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JAN ANNERSTEDT

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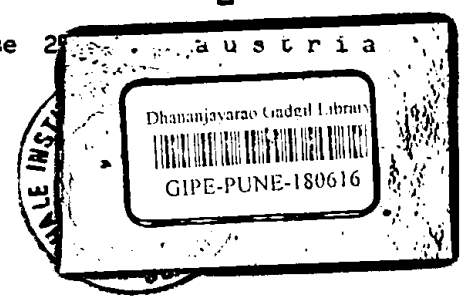

On the Present Global Distribution of R&D Resources

by

Jan Annerstedt
Institute of Economics and Planning,
Roskilde University Center

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INTRODUCTION AND SUMMARY

Is the majority of the countries in the world today forming a permanent research desert, and can the remaining countries be seen as a small number of R&D oases? These are classic questions for any student of the global R&D situation. But the questions should be much more qualified before they can be answered. A useful analysis should include some important practical-political perspectives, seen from the view-point of changing relations between developing and developed countries.

Here, the main analytical perspective is drawn from the north-south relationship, between more industrialized countries on the one hand, and less industrialized countries on the other. In the discussion I will be focusing on the less developed or so-called developing countries and their relations with other groupings of countries.

I do not adhere to those development theories, which are based on a purely nationalist approach, as if the necessary re-distribution of wealth and power in the world is to be solely between nations. On the contrary, today's development problems cannot be analyzed in full if they are isolated from their global context and defined essentially only at the national level. Technological and scientific developments are, in many of their aspects, global processes.[1]

Of course, at the practical level the political actor is often relating to a national government, interested in a changed international framework, which can form the basis for a more controlled and guided interdependence. Major great reforms in these matters--with a few exceptions--must take place at the national level even though the regional level of international relations can function as a partial substitute or, more often, a complement to the nation.

This chapter is not an attempt to analyze all aspects of technological dependence--far from it. Instead I am focusing on the extremely uneven distribution of R&D resources and the obviously most important way out: the building of an indigenous R&D capacity in all developing areas of the world.

At present the concentration of research and experimental development (R&D) to a small number of highly industrialized countries is one of the major features of global inequality. Less than 3 per cent of the world's R&D expenditures and just 13 per cent of its R&D scientists and engineers are in the hands of the developing countries. Six nations (USA, USSR, Japan, the Federal Republic of Germany, France, United Kingdom) employ nearly 70 per cent of the world's R&D manpower and spend nearly 85 per cent of R&D funds. The USA and the USSR alone account for more than half of the total R&D expenditures.[2]

One of the consequences of the disproportion in the distribution of R&D resources is a concentration of organized knowledge to very limited sectors within the economies of developing countries. The developing countries can do very little, if anything, if they do not secure a strong indigenous R&D potential which is problemoriented and directed to all sectors of economic and social life. Otherwise the "modernized" sector and its innovative capabilities will affect only a marginal share of the population, restraining growth in this sector from a possible socio-economic development in the whole economy.

My personal view is that without this domestic R&D capability developing countries have--in almost all situations of international competition--virtually no real choices. A continuing technological and scientific dependence on the developed countries in the final two decades of the 20th century is much more disturbing to social and economic evolution and deteriorating to national goals and ambitions than ever before.

In the past few years the developing countries have called for a new international scientific and technological order, as an integrated part of a new international economic order, which--in turn--requires a change also in the major orientations of global R&D. The six countries mentioned above spend almost six times as much on military R&D than all developing countries spend on all types of R&D. Together they use a quarter of every R&D dollar in the world for military purposes. A decrease of only a few per cent in the world's great armament arsenal could easily provide enough financial means to rectify the R&D situation of the developing world.

But the developed countries in the west are not eager for a real change in these matters of international politics. "For all their indifference and lack of interest, Western governments expect some small modifications of the existing economic order, and are even prepared in moderation to pay for them; but they do not expect or intend them to make much difference."[3]

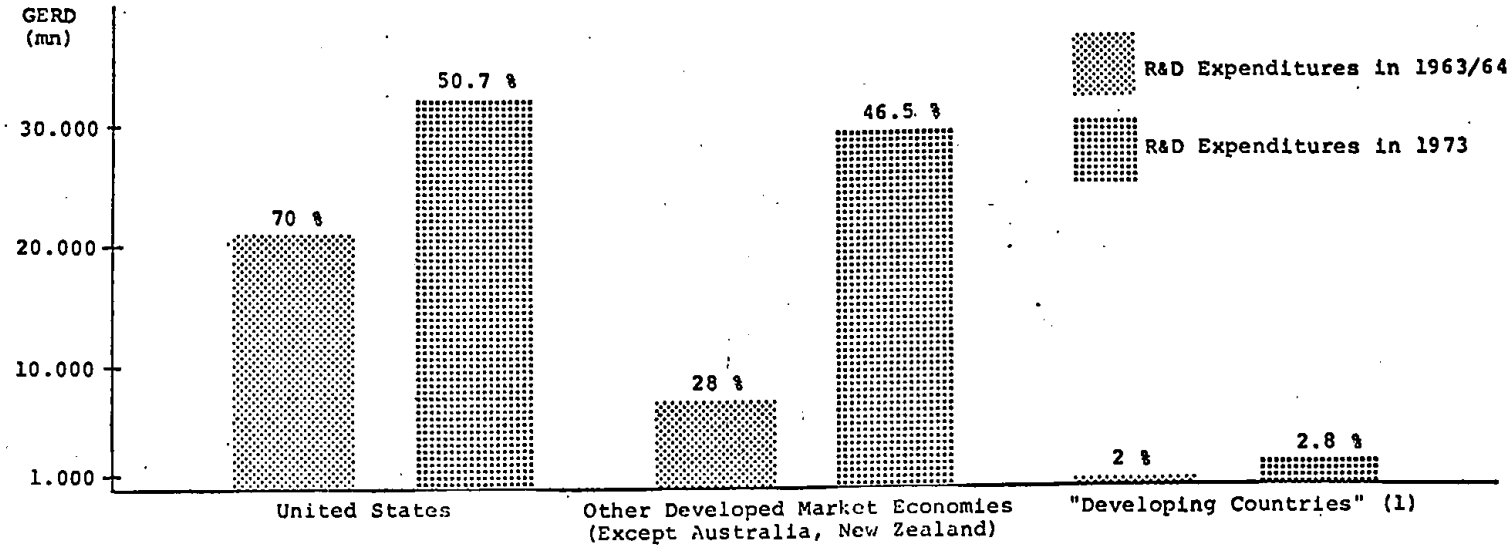
Retrospectively, international debates on the issues of development, technology and science have essentially sung to the same tunes--at least when it comes to practical suggestions and propositions for change. This implies, unfortunately, that the situation fifteen years ago has not, up till now, altered fundamentally. The same or similar disproportions remain between the centers of the capitalist world economy and its periphery.

