution is skew and there are only two values above the mean. Bahrain and Lebanon could not be said to be typical of the region. Most of the countries are stringed around the tropic of Cancer and contain a portion of the tropical desert. In Egypt it is customary to give an alternative density figure, i.e., one for the inhabited areas. On this basis Egypt has a density of 574 per sq. km. Since the densities for other countries are not available on this basis we have not adopted the higher figure for Egypt in this comparison.

TABLE II

Country	Density per sq. km. 1979
Bahrain	482
Lebanon	298
Kuwait	73
Turkey	57
Syria	45
Morocco	44
Egypt	41
Tunisia	39
Jordan	31
Iraq	30
Senegal	28
Iran	22
United Arab Emirates	11
Algeria	8
Sodan	7
Somalia	5
Saudi Arabia	4
Libya	2
Mauritania	2

Land as a factor of production includes the subsurface content. This should be studied with great care. The experience of Germany, Holland, Japan, Hong Kong and Singapore has demonstrated that the subsurface content is not an absolute constraint for the flourishing of a technology. The entire area between Manama and Dakar is so poorly explored that it is not possible to give any reasonable assessment of subsurface resources. It could be stated though positively that given the resources considerably higher densities and concentration of labour force would be required at key points.

III. Labour Force and GNP

To determine the size of the labour force and the role that it plays in the economy it is necessary to isolate the working age groups. In the developing countries particularly where primary education is not universal childern start working and enter the labour force around the age of 10. Where primary education has been introduced, children may be expected either to go on to secondary school or go to work. Among the older age groups people keep working till incapacitated. This is particularly true of the rural communities. Thus it is hard to determine the cut off points for the labour force. Where expectation of life is low there may not be many people left in the population in the higher age groups not to say of the labour force. In this region most of the countries do not have more than 3-6% of the population in the age group 64 and above. At the lower end we might find the contribution to the labour force greater but it is difficult to be exact. The next table, Table III gives an estimate of the labour force on the foregoing assumption.

In preparing for the next step in our study we give below three tables in which these countries are ranked according to different characteristics. The next table, Table IV gives a ranking of the countries by Gross National Product. Table V gives a ranking by per capita income. Table VI gives a comparison of the three rankings. Table III and Table IV are interdependent. Gross National Product is the sum of the primary factor earnings, including the primary factor labour. Theoretically the size of the labour force multiplied by the wage level could give the contribution of labour to GNP and thus indicate the measure of dependence of GNP on labour force. Therefore, it is not surprising that most of the countries stick close to their rank in the table for labour force, in the table for GNP. Outstanding departures are Sudan, Libya and Kuwait. The picture is completely shaken in the table for per capita incomes. Perhaps it shows, where the earnings of other factors become dominant, it is no disadvantage to have a small population. It may be observed that Turkey which ranks at the top in labour force and in the second place in GNP, ranks 9th in the table for per capita incomes. Other important instances are Egypt, Libya, Kuwait, U.A.E. and Bahrain. Egypt which is 2nd in labour force, 8th in GNP, ranks 18th in the per capita income ranking. The other four go up the scale. Kuwait ranks at the top.

TABLE III

Country	Labour force Estimates ('000)
Turkey	18,487
Egypt	11,530
Iran	10,491
Sudan	5,053
Morocco	5,008
Algeria	3,695
Iraq	3,690
Saudi Arabia	2,311
Senegal	2,298
Syria	2,103
Tunisia	1,882
Somalia	1,361
Mauritania	731
Libya	675
Lebanon	648
Jordan	621
Kuwait	390
Bahrain	—
U.A.E.	390

TABLE IV

Country	GNP ($000,000) 1975
Iran	55,628
Turkey	36,017
Saudi Arabia	33,234
Kuwait	15,268
Iraq	13,889
Algeria	13,684
Libya	13,512
Egypt	9,531
U.A.E.	8,880
Morocco	7,856
Syria	5,335
Sudan	4,152
Tunisia	4,089
Lebanon	3,385
Senegal	1,800
Jordan	1,237
Bahrain	574
Mauritania	423
Somalia	343

TABLE V

Country	Per Capita Income $1975
Kuwait	15,192
U.A.E.	13,599
Libya	5,533
Saudi Arabia	3,705
Bahrain	2,207
Iran	1,663
Iraq	1,249
Lebanon	1,070
Turkey	896
Algeria	869
Tunisia	731
Syria	720
Morocco	471
Jordan	458
Senegal	360
Mauritania	320
Sudan	267
Egypt	256
Somalia	108

