Directing Cuba's science

Mahindra Naraine, recently in the Caribbean, assesses the achievements of Cuba's science policy

IN FEBRUARY of last year, Cuba proclaimed a new constitution and established a new governmental system which transformed its existing central administration: ten months later, in December, the Council of Ministers—effectively the new Cuban government—was appointed by the National Assembly. The country was no longer ruled by decree, and elections had been held. The changes, marking the fourth phase of Cuba's modern history (see box), are now having their impact on the country's science and technology policy.

The institutional and infrastructural framework that the new order supercedes had a chequered record. It was characterised by the conscious promotion of science and technology—training personnel, creating research institutions, establishing means of international collaboration and starting research projects. Thus, in 1962 a new Academy of Sciences was created. In conjunction with the Soviet Academy of Sciences it assessed the country's natural resources, and, had as its first priority the creation of a soils map and national atlas. Other institutes were also established: the Institute for Sugar Cane Research, the Meteorological Institute, the Institute for Scientific and Technical Documentation and the Institute of Nuclear Research. In addition, the Ministry of Industry decided to set up special institutes to seek immediate or long term policies for the use of natural resources; these included institutions for the study of sugar cane by-products, mineral research, chemical research, meteorological research, standards and metrology.

In 1965 the National Centre for Scientific Research (CNIC) was created to carry out research in several fields, especially in the biological sciences. Most of its work is basic research, and it enjoys close associations with the various institutions and with the University of Havana. But although a few coordinating bodies were established—Councils of Agricultural Research, Sugar Research, Geology and Geophysics Research and so on—there was still no central directing body for science and technology. By 1974 the Cubans felt that they had a 'critical mass' of personnel and resources oriented towards research and development and that their socio-

economic development was solid enough as a base for further work.

There was good reason for this. The investment in the universities in the 1960s began to bear fruit in the 1970s with a growing volume of research and increasing manpower. There are now more than one hundred basic research centres of varying size including research institutes, experimental stations and specialised laboratories, in which there are over 21,000 technical workers (about 20% of them university graduates); expenditure in 1975 on the basic research centres was \$75 million. In 1957 there were an estimated 4,000 engineers and scientists and 5,000 middle-level technicians; in 1975 there were some 30,000 university graduates, about half of them scientists and technologists. University enrolment has grown from 15,000 (1959) to 30,000 (1970) to 83,000 (1975); the plan envisages 140,000 in higher education by 1980. In 1974 the breakdown by disciplines was:

Science and technology	52.8%
Agriculture	16.3%
Medicine	18.3%
Education	1.8%
Economics	7.0%
Social sciences	3.8%

In 1958 only 11% of the students were enrolled in science and technology. According to Cuban figures, there are 20 graduates and technicians per thousand of population. This means there are some 170,000 technicians in the country.

Highest priority

The Cubans have given education the highest priority, spending \$874.6 million in 1975. The 1976–80 plan provides for 1.7 million in primary school in 1980, and 1 million in secondary school. There are four universities, and in the different provinces there are also 'university colleges' which are attached to one of the universities. 'University units' are centres of production, services and research where workers can carry out productive activities and take classes. University research is to a great extent carried out in teaching departments as an integral part of the students' science and technology training and the education of the staff. Some faculties have developed centres around specific topics, where teachers are assisted by researchers working in nearby schools and where post-graduates are trained. Some centres,

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for example the Centre for Digital Research and the Institute of Animal Science, do only research and post-graduate training; this type of centre is not directly dependent on the faculty or schools, and aims to train quality personnel and develop research.

With such advances, it was by 1974 time for more changes. In June of that year the government decided to establish a National Council of Science and Technology (CNCT) to manage the country's science and technology policy. Central management was deemed necessary to avoid publication, reduce cost, manage international collaboration and to coordinate the work of the various institutes with socio-economic development. Indeed, in establishing CNCT it was explicitly stated that a national science policy was a political not a technical decision.

CNCT was set up as an organ of the Council of Ministers with its President being the Vice-Premier of Education, Science and Culture. One of its vice-presidents was the President of the Academy of Sciences. The immediate task of CNCT was to draw up the national science and technology policy; once this was approved by the Council of Ministers, it was expected to control the execution of the plan and to propose practical application of the results obtained. The CNCT itself, which did not administer any research and development centre, had three main parts:

1. Presidential Council (President, Vice-Presidents, Secretary General and Directors.)

2. Advisory Committee (Members of the presidential council; well known scientists from different organisations and institutions; technical ministers and or vice-ministers concerned with research sectors and sub-sectors of research departments in universities; directors of the major research institutions.)

3. Scientific councils (Set up according to the nature and needs of the managing bodies, they are intended to bring together the most famous specialists in the relevant discipline independently of the organisations where they usually work.)