DISTRIBUTION OF R&D EXPENDITURES: THE PERMANENCE OF A NORTH-SOUTH TECHNOLOGY GAP

70%--28%--2% remain the most cited figures, describing the international division of labour within world science and technology. Open up any UN document during the Second Development Decade and the developing countries are said to account for 2 per cent of the world's R&D expenditures. 70 per cent is spent by the United States of America and 28 per cent by the other market economies. This relationship was true, at least partially, in the first half of the

Figure 1

Distribution of R&D Expenditures (in million US dollars) among Developed Market Economies and a Sample of Developing Countries, in 1963/64 and 1973.



Sources: For 1963/64 UN estimates based on data from Unesco, OECD, Pan American Union. For 1973 preliminary data from the World R & D Survey (1978). Note: (1) The 1973 figure is based on the same sample of developing countries as the estimates for 1963/64, i.e. incl. only countries for which data was available in the mid-60's (e.g. China is not included).

1960's. The figures reflect the situation fifteen years ago.

Moreover, the figures do not represent the whole world, neither today nor at the time of their presentation. The socialist countries at different levels of development are not included, and R&D statistics did not exist, at that time, for a number of developed market economies and developing countries. But, for a long time, these figures were the best available.

In a reconstruction of the sample of countries used for the 1963/64 UN estimate, I have found that the total R&D spending of the countries included was nearly 29,000 million US dollars (in current prices). A decade later, in 1973, the same sample of countries taken together spent about 63,500 million (also in current US dollars). Not only the magnitude has changed in this ten year period but also the relations, especially within the sampled group of developed market economies. The United States' share has decreased to 50.7 %, while the others have increased to 46.5 %. However, as shown in Figure 1, even though an increase in absolute spending on R&D has taken place in the sample of developing countries, their relative share is still very limited (2.8 %).

Before concluding that the north-south division of labour in R&D is rather static one should, first, be reminded of the general weakness of national R&D data, especially for international comparisons, due to unreliable sources and different definitions and methods in the processing of data. The data presented here are drawn from a study in progress, which I hope to finish in 1979.[2]

Let us start with another global picture, based on national and international R&D data and, again, look at the world distribution of R&D expenditures (gross national expenditures on R&D /GERD/ summarized per region). It is shown in Table 1.

Table 1

Distribution of World R&D Expenditures among Major Regions and by Average Share of Gross National Product and per Economic Active Person, in 1973

	R&D Expenditures: -in mn US dollars	-in % of world total	-per EAP in US dollars	-in % of GNP at market prices
WORLD Total	96,418	100.0	66.4	1.97
DEVELOPING COUNTRIES	2,770	2.9	3.0	0.35
-Africa (excl South Africa)	298	0.31	2.8	0.34
-South and Middle America	902	0.94	9.0	0.37
-Asia (excl. Japan)	1,571	1.63	2.1	0.34
DEVELOPED COUNTRIES	93,648	97.1	182.1	2.29
-Eastern Europe (incl. U.S.S.R.)	29,509	30.6	160.0	3.82
-Western Europe (incl. Israel and Turkey)	21,418	22.2	135.1	1.55
-North America	33,716	35.0	331.1	2.35
-Other (incl. Japan, Australia)	9,005	9.3	129.8	1.76

Source: Prel. data from the World R&D Survey (1978). Figures are rounded, but percentages and other data are calculated on the most detailed figures available.

If all countries with available R&D statistics are included in a world total, they spent about 96,400 million US dollars on research and experimental development in 1973. On the average the developing countries accounted for about three per cent of this sum and the rest was spent by other countries, primarily in Europe and North America.

Within the developing world the African countries (with the exception of South Africa) used about ten per cent of the R&D resources, calculated in US dollars. The Latin American countries (incl. the Caribbean states) spent about a third, and the rest of the R&D expenditures was spent by the Asian countries (excl. Japan, Israel and Turkey).

The more developed countries, having about 97 per cent of the world's R&D funds in 1973, are still the dominant spenders. It is fair to say that the enormous gap between north and south in the mid-1960's has shrinked only slightly. At the same time the share of the global R&D funds, spent by the developing countries in 1963/64, would have been closer to one than to two per cent if all countries had been included. Now, fifteen year later in the comparison, their share is about three per cent if the trend continues. The concentration of R&D expenditures to the north remains.

However, among the developed countries are a few more powerful spenders. The United States and the U.S.S.R. taken together accounted for more than fifty-eight per cent of the world's R&D expenditures in 1973. Together with the four other most important R&D nations--Japan, Federal Germany, France and the United Kingdom--these six countries consume about 83 per cent of all R&D dollars. In all, they use a quarter of every R&D dollar in the world for military technology and science. (In the coming World R&D Survey I will elaborate further on the major socio-economic objectives of R&D.)

In summing up and following a terminology of the 1960's in grouping all countries into three "worlds", the Third

World spends nearly three per cent of the global R&D expenditures, and the Second World (eastern Europe and the USSR) a little more than thirty per cent, and the First World (all developed capitalist countries) the remaining two thirds.