TABLE VI

Country	Labour Force	GNP	Per Capita Income
Turkey	1	2	9
Egypt	2	8	18
Iran	3	1	6
Sudan	4	12	17
Morocco	5	10	13
Algeria	6	6	10
Iraq	7	5	7
Saudi Arabia	8	3	4
Senegal	9	15	15
Syria	10	11	12
Tunisia	11	13	11
Somalia	12	19	19
Mauritania	13	18	16
Libya	14	7	3
Lebanon	15	14	8
Jordan	16	16	14
Kuwait	17	4	1
Bahrain	18	17	5
U.A.E.	19	9	2

High per capita incomes require a factor which is independent of the size of the economically active population and independently distributed. The presence of this factor should radically alter the labour-output co-efficients. Practically all the growth models are extensions of the compound interest formula. They aim at an analogue of the rate of interest which will be greater than the combined effect of negative factors like, increase in consumption, population growth, depreciation of fixed assets and so forth. A model which does not alter labour-output ratios radically will not give the growth of which planners' dream.

It may be said that oil or other natural factors are not distributed on the surface of the earth as we wish. The point is valid. But oil is not the only such factor which could help alter the labour output co-efficients. There are many other which could play a similar role. The most important is technological innovation. Even in the case of oil, the significant factor is oil technology and not oil as such. Of course oil technology could not be applied in the absence of oil, but without oil technology it could never play the role it does today. Both extraction and refining of oil are continuous processes which do not require high labour intensities. In case this technology had called for high labour intensities, manual operations and step by step production the picture in the ranking of countries would have been quite different. There are other minerals which are accessible and marketable, as for example in Somalia, but which contribute nothing because the technology required, both the know-how and the trained personnel, are not there.

In the debate which is going around, it is almost being taken for granted that the developing countries should strive for viable labour intensive technologies. The example of China is frequently quoted. In China there have been many new factors. Technological innovation is one. Imported technology, mostly of Soviet or European origin, is another. Perhaps, most important of all is the organizational change which has made decentralized decision making compatible with centralized control of objectives. This has given freedom for exercise of innovative abilities.

The situation in one country is rarely repeated elsewhere. As recommended, even the example of China, cannot be followed blindly. A blind effort at search for labour intensive technologies may lead to some curious results. Labour intensive refining of petroleum may be total disaster, commercially if not physically. Whatever the decision, if it is to be optimal, it should take into account the technology involved, the education and skills of the available manpower and the patterns of organization.

IV. Human Capital

We now consider human capital formation and manpower development. Harbison and Myers in their pioneering work have mentioned seven different items which could provide a metric. For their composite index they have utilized two, viz. the pupils enrolled at second level as a percentage of the estimated population aged 15 to 19 inclusive, adjusted for length of schooling, and the enrollment in third level education as a percentage of the age group 20 to 24. They have defined four levels for the composite index. In their study the countries at level I had mean index value 3.2, median 3, and range 0.3 to 7.5. For level II, the mean is 21, median 23, and the range 10.7 to 31.2. Level III has mean 50, median 48 and range 33.0 to 73.8. For level IV the mean is 115, median 105 and range 77.1 to 261.3. The Harbison and Myers study is out of date as far as facts are concerned, but the method expounded remains of interest even today. Table VII gives names of some of the countries in Harbison and Myers ranking.

TABLE VII

LEVEL I	
Somalia	1.6
Saudi Arabia	1.9
Senegal	5.5
Sudan	7.5
LEVEL II	
Libya	10.8
Tunisia	15.2
Iran	17.3
Lebanon	24.3
Turkey	27.2
Iraq	31.2
LEVEL III	
Egypt	40.1

Only 11 countries out of 19 appear in this ranking. From the available data, some of it given in other tables, it appears that Morocco, Algeria and Syria would not rank lower than other countries in level II. The information is slightly out of date. Updated comparative figures are difficult to assemble, but we attempt to give as close information as possible. Before we go further one observation is called for. China ranks immediately after Iran with 19.5 points and above Lebanon. This is interesting. Among other things it also implies that in order to develop a sophisticated technology, say at the level of nuclear power generation, a composite index of 20 and above is sufficient. To put it crudely, in the mid-sixties at least four countries, Lebanon, Turkey, Iraq and Egypt had the means for the requisite technological development, with Iran close behind. There are a few points to be observed in this context. The percentage of students enrolled in science and technology at higher education level in China was twice the percentage in Egypt or Turkey and three times the percentage in Iran. Moreover, large differences in the absolute size of the total population count. The significance of this cannot be appreciated unless minimum critical manpower levels required are clearly known.