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Close collaboration with the Central Planning Authority (JUCE-PLAN) and with other bodies was necessary to achieve proper integration of science and technological plans with the socio-economic and cultural development of the country and to ensure that the science and technology plan would be one of the categories of the national economic plan. The 1976-80 economic plan was approved at the first Congress of the Cuban Communist Party in December 1975, and has three aims: to increase and diversify agricultural production to make the country self sufficient in food; to increase industrialisation; and to increase the production of sugar and nickel to pay for imports.

In agriculture the main areas of expansion will be rice, vegetables, citrus, poultry, fisheries and livestock. Industrial production will be increased in all areas, particularly fertilisers, steel, cement, paper and agricultural machinery. It is planned to produce about 600 cane harvesters a year from a Cuban design; this will reduce the workforce in the sector from about 370,000 to 50,000 by 1980. A nuclear reactor with capacity 880 MW will be built with Soviet assistance; in 1975 Cuban electrical generating capacity was 6.5×10^{12} W (about 700 kWh per inhabitant) but this is expected to increase by 35% over the next five years.

In 1959 sugar constituted 80% of Cuban exports and it held a similar position in 1970. In the future it is expected that the extensive Cuban nickel deposits will take over the role of main exchange earner, hence the 300% proposed expansion in nickel production.

CNCT plan

The CNCT drew up a plan for 1976-80 to link up with the national economic plan, slowly integrating indigenous research with technology transfer. Technology transfer is considered by Cubans to be indispensable to rapid economic development, but for it to be effective it must be adapted to local conditions and that means a large research and development base is essential. The CNCT plan focuses on the exploitation of Cuba's extensive laterite deposits; the application of nuclear technology and solar energy; the development of the electronics industry (to produce 100,000 television sets and 300,000 radios per year) and the development of computing and information systems (Cuban designed mini-computers are now being manufactured with Japanese components—under a Soviet-Cuban agreement, Cuba will provide the Comecon countries with certain components); the use of local products; and agriculture,

Cuban chronicle

Over the past hundred years Cuba has undergone three major transformations, and the development of its science and technology policy has tended to reflect this historical development.

The second half of the nineteenth century, ending with the first US intervention from 1898-1902, coincided with the rise of Cuban national consciousness and the struggle against Spanish colonialism. The first Cuban Academy of Sciences was founded in 1860, immediately prior to the Ten Years War, by about thirty European-trained academics, many of whom made contributions to world science. Attempts to introduce scientific and technical methods to Cuban agriculture, then in a primitive state, were unsuccessful; colonial conditions meant the Academy was 'peripheralised', and new development stemmed from technology transfers rather than indigenous sciences. By 1895 there were 1,186 students in institutions of secondary education—0.7 per thousand of population; the subjects studied were mainly Greek, Latin and rhetoric.

Cubans view the period beginning in 1902 and ending in 1958 as "the period of the neo-colonial republic marked by the presence of American imperialism." Local scientific activity was minimal and there were few research centres. The Academy of Sciences suffered a slow decline: by 1959 its yearly state budget was \$600 and it did not possess a librarian. It was attached to the Ministry of Justice, while the Geographical Society of Cuba fell under the Ministry of State and the National Observatory was part of the Ministry of Sea and War. By 1958 15,000 students were enrolled in higher education, with 11% studying science and technology. About 60,000 students were in secondary education, representing about 10 per thousand of population. American missions in 1937 and 1950 commented on the paucity of technicians, the scientific and technological backwardness of the country and especially in the sugar industry, and the lack of facilities for research at the University of Havana.

The period was one of great political instability and culminated in the Batista dictatorship. The plantation economy, dependent on sugar for more than 80% of exports, was heavily reliant upon the US economy both in terms of trade and

direct investment. The urban/rural dualism intensified, and by 1958 Cuba had half a million unemployed and two million illiterates and semi-literates in a population of 6.5 million. The period is seen as one of increasing cultural domination with continual attempts to belittle Cuban achievements. The example is cited of the recognition given to the American Dr Walter Reed as the discoverer of the carrier of yellow fever; in Cuba the Cuban Academician Dr Carlos Finlay is considered to have deciphered the problem.

The successful revolution of Fidel Castro and his followers in 1959 marked the start of Cuba's third period. Influenced by Soviet industrialisation, Castro and particularly Ché Guevara felt that a similar programme was necessary for the Cuban revolution to succeed. Science and technology were therefore recognised as critical factors in social and economic development, and in spite of a critical resource shortage, human and material resources were allocated for the creation of research centres to meet the requirements of the development plan.

The development plan which emerged for 1961-63 followed eighteen months characterised no less by chaos and government measures to gain control over all aspects of Cuban society, than by a programme of agrarian reform and a campaign to eradicate illiteracy. It was drawn up by Guevara and was intended to transform the Cuban economy from an agricultural to an industrial structure. It was expected to accelerate development on many fronts by means of import substitutions with emphasis on heavy industry. The programme exceeded Cuba's technical, administrative and resource capabilities; it ended as a failure.