DISTRIBUTION OF R&D MANPOWER: INDICATIONS OF A FUTURE CHANGE

Financial indicators used for international comparisons are always of somewhat questionable reliability. Less controversial are manpower statistics, although they too are subject to methodological problems. In international R&D statistics it is often regarded as a qualitative step to go from R&D funding to the actual number of active researchers and other R&D manpower. I personally think that a more representative comparison can be made with manpower data.

In fact, looking at the first two columns of Table 2, it is obvious that the previous R&D expenditure data seem to underestimate the R&D effort in developing countries. Here, they have more than twelve per cent of the world's scientists and engineers engaged in R&D, or 290 thousand of the world's 2.3 million researchers. Some time series for the 1960's seem to indicate that their share is growing.

3/4 of the researchers in developing countries are active in Asian research and development, while about ten per cent in Africa (excl. South Africa). The Latin American countries, which account for the remaining share, have the highest average number of researchers per million economically active population (460 researchers/mn EAP).

If we broaden the perspective to include the total R&D manpower, i.e. all personnel working with R&D, the relations between north and south shift slightly to the advantage of the latter. They have, foremost in Asia, a somewhat higher number of technicians and other supporting staff per researcher than the developed countries have.

Table 2

Distribution of Researchers (R&D Scientists and Engineers) among Major Regions and per Million Economic Active Population, in 1973

	Researchers (R&D Scientists and Engineers):		
	-total (000)	-in % of World total	-per mn EAP
WORLD Total	2,279	100.0	1,570
DEVELOPING COUNTRIES	288	12.6	307
-Africa (excl. South Africa)	28	1.2	271
-South and Middle America	46	2.0	461
-Asia (excl. Japan)	214	9.4	292
DEVELOPED COUNTRIES	1,990	87.4	3,871
-Eastern Europe (incl U.S.S.R.)	730	32.0	3,958
-Western Europe (incl Israel & Turkey)	387	17.0	2,441
-North America	548	24.1	5,386
-Other (incl Japan, Australia)	325	14.3	4,687

Source: Prel. data from the World R&D Survey (1978). Figures are rounded, but percentages and other data are calculated with the most detailed figures available.

Before concluding with the laconic statement that about 12.6 per cent of the world's researchers in 1973 were active in the developing countries and about 87.4 per cent in the developed, we should try--at least--to give an idea of the dynamics of the present situation.

In all economic and social statistics there is the dilemma of stock and flow: what is to be measured? Which are the important trends of the present situation and the potential in the flow of researchers in the world, especially in the developing countries? These questions are even more difficult and delicate to deal with than the description of the number of researchers and other R&D manpower.

In 1973, the base year for the R&D figures in this chapter, there were 4.6 million students graduating from universities and other institutions of higher learning all over the world. 23 per cent of the third level graduates were from the developing countries (not considering those who were foreign students in developed countries and excluding China because of lack of reliable statistics). The other 77 per cent, or 3.6 million graduates, were in developed countries. Comparing these figures with the data on researchers will give a little more optimistic picture, seen from the developing countries.[4]

Among the twenty countries in the world with the highest total number of university graduates were seven developing countries, namely India, Brazil, the Philippines, Bangladesh, the Democratic Republic of Korea, Egypt and Pakistan. Looking backwards it is possible to see a clear trend in the building of a relatively larger stock of highly qualified manpower, including scientists and engineers. The educational expansion has been relatively slower in the developed countries and so has the increase in the stock of researchers. Still, as we have seen earlier, the R&D scientists and engineers in these countries by far outnumber those of the developing countries.

Returning to a relational indicator we have used earlier --economically active population--we also see a slightly

changing world picture. The number of third level students per million economically active varies from country to country, but several developing countries have high numbers. Only the U.S.A., Canada, Israel and New Zealand have more students per million EAP than the Philippines, Lebanon, Argentina, Venezuela and Chile, or 54,500 to 48,050 in the latter five countries. This, again, underlines the present dynamics in the R&D situation on a global scale.

THE MAIN ISSUE: THE NECESSITY OF INDIGENOUS R&D CAPACITIES IN DEVELOPING COUNTRIES

The idea, often put forward in developed countries, that there are no real problems with the existing international distribution of R&D capabilities, is based on the false view that developing countries can--rather freely--draw upon technologies available from the developed countries. Even a brief look at the world trade in technology reveals that it is highly monopolized by the owners of technology (mostly large companies or multinational corporations), who determine prices and, in many different ways, the use and further development of the technologies. The dependencies due to less-informed buyers lead to serious restrictions on the national choices for development. Those developing countries, that do not even have such a minimal R&D capacity to be able to evaluate different technologies are, in a basic sense, in the hands of those who control the technologies.[5]

A national strategy based on the principles of self-reliance implies a selective de-linking from the technological systems emanating from the industrialized countries. The ability to use transferred technology as a starting point for further innovations depends, also, on the domestic scientific capabilities. In fact, and judging from the examples at our disposal, there is no real alternative to building and further developing an effective indigenous R&D capacity.

In a UN document of the Second Development Decade this dual technological strategy is underlined:[6]

> "Far from being substitutes for each other, the obtaining of technology from advanced countries and the building up of a scientific and technological capacity are, in fact, complementary. They must be pursued together, and in some relevant sense the building up of an indigenous capacity is the primary task of the two."

I will not go into detail as to why a national science and technology capacity is such an extremely powerful tool in development and in achieving national and other goals. It will be enough to look at the history of any of the more industrialized social formations in the world. Every industrialized country has relied heavily on R&D and other forms of organized knowledge and stimulated innovation. I know of no single country in western Europe which has attained its position without an indigenous R&D capacity, even though the imports of technology--in all its many forms--have been important.

Further, the problem is not that of a capacity only. Needed is also a political commitment to research directly oriented to national needs. A more self-reliant R&D strategy should be complemented by control over crucial processes of innovation, most notably in production technologies. This includes an ability to reproduce and further develop those technologies especially essential for the elimination of poverty and, more important as a strategy, the construction of an equitable society.