To assess the present situation we give four tables which show a ranking of the countries on the following bases:

Enrollment in secondary schools, and

Enrollment in vocational schools.

TABLE VIII

Country	Secondary Level Students
Egypt (Estimated)	2,205,392
Iran (1976)	2,183,137
Turkey (Estimated)	2,130,185
Iraq (1976)	600,007
Morocco (1976)	529,027
Algeria (1975)	512,428
Syria (1976)	512,187
Sudan (1976)	327,043
Saudi Arabia (1975)	222,797
Tunisia (1976)	209,006
Jordan (1976)	185,700
Lebanon (1975)	174,711
Libya (1975)	166,122
Kuwait (1976)	111,166
Senegal (Estimated)	91,413
Bahrain (1976)	18,575
U.A.E. (1976)	15,225
Somalia (1976)	12,389
Mauritania (Estimated)	6,142

TABLE IX

Country	Vocational Students
Egypt	300,213
Turkey	245,304
Algeria	58,473 *
Iran	48,867 *
Morocco	13,772
Iraq	9,616
Senegal	9,238 *
Syria	3,566 *
Kuwait	3,558
Sudan	2,983
Jordan	2,958
Lebanon	2,198
Saudi Arabia	1,892
Libya	1,457
Bahrain	1,138
Somalia	736
Mauritania	452
U.A.E.	66

* Includes teachers under training.
Note—Data not available for Tunisia.
(The data pertain to 1971).

The countries in this region show considerable variation with regard to secondary education. Egypt, Turkey and Iran have the capability to enroll over two million students at secondary level. In the three countries the education is in mother tongue which gives them an advantage over some of the other countries of the region as far as absorption and innovation of information are concerned.

Vocational education is perhaps more important than some of the other forms of education for bringing about widespread economic change. The reasons are not far to seek. In the first place vocational education changes the relationship of man to his tools by familiarizing him with the use of tools, possibly new tools. Second by changing the toolkit it changes the style of earning livelihood. Third, it is not expected to call for high IQ levels. No more than 5 per cent of those who clear the primary level would be unable to pick up a trade. Fourth, it does not depend too much on the verbal ability and thus those who do not rank high in terms of verbal ability could show high achievement in vocational education. Fifth, it is compatible both with labour intensive as well as capital intensive technologies, with only one difference that in the case of capital intensive technologies or higher machine to man ratios the training in basic sciences would have to be more intensive or vocational education would have to be added to higher education. Data available are a decade old but are indicative of the trends. With regard to vocational education, two countries, viz, Egypt and Turkey stand apart. Egypt has enrollment of 300,000 and Turkey has enrollment of 245,000 in vocational schools. However, it is surprising that Egypt achieves this enrollment with 317 schools while Turkey has 930. The only explanation is that both have about the same number of teachers. Egyptian vocational schools are manned by 15,689 teachers and the Turkish by 15,285.

The two other countries which have appreciated the importance of technical education are Algeria and Iran. Algeria has an enrollment of 58,473 and Iran has enrollment of an 48,867. The figures include teachers under training in both cases. Morocco and Senegal come next, but below it seems that the process has just started. It may be observed that vocational education may have to cut across quite a few cultural prejudices and in new emerging societies this may take some time. The full significance of the importance of vocational education emerges in the context of human capital.

V. Human Capital and Economic Growth

The concept of economic growth has aroused considerable, though generally irrelevant, controversy. Partly the reason for this is the oversimplification of economic categories in the earlier synthesis of economic thought. This oversimplification led to considerable semantic difficulties. An area of confusion for instance was the rate of interest and the marginal productivity of capital. Now comes the question of marginal productivity of investment in various alternatives, including marginal productivity of investment in education.

Edward F. Denison has shown that in the United States during the period 1929 to 1957 the annual increment in value added was 0.0293 of the GNP. Of this, 0.0067 was the contribution of education which is about 23 per cent. Denison has given a breakdown of the factor earnings, 73 per cent labour, 4.5 per cent land, and 22.5 per cent capital. The labour's share is 320 per cent of the share of capital, while the share of labour in the increment is about 360 per cent of the contribution of capital. The relative proportions of education or investment in human and physical capital are 158 to 100.

Dension is careful to point out that the results refer to a particular period in the history of United States, and neither the method nor the results imply that education is always or everywhere more important to growth than capital. One of his critics, John Vaizy, has offered a four factor hypothesis. Technological change, physical capital accumulation, skills of labour, and the general educational level of society. The hypothesis is plausible but there is no attempt at verification of the type undertaken by Denison. We only wish to point out that technological change, labour skills and the general educational level of society are not altogether independent of education, the number of years in school, however we may try to isolate these phenomena. We do concede the exceptions, like Faraday, and we wish we had more of them.

Reverting to the previous argument, Denison has shown that in order to increase the rate of growth of the US economy by 1980 from 3.3 per cent to 3.4 per cent we would need an increment of 2 per cent in inputs. The requirement could be slightly lower, say 1.83 per cent, given the economies of scale. If the additional increment in inputs is not to be proportionately distributed and the entire increment has to be obtained from one factor alone, say labour, then the additional increment in the labour input rate would have to be 2.4 per cent. The objective could be achieved by any one of 8 alternatives given by him. Four of these are less meaningful outside a developed economy and we discuss them first.

I. Reduce the incidence of death by one half in the age group 64 and below.

II. Reduce the incidence of time loss due to morbidity and accidents.

III. Operate a work week one hour longer than otherwise.

IV. Eliminate two thirds of the loss of work resulting from seasonal fluctuations in non-farm production.

It is obvious that we could not apply a prescription for the US elsewhere. The reason we discuss it here to note the nature of the recipe. The first two measures are basically demographic. It is assumed that there is an accumulation of human capital in the age group below 64. If this accumulation were not there the incidence of death would not have the same significance. The same comment applies to the second alternative, about reducing the time lost due to morbidity and accidents. In the background there is another assumption. It is tacitly assumed that there is full employment or near full employment. If it were not so the prescription would read, "Employ more people, it may be cheaper". The next alternative again assumes full employment at the regular week hours. Here full employment involves not only labour but all factors. If there are not idle resources, the only way to get more out of them is to work them longer. If there were any idle resources, a reprogramming during normal hours might give better results. Elimination of seasonal fluctuations in the non-farm sector is an exercise in programming of activities.

The next four measures have relevance in a wider context. Since numerical parameters are changed from one economy to the other, the numbers mentioned will have significance only for the US economy. Outside the US new parameters would have to be defined, but there is no difficulty about the nature of the policy and its implications. The four alternatives are :—

V. Draw into the labour force one-tenth of all the able bodied persons over twenty years of age, who will not be working otherwise.

VI. Double the rate of net immigration over the next twenty years.

VII. Reduce all cyclical unemployment below what it would be otherwise by 2 per cent of the labour force, assuming that the total unemployment rate is above 4 per cent.

VIII. Add one and a half years to the average time that would be otherwise spent in school by every one completing school or make an equivalent improvement.

As already pointed out there are two points to remember. First, that the general economic background cannot be ignored. Second, that parameters differ from one economy to the next and therefore no quantification is possible on a universal basis, which could be applicable to all countries. Below we discuss these measures keeping in view the two points of caution.

Take the first measure about mobilizing additional ten per cent of the labour force. This is not possible without creating jobs for them. Around the time Denison developed his ideas, the value of fixed assets called for per job, in the United States was, in textiles $2,760 in paper $7,310, in chemicals $8,320, in machinery $4,860, in basic metals $8,600. With inflation these figures would stand higher. If the number of additional workers who have to be mobilized is 100,000, the bill of fixed assets for job creation at the prices then prevailing may be on the average $600,000,000. If we assume the rise in prices to be of the order of 30 per cent, the cost could be $900,000,000. This does not take into account the working capital. We have assumed roughly average capital ratios. In the case of some industries the ratios would be higher and the investment required for each job would be more. The ratios have been lower in Japan. The Japanese industrial structure has been less capital intensive in terms of the cost of physical assets. There is no doubt variation from industry to industry. It is not clearly established whether this is due to higher investment in human skills, but this is a possibility which requires to be explored.

In the context of the countries listed in the present study, the point about one-tenth of the able bodied requires some elaboration. The difficulty arises with the problem of under-employment. An under-employed person is employed and he is not looking for work. If we treat the under-employed as unemployed, the numbers to be mobilized may be much larger.