This, in brief, was a summary of what is usually understood by an indigenous R&D capacity. But I would like to go one step further.

THE NEXT STEP: SOCIAL INTELLIGENCE AND GUIDANCE IN THE DEVELOPING COUNTRIES

Even for the developing countries that have attained a minimal indigenous R&D capacity the external context of their economies presents important limitations to national action. But, more crucial are the internal problems of the economies, such as the general functioning, regulation and planning; innovative abilities at large, res-

ponses not only to market demands but also to the real social and other needs of the majority of the population, etc. Being more and more integrated into the capitalist world economy does not leave room for many real choices, but there is certainly a Handlungsspielraum or freedom of action, even though it is usually severely limited.

However, one important way of compensating for the structural dependence (and certainly only to a limited extent) is a development of capabilities to forecast and evaluate long term trends and situations. One elementary step in this direction is simply to be better informed: "Today, the ability to use and disseminate information in the creation of production technologies is concentrated to a small number of mammoth multinational corporations. Developing countries must devise independent information systems and mechanisms, connected to the existing systems, for exchanging information on all stages in the production and diffusion of technology. Counter-expertise will be crucial in bargaining with multinational corporations and other owners of technology."[7] This leads to a policy question as to whether the capabilities of social and economic intelligence and guidance at the national level could not be an effective tool for the developing countries in determining their future as social formations.

Some developing countries have already established different procedures to exploit more effectively all their resources, especially their scientific and technological potential. Institutionalized social intelligence, according to Stevan Dedijer, focuses on the development of the learning function of power and decision centers in all key social systems making up a country, i.e. not only the state and industrial planning organs. It is the skillful management of the two basic resources of the intelligence function: policy or practical-oriented information and selective secrecy.[8]

Again, in the words of a UN statement:[9] "A country without an indigenous scientific and technological capacity has no means of being aware of its own needs, nor of the opportu-

nities existing in science and technology elsewhere, nor of the suitability of what is available for its own needs."

In institutional terms the systems of production, of R&D and of social guidance cannot be completely separated. Each business enterprise, each part of the state machinery, each R&D institute etc. embodies parts of all three systems or functions. But a more coherent social guidance system is specific for each and every country. The guiding system at the national level reflects past performance in creating innovations, and should be able to anticipate problems and generate social action, reacting and critically adapting to the complex changes of the rest of the world.

Effective social intelligence and guidance in a developing country will require a certain minimum of openness and transparency of planning and decision-making, which allows for the formulation of alternative goals and permits real choices among them. Here, conflicts of interest and contradictions in the social system should be seen as driving forces of development and change.

THE DIPLOMATIC OFFENSIVE IN THE UN SYSTEM: A LONG, ENLIGHTENED MARCH TO NOWHERE

All efforts in the international forums of diplomacy during the last two, officially proclaimed, development decades have referred to and underlined the importance of research and development capabilities in the developing countries. Still, as we have just seen from the most recent R&D statistics, little has been achieved. But let us now move from the national level to that of international diplomacy, and continue to focus on indigenous R&D capacities in the third world as an issue in international deliberations.

Science and technology for developing countries is an old issue even on UN agendas. Before 1963 and the Geneva meeting of the first UN Conference on Science and Technology technical assistance programs, such as those of UNDP and other UN agencies, included a large number of policy issues

concerning the R&D efforts of developing countries. These and similar activities were regular and of permanent character, e.g. Unesco programs to support R&D planning and policy-making in developing countries.

In retrospect and with due reverence for the Geneva conference, which produced thousands of pages on more or less important matters relating to science and technology for development, 1963 could better be remembered as the first year of the UN Committee on the Application of Science and Technology to Development (ACAST), reporting to the Economic and Social Council (ECOSOC). ACAST's largest recommendation was published eight years later and was based, partly, on a statement by a group of researchers at Sussex university under the chairmanship of Hans Singer. The "World Plan of Action for the Application of Science and Technology to Development", as it was called at the beginning of the Second Development Decade, started with the premise that "the developing countries must have their own scientific and technological capability".[10] This did not imply a narrow limitation of R&D policy to decisions related to R&D only, but a policy concerned with "the reciprocal interaction between science, technology and the economy."[11]

The "Sussex Manifesto", written by the ACAST expert group, was published in 1970, the same year as the UN General Assembly inaugurated the Second Development Decade. Its prime focus was the gap in the distribution of R&D resources, characterized by four main elements:

- the weakness of R&D institutions in the developing countries,
- the (mostly negative) impact of R&D in developed countries on that of developing countries,
- the problems of access to international R&D by the developing countries, and
- the obstacles arising from underdevelopment itself to the application of new technologies for development.

These four points, brought into the discussion in diplomatic circles nearly a decade ago, are still issues of great controversy between north and south, when it comes to con-

crete action. Little has been done to rectify the situation characterized above.

The ACAST work during the following years elaborated in detail on several matters related to these points. The national R&D capacity building was one major component in their "package of reform", already defined in the World Plan of Action.

For ACAST the building of this national capacity involved two major components of a research policy, namely (a) a suitable machinery for decision-making, i.e. including planning and control of research and development on the macro level; and (b) an adequate network of scientific and technical services and problem-oriented research and development institutes.

The first component was specified further in a set of "effective arrangements for formulating and executing a national science and technology policy", varying in ambitions from country to country.[12] Stress was put on locating councils at the "highest level of government" in all developing countries. The suggested institutional set-ups were coupled with policy ambitions, such as targets of the R&D effort (e.g. 0.5 % of GNP to R&D by the end of the Second Development Decade), and the identification of various priority areas for national R&D.

The second component of the suggested national R&D effort can be summarized as a domestic base and infrastructure for organized innovation. Apart from the network of scientific and technological services the Committee proposed an effective co-ordination of R&D in the major sectors of society, that is agricultural, industrial and energy research. This presupposed an improvement and expansion of the institutions of higher learning, such as universities and others of "proper specialization", and--even more importantly--effectively working specialized or multipurpose R&D institutes, designed to tackle problems of different sectors, linked with "information and reference centers

in developing countries".[13] Finally, this second component included another educational element, which was the training of "subprofessional" personnel engaged in R&D and its diffusion.