The measure concerning higher rate of immigration is important. This has been going on for quite some time. There is net immigration from outside and there is migration within the region. There is considerable scope for increasing both. Whether it could be doubled is yet too early to say. The essential point is that in case it is decided to accelerate economic growth and there is insufficient manpower, then the only option is to get it for labour are exhausted. The fwo large sources of trained manpower within the region are Egypt and Turkey. The Turkish trained manpower is of a standard that it can meet the demands of sophisticated West German technology. This does present a problem. The wages which have to be offered to the Turkish emigrant labour should equal or should almost equal their transfer earnings in West Germany. Every country in the region perhaps could not attract Turkish emigrant labour. Egyptian labour has made a contribution in technical fields. It is not certain whether at projected rates of growth it would be sufficient to meet both the domestic and the regional demands. Under these circumstances, the labour market in the regions around may have to be exploited for the purpose.

In the developing countries the cyclical unemployment merges with the expansion and contraction of underemployment. This makes the assessment of the unemployment situation complicated. There is substantially more underemployment, which, in some cases, could be reduced to a logically equivalent unemployment. The person who is underemployed is not looking for work and thus he could not be called unemployed. If six underemployed persons are doing the work of two fully employed persons, we could not say that four out of six are unemployed, which logically would be the case. The suggestion is not quantifiable, but it does call attention to an important problem area.

The proposal about adding a year and a half of schooling either in terms of quality or quantity is interesting and has many implications. It could be interpreted as a measure which could enhance the present capabilities of the educated labour force. A measure of this type would include any, "intelligence multiplier", a tool or a set of tools which could yield the advantage envisaged in the proposition. Under certain circumstances depending on the nature of the technology being handled a computer could provide the necessary edge, an equivalent of a year and a half of additional schooling. The computers may have a pertinent role to play in developing economies, even though intuitively "labour intensive" methods would appear to be better, particularly where large numbers in the age group 15-64 are not fully employed.

The foregoing assumes that the additional investment in education or its equivalent will balance the physical capital without requiring additional investment in fixed assets or without altering their value or role. A thing like this is rare, but not unknown. New Math for instance has tended to eliminate the Chinese abacus in use in Japan, while it has made people almost dependent on the pocket calculator.

We would like to say something about the ever present rival conjecture. Suppose it does not happen that way. We have glanced at a well-conceived hypothesis based on the study of one country. We have noted the caution about its strict relevance only to a particular period in the history of the United States. However, the phenomenon is so general that it calls for a look at the experience of other countries. We could check on the Soviet record, as compiled by western scholars. Brukbaker has identified the sources of Soviet economic growth with the help of Cobb-Douglas type of analysis, adjusted to include the effects of technical change. It was found that not all the growth could be explained in terms of conventional factors. The function was further amended to include the investment in education but considerable residue remained. Some of it could be explained by growth in the quality of capital. There is reason to assume a strong link between the quality of new capital and education, since the new capital is mostly of domestic origin. The relative contribution of factors has varied from time to time. This is quite instructive. In the years 1937-40, the contribution of labour to growth was 87.89 per cent, of educational capital 13.33 per cent and that of growth in the quality of capital—41.50 per cent. In 1958 the position seemes to reverse itself. For 1958-61 the contribution of labour is—11.83 per cent, of educational capital 4.17 per cent and that of growth in the quality of capital 44.83 per cent. In the earlier period there was considerabie stress on the organization and work methods of labour. This culminated in the movement of Stakhanov, which made a major contribution in raising coal production. Later this movement was adapted to the requirements of other industries also. By 1958 Soviet Union had come in contact with western technology in a large way. The Soviet scientists who always had a high academic tradition were now invited to translate their work into technological form. This is the period of first nuclear explosions and the first sputniks. The contribution of the educational capital is reflected as much in the growth of quality of fixed capital and equipment as in the final products. Without this improvement of fixed capital and equipment the advance of Soviet technology and economy would have been impossible.

There is an aspect of the Soviet experience of development of technology which should not be lost sight of. There is a constraint of human resources on the development of technology. While Soviet Union was able to develop sophisticated technology in the field of nuclear and space engineering on its own, it preferred to buy technology for a few items from outside. Notable in this regard is the purchase of automobile and tractor technologies, earlier from Ford and later from Fiat. Obviously such technology is not out of reach, but a diversion of human capital for the effort could affect programmes of higher priority.