This was--after its confirmation in the form of carefully worded resolution texts of the UN General Assembly--an essential part of the "package deal" offered by the UN system to the planners and politicians of the developing world. It was recommended at the beginning of the Second Development Decade and repeated, though in other words, many times thereafter. Reading UN resolutions in this area of activity reveals the ACAST link in the formulations, especially on R&D capacity problems.

The effects of the ACAST work and of that of a few other UN committees and agencies in international action is difficult to evaluate. Even if the concrete efforts generated from the UN resolutions are easy to recall, it would be fair to say that little specific action has been taken. But the tone of international--and sometimes also national--discussions was set for many years. The same is true of what is regarded as "responsable" and "realistic" frameworks for diplomatic deliberations. Like most negotiated documents of the UN system the process was more to establish a minimum platform than to lay the cornerstone of a new international scientific-technological order. However, the platform included, as mentioned earlier, the shaping and support of developing country efforts to build indigenous R&D capacities--although this support never really emerged.

These and other policy proposals were inherited by the permanent ECOSOC Committee on Science and Technology for Development, to which ACAST was to report in the years following. The committee's first meeting in 1973 was a stormy confrontation between the demands of the developing countries and responses or countervailing procedural actions by most of the developed countries--a pattern of discussion, which was soon to be typical in UN and other international settings, whenever the agenda included very

concrete items on R&D for development.[14]

However, in 1975 at the 7th Special Session of the UN General Assembly the controversies were kept at a low level of intensity and the essential points from the ACAST Plan of Action were more or less incorporated, in careful wording, in a resolution on "development and international economic co-operation", containing also the decision to organize the UN Conference on Science and Technology for Development (UNCSTD).

The emphasis on national capacity building in the developing countries remains central to the UNCSTD exercise. In the resolution defining the main objectives of this new conference a special paragraph underlined the efforts to "strengthen the technological capacity of developing countries so as to enable them to apply science and technology to their own development".[15] The preparation of national papers, says the UNCSTD secretariat, "provides a reason and an opportunity for each country to review and reconsider its national performance in the build-up and application of science and technology for development in the context of the local social, political and economic climate."[16]

As I have indicated, there is--in almost all the UN discussions and resolutions--a continuous accentuation of indigenous or domestic R&D capabilities of the developing countries. In a recent study of the UN conference politics the importance of an indigenous R&D capacity in the development process is seen as an area of emerging consensus--often explicit in the resolution texts.[17]

UNCSTD AND INDIGENOUS R&D CAPACITY: MUCH NATIONAL COMMITMENT AND LITTLE INTERNATIONAL ACTION

An overview of the national papers to the UNCSTD conference[18] leads to other conclusions than those hoped for by the Secretariat in 1977, i.e. "reviews in depth of each country's experience, both favourable and unfavourable".[19] Instead, the national papers of the industrialized world in both

west and east seem to be well polished and diplomatically worded documents, as high-level products of negotiations between government officials and segments of the most important interest groups in industry and research. There is little, if any, critique, evaluation, or contrasting views of the building, functioning and major directions of the national R&D system. R&D resources and capabilities are mostly described in institutional terms, with some illustrations through statistical data on R&D finance and manpower, and very general comments added.

Only national papers of developing countries have elaborated more systematically on the problems of R&D resources--in the sense of a critical and forward-looking self-appraisal. Nearly all developing countries underline the need for strengthening the national R&D system.

There are notable exceptions to how far the constructive selfcriticism is carried out in the national papers. The most openhearted countries are those with a small or negligable R&D effort of their own. The national paper of Bhutan--a country with little more than one million inhabitants and isolated from the rest of the world until the early 1960's--presents a vivid historic and factual account of its technological dependence. Having no R&D of its own, all technical equipment is bought from India.[20]

A similarly open appraisal is made in the national report of Nepal (with a population of more than twelve million). With some 2,400 "high level" science and technology manpower and spending in the mid-1970's between one and three per cent of the total budget on R&D the report frankly states: "The few research institutions that are fairly well-equipped with laboratory facilities are mostly engaged in research of their own institutional interests and often of marginal relevance to the broader needs of the country. Thus investments in R&D have become an expenditure which has not served to boost the national economy."[21] True, this is a subject touched upon in other national papers, but seldom so candidly.

The Nepal national paper goes on to summarize the many deficiencies of the R&D system that impede the rapid utilization of knowledge for development.[22] Of these the following should be mentioned:

- Absence of a national science and technology (S&T) policy in which priorities are well defined;
- Lack of coordination among various S&T infrastructure organizations in the country;
- Inadequacy of scientific manpower in all sectors;
- Inadequate integration of R&D activities with the national development plan; and
- Isolation of Nepalese scientists and technologists from the active learning and research centres of the world.

If only a small number of the national papers had been more ambitious and a little more truthful in the description and analysis of their R&D systems, the UNCSTD papers would have been a major contribution to the diagnosis of the state of affairs, so crucial for finding remedies.

Nearly all national papers, even those from countries with the lowest per capita income, spell out the third world ambition to "develop scientific and technological capability, to generate, select, adapt, absorb, use, maintain and operate technology" (Bangladesh).[23] Indigenous capacity is even seen as a goal in itself. To quote a summary statement by the Algerian government,[24] that the country's leaders want to "algerianize scientific research, integrate it with economic development and link it with the education, plan it and democratize it."

To make the discussion somewhat more concrete the list of national goals and priorities for R&D are now longer and more systematic and specific, compared with the ones presented at the previous UN conference in 1963, and other parts of the country's innovative activities--planned and non-planned--are brought into focus. Bangladesh says it also wants to "generate capacity for innovation among the average ordinary citizens and give them the means to try out their ideas and build self-confidence."[25]

But the present restraints to new national innovative activities are often dealt with explicitly in the national reports. Even partly industrialized countries like Turkey are aware of their present position in the techno-industrial division of labour between north and south. "Technology generation in Turkey", the national paper says,[26] "is not even at a level that could be mentioned. There are some limited efforts, but unfortunately not directed effectively."