Before we go to questions pertaining to choice of technology we recapitulate in a better defined form the relationship between education and economic growth. Nelson and Phelps have shown that output may be defined as a function of currently purchased capital, the labour force working with it and the average technology common to all the vintages of capital in use. In a broad sense the statement is obvious. There was technology, once dominant, associated with the steam engine. There is a technology now in use associated with diesel and electric movers. For a while all the three technologies were running parallel and cach contributed to the output. The earlier average technology was either steam or steam plus diesel, while now it could be said to be diesel-electric. Perhaps on the horizon one could see the end of internal combustion and diesel technologies. The future average technology may be electric or more evolved and elaborate form of it. The function of education and manpower training could be understood in terms of the gap between the theoretical level and the average level. The rate at which the theoretical technology is translated into practice depends on the educational level of the labour force and the gap to be bridged. If the theoretical advances in technology are rapid and the gap between the theoretical and average levels is growing, the need for raising the educational attainment levels increases, in order to keep the average technology abreast or as close to the theoretical advances as possible. In a state of technological stagnation the gap may cease to exist. If the technology is advancing it is likely to be positive. In an equilibrium, a theoretical possibility, it may be constant.

The technology jobs could be ranked according to the degree of innovative ability required. Routine jobs could be said to require hardly any such ability, though even here considerable education may be required to master the skills. Probably education is more important in cases where higher innovative ability and innovative responsibility are involved. The current view commonly held is that a job being given, a less educated worker is as good as a better educated one. This may not be necessarily the case. We pointed out earlier that in the case of Japan the capital labour ratios were lower and one explanation could be that the highly educated or trained worker was substitutable for certain capital goods. This is suggested by Nelson and Phelps also. First, it is not necessary that the marginal rate of substitution between the better educated and the less educated be constant and second, the better educated worker could be substituted for certain capital goods.

It is necessary to appreciate the Nelson-Phelps gap clearly in the context of the developing countries. Even in the selection in the present study the differences between countries are likely to be sizeable. In quite a few it is reasonable to assume that the gap between the average technology in use and the one being inducted is the maximum. This emphasizes the function of education. The demands on education are going to be maximum at all levels, routine as well as innovative. For proper technological diffusion there should be dispersal of educated manpower at all levels, not only the technical but also the managerial levels.

VI. Choice of Industry

There can be no choice of technology without choice of industry. Theoretically we can and do study disembodied technology, but when we come to decision criteria we run into difficulties. One of such difficulties has already been pointed out in the shape of different capital-labour ratios for different industries. Since there is a specific technology associated with an industry or to put it more generally, there is a specific set of technological alternatives associated with each industry, every choice of technology implies a simultaneous if not a prior choice of industry.

The choice of industry is dictated by a variety of factors. In a comprehensive sense agriculture and mining are industries. The choice of both is dictated by some sort of necessity. Primitive agriculture developed out of necessity to feed the population after pre-agrarian sources of food had ceased to be sufficient. Gold mining became necessary because there was gold lying around and people were prepared to pay for it. In fact it was much more than that sometimes. However, the same sort of necessity may not be present in every case. Holland is a small country with great traditions. You can go across from Rotterdam to the Ruhr border in one day on bicycle. Holland manufactures aircraft and operates one of the best airlines in the world. The two choices, to manufacture aircraft and to operate an airline with aircraft mostly purchased from US., do not follow from any necessity originating in domestic demand for transport.

Choice of industry has raised more controversy than choice of technology in the economic history of the world. The controversy has been linked with protection at various stages. Joining the controversy implies agreeing to play the game, which is not intended here. Apart from any controversial issues, there is a practical contingency of which men do not seem to be aware. The forthcoming population explosion is an accepted fact of life. One of the implications which is poorly realized if at all, is the breakdown of the transport and distribution systems for goods. The present location of industry around the globe is not optimum for meeting the situation.

The choices of industry have to be made keeping in view the particular situation of the country or the region. The procedure for choice is the same as for portfolio selection. The return on individual projects may be calculated as discounted cash flow, or as an internal rate of return, or as total value added. The total value added method, if we could identify individual factor earnings, could help us to assess the employment potential. The portfolio may ultimately contain one project or many. Initially there must be at least one choice, i. e., at least two projects to select from. In using the portfolio selection procedure we can avoid a great deal of formal planning without losing anything. If we are programming for utilisation of manpower, then the maximization of return is subject to the manpower constraint, which may be insufficient manpower in some case or an excess or surplus of it in others.