Also, the interlinks between R&D and other economic and social activities seem to be weak, or--to use the diplomatic prose of a national paper--"there appears to be a large communication gap between the technologists in Thailand and those outside this group, including political and economic decision-makers and the general public",[27] and, as for some cases in Ghana, "the problem with locally-created technologies is the lack of entrepreneur response."[28]

Obviously, on the macro-level, R&D does not seem to be an integrated part of nationally functioning innovative systems. But the basic problems of an indigenous R&D capacity remain. Like the Sudan, which has delivered an ambitious and well structured national paper, most developing countries declare that they are making "genuine efforts" to "develop the necessary capacities" for R&D.[29] But the constraints are many, "amongst which the following may be mentioned:

- Shortage of training personnel and expertise;
- High cost and inadequacy of physical facilities;
- An underdeveloped technological environment;
- A general preference for the highest levels of education, resulting in a slow build-up of important supporting middle level cadres."

To state a general problem for the developing countries in just a few classic words: R&D money and manpower.

Lebanon may well represent the large number of developing countries for which a major "problem is that of budgetary constraints over the years /.../ causing an institutional insecurity and jeopardizing effective planning. This inse-

curity within the researchers' milieu is deeply felt by young scientists and is being clearly considered at the choice of research activity as a career."[30] However, for a limited number of developing countries the strengthening of an indigenous R&D capacity is not regarded as a matter of scarce financial resources. A small R&D effort in a developing country "is not because the country cannot afford more, but because there does not exist a capacity to spend more money effectively",[31] as the Turkish national paper says. And Jordan adds: "The absence of national science and technology policies is not so much a reflection of the inexistence of a scientific and technological base, but of the fact that such a base is not adequately organized into an institutional framework."[32]

Even though other R&D resources are limited and badly organized in most developing countries, the potential R&D manpower is increasing in nearly all of them--as we have seen from the earlier statistics and in spite of a sometimes conspicuous emigration. Still, the current lack of highly qualified manpower seems to be a bottle-neck for creating a national R&D capacity, even in resource rich countries like Iran, at least until the 1979 revolution. The shortage of manpower caused qualified Iranians to develop other skills, "rather than developing indigenous technology", although this is said to have been encouraged in recent years.[33]

As I have tried to show the building-up and strengthening of an indigenous R&D capacity is--at least for a large number of developing countries--an important immediate goal, maybe more significant than a better position in the international trade with technology. As Tanzania so lucidly states:[34]

> "The only contribution Tanzania is expecting from the 1979 UNCSTD in Vienna lies in her hope that the UNCSTD will also facilitate the development of the necessary political will at both the regional (African) and global levels which will enable the international community to cooperate with Tanzania in the establishment, and strengthening of her science and technology institutions and in the areas of research and the development of scien-

tific and technological manpower, in general, through the mobilization of more resources from the international community."

At the regional level the picture is a little different, judging from reports of formal and informal expert meetings, designed for UNCSTD preparations and policy advice. I have reviewed less than ten such regional and sub-regional meetings. In general, special emphasis is placed on the building and developing of the national R&D capacity, as a precondition for change. This theme is put forward systematically in one regional report, that of the Arusha meeting in 1978 on "African Goals and Aspirations in UNCSTD".[35]

The report of the meeting stresses all aspects of the national R&D capacity building, especially in Africa, where research activities "are inadequate to cover all the continent's needs."[36] The recommendations are many and detailed. For UNCSTD the Arusha meeting expressed strong hopes for a new framework of international scientific and technical co-operation, implying the establishment of a New International Science and Technology Order (NISTO) as an integrated part of a New International Economic Order (NIEO). This new framework, say the African participants,[37] should include:

- Increased financial resources from research-funding bodies in developed countries to research institutions in the developing countries with "no strings attached";
- Respect for the autonomy of each developing nation in determining its research priorities and consequently a decisive change in the present system, which is to a large extent characterized by externally oriented research planning and funding; and
- Increased efforts on science and technology capacity building at the national and, where feasable, at the regional levels /.../ which represent the weak links for effective international cooperation as well as for the utilization of science and technology for development.

This and similar regional conferences are not the sole meeting places for support of national R&D efforts. Parallel to the pre-UNCSTD activities is the emerging technical cooperation among the developing countries (TCDC), or--as it is phrased in the latest document of the kind (the

"Buenos Aires Plan of Action" from September 1978)--"the collective self-reliance among developing countries through exchanges of experience, the pooling, sharing and utilization of their technical resources, and the development of their complementary capacities".[38] This plan of action, which puts a great emphasis also on national R&D capacities, is the result of many years of promotion of a "wider and more effective cooperation among developing countries", for which TCDC is an important instrument.[39] Since about 1974, both inside and outside the UN framework, discussions have brought the issue to a new and more concrete common platform of the third world nations. The Buenos Aires Plan was--in parts--inspired by the 1977 Kuwait Declaration on TCDC, an expert meeting following four regional intergovernmental meetings on the subject. For many reasons, it is not likely that the Plan soon will be put into effective international action. Its future is related with an eventual success of the same diplomatic offensive that brought about the NIEO.

The choice of national development strategy is now even more crucial than before the launching of the idea of a NIEO. With only a little success in the ongoing deliberations between north and south the developing countries will find themselves in a new dilemma. Some developing countries will probably accept the suggestions and pressures from the north of an integration of their economies into a slightly modified capitalist world economy. This is a strategy already applied, in part, by those developing countries following the path of an export-generated growth (e.g. Brazil, with sub-imperialist ambitions; and South Korea, with its sub-contracting industries).

Other developing countries, and these may be fewer in the years to come, will concentrate their ambitions more on the build-up, renovation and transformation of their economies. This will imply a selective de-linking from the world market and, for some groups of countries, a much more intense regional economic cooperation and regulation. Here, a strategy for technological and scientific develop-

ment, in harmony with national and local goals and ambitions, is crucial for achieving greater autonomy and increasing the capabilities for self-directed economic and social development.

Why this re-structuring of third world mutual strategies towards the industrialized countries?

THE RISE AND FALL IN THE BARGAINING POSITION OF THE DEVELOPING COUNTRIES

Until recently the developing countries had--as a group--a relatively favorable position in the international diplomatic arenas. Three factors marked the relatively strong bargaining position of the developing countries in the early part of the 1970's. First and foremost were the OPEC price increases and other regulations of crude oil supply. The second factor was subsequent demonstrations of bargaining power by raw material producers, including OPEC's support of cartels of similar nature. The third factor that temporarily changed the position of developing countries to the better, was the boom in international markets for raw materials and agricultural products leading to, e.g., better prices of important products from developing countries.[40]

These three factors (and a few others) were power-generating conditions for the potential success of the diplomatic offensive, calling for a New International Economic Order at UN and other international agencies. Of course, the long term ambitions varied among the developing countries, but many of the short term goals were shared and put forward jointly by the Group of 77.

The short term goals were, in the field of science and technology, several major proposals and concrete demands known from earlier deliberations, e.g. a "code of conduct" in transfer of technology. This general diplomatic offensive, as we now see it in retrospect, culminated as early as at the 7th Special Session of the UN General Assembly in 1975. From then on, during the past three years, we can

follow "a progressive deterioration in the position and bargaining power of the developing countries", as Geoffrey Barraclough recently observed.[41]

Hence, the general confrontation between north and south on the international scene faded before it really started. The Paris talks in 1976 never reached the stage of serious collective negotiations even though a special agency for a "constructive dialogue"--the Conference on International Economic Co-operation--was designed and proclaimed as a permanent negotiating body on matters raised in 1974 and 1975, summarized in the black box of the NIEO. The Group of 77 was, as a group, talked into and out of marginal changes in commodity price setting etc., while its temporary power base eroded--the world market and the capitalist world economy ran into difficulties of another nature.

Differing national ambitions and goals (used and promoted in the talks by the northern countries) and the fragmentation of the many issues of the NIEO (also stimulated by the north) broke up another tactical diplomatic resource of the developing countries. Algeria, to mention one example, found itself in this process to be on a different general course from, e.g., Saudi Arabia. This is true for specific matters and, even more clearly, in the general conflict between, on the one hand, tactics of temporary and short term concessions without a precise common program and, on the other hand, long term structural changes of some essential disproportions of the capitalist world economy.

The Paris talks--seen as an important example of the policy of a "package" confrontation between developing and developed countries--have now more or less been replaced by direct bargaining on specific issues between capitalist powers and individual or groups of developing countries. Mexico, as an example of a more resource rich developing country, soon discovered that more was to be gained in direct negotiations with an industrialized country or with a specific multinational company of the west. It is, at this

time, too early to call this shift of bargaining strategy of some relatively more industrialized developing countries (including India, Argentina, Brazil) a general shift of emphasis and, even, ambitions among the Group of 77. Instead of seeing this country-by-country and commodity-by-commodity bargaining as a typical phenomenon of today's north-south relationships, it could also be understood as a change only in the present tactics of collective bargaining, following with more pragmatic, politically realistic and economically feasable choices of issues used for collective negotiations on international diplomatic arenas, especially within the UN system and for changes of the UN system. But it is clear that it can easily undermine a crucial asset of the third world, the minimal political unity. To proceed through collective bargaining on strategic issues has so far proved to be--in most cases--a necessary precondition for operational success in case-by-case negotiations by individual countries.

Among the many reasons behind the recent shift are changes inside the capitalist leadership, following the relative boom of some western European economics and that of Japan. One illustration only is the quantitative changes in industrial R&D within the OECD area.[42]

As we have seen earlier, the US share of the non-socialist world's R&D expenditures has decreased, and the same is true for industrial R&D of the US. After an expansion of industrial R&D in the 1950's and most of the 1960's, US industrial R&D (measured in constant dollars) has declined. Relatively, US industrial R&D still (in 1975) represents about half of the industrial R&D in the OECD area, but the share has diminished continuously.

Industrial R&D in the United Kingdom has, also, deteriorated (in constant prices) between 1967 and 1975, while--in the same period--Japan and the Federal Republic of Germany have increased their industrial R&D. The relative share of these two latter countries is still growing significantly.

Three important centers of industrial R&D are consolidated within the capitalist world economy (not to mention the fourth center of the world, i.e. the USSR). Two of them--that of western Europe (with Federal Germany and France in the lead) and that of Japan--are still growing in absolute and relative terms. The other one (USA) is declining in both absolute and relative terms. And, to summarize, the concentration to the five biggest industrial R&D powers of the capitalist world remains: USA, Japan, Germany, France and the UK performed (in 1975) 88 per cent of the OECD total. The eleven biggest industrial powers of the west had 97 per cent of industrial R&D.

This concentration is fortified by a further concentration within the major national economies to large corporations and to a number of expansive industrial branches. The pattern described here can also be illustrated by other R&D statistics, e.g. on patents and the distribution of licenses.

Hence, industrial R&D resources seem to be in firm control by the center powers, but still, as has been noted by Barraclough,[43] "the rivalry and competition between Western Europe, North America, and Japan, which have become so marked a feature to their relations today, create opportunities for developing countries to improve their standing by bargaining with one or other of the industrial nations." But, to return to the main theme of this chapter, and to quote a recent policy statement.[44]

> "The new international economic order can only be successful in the long run if it brings about a real change in the present international division of labor, including a global and regional redistribution of the resources to research and development. /---/And only a national awareness that includes a widespread understanding, active participation, and critical support can lead to a science and technology for all the people. It must be integrated with national programs and clearly defined goals."