Sometimes priority is given to a dominant sector, say agriculture, petroleum or shipping, for the simple reason that the range of choices appears limited by natural factors. In such cases there is no method of testing the optimality of the decision and of determining what is foregone in making the choice. Even in such cases where the natural constraints have a powerful over-riding effect a number of alternatives could be introduced. Cuba, for example, is basically a single sector economy with only a couple of major crops, but it has been able to achieve a balanced distribution of its labour force. About 27-29 per cent of the labour force is deployed in agriculture, while 21 per cent is in manufacturing, which includes sugar refining, beer, denatured alcohol, laundry soap, cigars, leather and leather products, and cotton fabric. The position of the distribution of labour force in the region is given below in Table X. The countries are not ranked because that would require that all data pertain to identical or nearly identical periods, which, as the table shows, is not the case.

With the exception of Senegal, there is no other country which approximates the distribution of labour in Cuba mentioned earlier. Practically all the countries listed are striving more or less successfully to achieve a new equilibrium in their economic systems. Some of these countries have the means to achieve this in a relatively short period. At least the financial and physical wherewithall is within reach. Others have to struggle against greater odds. Below we give an outline of the effort that is being made. This is not a complete picture of the industrial system existing in the countries and it is not a resume of their development programmes. A chart which appears later indicates our intention in giving this information. The objective is to identify the areas of the technology in qualitative terms.

In Algeria the new industries are iron and steel petrochemicals, transport equipment, cement, plastics, heavy engineering and electrical engineering. In Bahrain apart from oil refinery there are two major projects, aluminium with 120,000 tons per annum capacity and the

TABLE X

Country	Year	Percentage of labour force in	
		Agriculture	Manufacturing
Algeria	1966	50.4	6.9
Bahrain	1971	6.6	13.9
Egypt	1968-69	49.2	11.1
Iran	1966	41.8	16.7
Iraq	1970	52.0	5.6
Jordan	1961	35.3	8.4
Kuwait	1970	1.7	13.7
Lebanon	1960	50.0	10.0
Libya	1964	35.7	7.2
Mauritania		—	—
Morocco	1960	56.3	8.2
Saudi Arabia	1970	28.1	4.4
Senegal	1964	4.9	22.7
Somali		—	—
Sudan	1970	89.9	4.1
Syria	1968	31.7	15.0
Tunisia	1966	41.0	9.5
Turkey	1970	66.9	8.4
U.A.E	1968	23.6	5.8

Arabian Gulf Repair Yards which can handle upto 375,000 tons tankers in dry dock. Although the Egyptian industrialization is traditional in pattern with textiles accounting for a third of the output there are new projects in the fields of basic metals and chemicals, notably the Nag Hamadi aluminium complex, Halwan steel and the Talkha fertilizer project. Iran's new industrial programme includes petrochemicals, fertilizer, iron and steel, heavy engineering and transport equipment. Iraq has started expanding its industrial base recently with the setting up of steel mill, electrical equipment factory and agricultural machinery plant, apart from the traditional sugar factory. Jordan has a small industrial base consisting of cement, petrol refining and a possibility of Wadi Araba copper exploitation. Phosphate mining is in the same category as crude oil extraction. Kuwait apart from the oil refinery has only fertilizer capability in its industrial base, though with its high per capita income and capacity to save, there could be no problem about laying down a base of petrochemicals light engineering, and electrical engineering. Kuwait could easily draw upon the experience of Hong Kong and Singapore. Lebanon has a traditional base with textiles, tobacco, food processing and cement, dominated by small establishments which have capital around £ 200,000 and which employ about 20 workers. Libya has a small industrial base, mostly consumption oriented. It is ideally situated for continuous process manufacturers like petrochemicals, fertilizer, cement. Mauritania basically an agricultural country is mining iron and copper ores which could emerge into appropriate industrial development. Senegal has a large variety of industry located in the traditional sector, e.g. leather and shoes, vegetable oil, textile, alcohol, sugar, tobacco, food processing along with some chemicals, assembly of vehicles and a naval shipyard. Morocco is dependent in phosphate mining just as some other countries are dependent on oil. The plans include development of basic metals, PVC, and fertilizer. Saudi Arabia has no industrial base though Petromin has been established to develop petrochemicals and minerals. Somalia is still partly in the pre-agrarian stage. Metals, including some radio active metals have been located. Subject to will and adequate supply of manpower it has substantial potential. Sudan has a small industrial base producing mainly consumer goods. Syrian industry is again traditional or consumption oriented, 33 per cent food and tobacco, 32 per cent textiles, of the value of the output, with fertilizer and metals on the margin. Tunisia is developing its industrial base with new fertilizer plants, iron and steel complex, electrical engineering, manufacture of vehicles and tractors. Turkey has a large industrial base including textiles, iron and steel, cement, heavy transport vehicles and petrochemicals. The United Arab Emirates have started with oil refining, LPG and cement, but the breakthrough in the form of an integrated petrochemical complex has yet to come.