FOOTNOTES

1. Roemer, J E (1976): Critique of the Nationalist Approach to Development. A Research Agenda, Paper prepared for the UNCTAD Secretariat (Geneva), July 1976 (mimeo), and Barraclough, G (1976): The Haves and the Have Nots, in The New York Review of Books, May, 13, 1976.

2. The statistical figures of this paper are based on a larger statistical study (called the "World R&D Survey"), to be published by the OECD Development Centre. The Survey is still in progress and, hence, the figures should only be referred to and considered as preliminary until the complete set of statistics is avaible. The main sources are national (cfr. my "An International Bibliography of R&D Statistics (Preliminary Version)", Roskilde University Center, June 1978). For two countries special statistical reports have been produced in 1977 (rev. 1978) by Boel Billgren and Jon Sigurdson (on China) and in 1978 by Anita Göransson (on the Soviet Union); both are circulated as "Occasional Papers" by the OECD Development Centre. I have also relied on R&D statistics from OECD and Unesco. If not specifically mentioned all statistical figures are drawn from the "World R&D Survey", which will include a chapter on methodological problems.

3. Barraclough, G (1978 A), Waiting for the New Order, in The New York Review of Books, Vol 25, No 16 (October 26, 1978), p.46.

4. Cfr. UNCTAD: Policy Issues for Developing Countries: Co-operative Exchange of Skills among Developing Countries, Geneva: Mimeo TD/B/C.6/AC.4/8 (4 February 1978).

5. These and similar points have been developed in The Sussex Manifesto: Science and Technology to Developing Countries during the Second Development Decade, Sussex University: IDS Reprints, No 101 (1971), pp. 4-; in Implications of Multinational Firms for World Trade and Investment and for US Trade and Labor. Report to the Committee on Finance of the US Senate, Washington: Committee Print (February 1973); in Singer, H W (1975): The Strategy of International Development, (Cairncross/Puri eds), London, pp. 208-233; and in Annerstedt, J & Gustavsson, G (1975): Towards a New International Economic Division of Labor?, Roskilde: Roskilde Universitetsforlag, Part II.

6. World Plan of Action for the Application of Science and Technology to Development, New York: United Nations (Department of Economic and Social Affaires) 1971, p. 31.

7. Quoted from a communication from an ad hoc group of the "Symposium of Science, Technology and Development", Algiers, September 9-12, 1978, pp. 3-4.

8. These recommendations are discussed in an original contribution by Stevan Dedijer in his "The IQ of the Undeveloped Countries and the Jones Intelligence Doctrine", Lund: Research Policy Program (mimeo, October 15, 1978).

9. Note 6, ibid., p. 31.

10. As interpreted in "The Sussex Manifesto" (note 5), p.1.

11. Ibid., p. 3.
12. Note 6, ibid., p. 33.
13. Ibid., p. 35.
14. These characteristics of UN diplomacy were given in a Swedish government commission Forskning för utveckling (Research for Development), Stockholm: Allmänna förlaget (SOU 1973:41), pp. 74-77.
15. UN Economic and Social Council resolution No. 2028 (LXI), August 4, 1976, paragraph 2, point b.
16. UNCSTD Secretariat : Guidelines for the Preparation of National Papers, New York: United Nations (A/CONF.81/INF.1, March 7, 1977), mimeo, p. 22.
17. A study performed by John Logsdon and Mary Allen and summarized in Rittberger, V (1978): The New International Order and United Nations Conference Politics: Science and Technology for Development as an Issue Area, Geneva/Tübingen (draft manuscript, May 1978).
18. A nearly complete collection of national papers to UNCSTD is at the readers' disposal at Research Policy Institute, University of Lund, Sweden. Responsible: Boel Billgren. The following presentation is build on a systematic overview of the problems of domestic R&D capacities, as presented in the available national papers.
19. Note 16, ibid., p. 22.
20. National Paper of Bhutan (1978).
21. National Paper of Nepal (1978), p. 23.
22. Ibid., pp. 23-24.
23. Summary of National Paper of Bangladesh (1978), p.3.
24. Resumé du Document National Algerienne, (1978), p.3.
25. Note 23, ibid., p. 3.
26. A Turkish View on Science and Technology for Development. National Paper to be Submitted to UNCSTD, Ankara: The Scientific and Technical Research Council of Turkey, (First Draft, May 1978), p.6.
27. National Paper of Thailand (1978), p.4.
28. National Paper of Ghana (July 1978), p.8.
29. National Paper of Sudan (1978), p. 40.
30. Draft Paper of Lebanon for the UNCSTD (May 1978), p. 19.
31. Note 26, ibid, p.6.
32. National Paper of Jordan (1978), p. 16.
33. National Paper of Iran (1978), p. 19.
34. National Paper of Tanzania (1978), p. 39.
35. Science and Technology for Development. African Goals and Aspirations in the UN Conference. Report of a Symposium held in Arusha, Tanzania, January 30 - February 4, 1978, Dar es Salaam: Tanzania National Scientific Research Council.

36. Ibid., p. 18.

37. Ibid., pp. 20-21.

38. "Buenos Aires Plan of Action", September 12, 1978, (Decisions of the Conference), p. 6.

39. Ibid. p. 4.

40. Barraclough (1978 A), ibid., p. 46.

41. Ibid., p. 45. These and some of the following points have been discussed, also, in ul Haq, M (1976): The Bargaining Power of the Poor Nations, a chapter in his The Poverty Curtain: Choices for the Third World, New York: Columbia University Press, pp. 169-183.

42. The data of industrial R&D within the OECD area are taken from a series of seminars, held by J-J Salomon (OECD), in various parts of Scandinavia in October 1978. His presentations of statistics were build upon a recent study by the Organization's Science and Technology Indicators Unit, "Trends in Industrial R&D in Selected OECD Member Countries 1967-1975", Paris: OECD, September 1978 (mimeo).

43. Barraclough, G (1978 B): The Struggle for the Third World, in The New York Review of Books, Vol. 25, No. 17, (November 9, 1978), p. 54.

44. Note 7, ibid., pp. 1 and 4.

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