In addition to the above it is relevant to take into account a distinction between international and local industry. In the case of the former the product could be purchased internationally if not produced

CHART I

Country	Iron and steel	Copper	Aluminium	Petroleum/Hydrocarb	Petrochemicals	Chemicals	Fertilizer	Plastics	Cement	Heavy Engin.	Light Engin.	Electric. Engin.	Shipyard	Heavy Transport	Vehicles	Agricultural Machinery	Tractors	Food/Beverages	Tobacco	Sugar	Alcohol	Textiles	Vegetable oil	Leather & Products
	Industry/Technology																							
Algeria		x			x	x			x	x	x	x				x								
Bahrain					x								x											
Egypt		x		x	x			x															x	
Iran		x			x	x		x		x				x										
Iraq		x			x							x			x			x						
Jordan		x			x			x																
Kuwait					x	x		x			x	x												
Lebanon										x								x	x		x			
Libya					x	x		x		x														
Mauritania	x	x																						
Morocco		x						x	x															
Saudi Arabia					x	x		x	x	x														
Senegal							x							x		x		x	x	x	x	x	x	x
Somalia																						x		
Sudan																		x			x	x		
Syria		x						x										x	x			x		
Tunisia		x						x						x		x	x							
Turkey		x			x					x					x							x		
U.A.E.				x	x					x														

domestically. On the other hand the product of the auto repair or service station, a beautician's shop or a laundry has to be produced on the spot. The same applies to transport. Similarly there are services of hospitals and computers. In a modern industrial society heavy investment is called for in all these industries. Irrespective of what else is put in the portfolio, the local industry will call for an investment proportionate to the size of the population and the level of per capita incomes.

VII. Choice of Technology

The chart opposite shows the pattern of demand for technology. Individually the largest demand has been for petroleum refining technology. However, as petroleum technology is understood today, it includes petrochemicals, fertilizer and plastics. If the comprehensive view is taken then there are about 44 programmes in 19 countries which call for different aspects of petrochemical technology. The next important technology in the present context is metallurgy particularly iron and steel. There are approximately 12 programmes of this type. There are 7 projects involving cement production. Four projects concern manufacture of vehicles, both light and heavy, two projects of heavy and light engineering, one for agricultural machinery and one for production of tractors. Petroleum technology is generally not labour intensive. Aluminium smelting and cement again are not very labour intensive. Iron and steel complexes if they include some engineering can absorb a lot of manpower which must be educated and skilled. The eight engineering technologies including tractors, agricultural machinery, transport vehicles, cars, ship repairing and engineering, electrical, light and heavy engineering call for educated and skilled manpower in a large measure. The traditional sector which includes food, tobacco, beverages, textile and leather could expand but the technology demanded is not so scarce and does not require that high level of education and skills.

The local sector that we mentioned earlier will call for high level technology as well as for example in radio and television or computers and other information processing. In the local sector, a sizeable contribution is made by construction industry, which calls for a variety of technology at various levels.

Hewever, all of this technology is imported. In fact, all the technology of the world is concentrated in about 30 countries today. A lot could be said for science and technology for development but as far as developing countries are concerned, it could be meaningful if there is basic capacity to absorb and create technological knowledge and to be able to use it. The failure of the UN Conference on Science and Technology for Development shows that the challenge of the future calls for greater initiative on the part of our technologists.

BIBLIOGRAPHY

The data are derived from:

1. *World Statistics in Brief*, 1978.
2. *Year Book of Labour Statistics*, 1979.
3. *World Tables*, 1976.
4. *World Atlas of the Child*, IBRD, 1979.
5. *UN Statistical Year Book*, 1977.
6. *World Population Data Sheet*, Population Reference Bureau Inc.
7. *Statistical Year Book UNESCO*, 1977.
8. *Encyclopaedia Britannica*, 1974.
9. Harbison and Myers: *Education, Manpower and Economic Growth*, McGraw Hill.
10. Wykstra (Ed.): *Human Capital Formation and Manpower Development*.