The second growth strategy from 1964-75 reoriented previous plans, with their emphasis on agriculture, to centre on sugar and exports. Industrialisation remained the long term objective, but it was to be a gradual process with immediate expansion on a few fronts, such as cement manufacture, fertilisers and steel. Consequently, the science and technology infrastructure continued to expand, particularly in the training of personnel and in the establishment of research centres (see main story).

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livestock and fisheries. Over 100 problem areas have been identified for research and development activity.

Under the most recent changes, however, the National Scientific and Technological Council (CNCT) has disappeared. Its duties have been taken over by the State Committee for Science and Technology (CECT), whose head is a member of the Council of Ministers. This committee is the agency in charge of directing, coordinating and supervising the implementation of state and government policy in science and technology. It has to advise the government, prepare science policy, supervise research, establish research centres, and manage the science and technology information system.

The Academy of Sciences is now classed as an institute that is a central state agency, but its director will not be a member of the Council of Ministers. It has been charged with the drawing up, supervision and implementation of basic research and with being the link with foreign organisation. The various other technical ministries, covering, for example, the chemical industry, and mines and geology, will continue to have their own laboratories and do their own industrially oriented research. The work of all such ministries, however, will be coordinated by the CECT,

which will also link up with the Academy of Sciences, the Ministry of Higher Education and the Ministry of Economic Collaboration.

Growing role

Cuba's international role is now growing; it is unusual to find a country so little endowed with natural resources such a large source of aid. Cuba's aid essentially comes from the technical expertise that is the result of its massive investment in scientific and technological education. The success has been little short of phenomenal, and it is estimated that there are more experts in the developing countries from Cuba than from any other country. But it is well known that Cuba has not achieved this by its own means. Since 1960 it has been drawn into the Soviet orbit; in 1970 the Soviet-Cuban Commission for Economic, Scientific and Technical Cooperation was formed, and in 1972 Cuba joined Comecon. Cuban development has been underwritten by the Soviets to the estimated sum of \$5 billion since 1959. The full contribution of the Comecon countries is hard to assess, for apart from credits they provided expertise in the early years and also trained Cuban personnel. In 1969 as much as 20% of the scientific and technical staff engaged in research

and development in Cuba were foreign but this manpower assistance declined as the Cuban investments in education began to produce results around 1970.

An important instrument in Cuba's new international role is the State Committee for Economic Collaboration (formerly the National Commission for Economic, Scientific and Technical Collaboration). In coordination with the State Committee for Science and Technology, it plans and administers foreign technical aid. As the relentless industrialisation drive continues, Cuba's voice is growing more important in the 'North-South' dialogue. Along with India and Yugoslavia she has been one of the leading advocates of greater trade between the underdeveloped countries. For a country that in the next decade expects to be the most industrialised of that group, it sounds like good business. Mexico and Cuba have already designed sugar mills and equipment for sale to the developing nations.

How far Cuba will be able to continue this programme and supply these countries is uncertain. What is certain is that a massive investment in science and technology has meant great political and economic gains. Castro was indeed prophetic: "The future of this country," he said in 1960, "must be the future of men of science." □

USA

Feasible, sound and attractive

A new report on the prospects for solar energy was published last week. Colin Norman reports from Washington

GIVEN sufficient political and economic support, solar energy technologies could supply as much as 40% of the world's energy needs by the turn of the century, and a startling 75% by the year 2025, according to a report published last week by the Worldwatch Institute, a small think-tank concerned with global problems. Such a major shift from fossil fuels to renewable energy resources "would require an unprecedented worldwide commitment of resources and talent", but the social and economic benefits "would far outweigh the costs and difficulties", claims Denis Hayes, who wrote the report*.

Though a multitude of enthusiastic articles and studies have been written

in the past few years to extol the virtues of solar power, the worldwatch report is already attracting considerable attention. For one thing, it was published while the Carter Administration was in the midst of putting together a long-awaited energy policy for the United States, a policy which is expected to place increased emphasis on renewable energy resources. It also breaks new ground in analysing the worldwide potential for solar power, while most other studies have concentrated on solar prospects in a single country. And its upbeat conclusions are also tempered by some realism about the political obstacles along the road to a solar powered world.

Hayes begins by noting that a transition from oil and gas to alternative power sources is inevitable, given the fact that production of oil and gas is expected to peak in the 1980s and that the price of those fuels is already beginning to increase by leaps and bounds. He argues that a switch to coal to provide energy needs over the next 50 years would result in "an absolutely

intractable problem" of massive increases in atmospheric carbon dioxide, that a switch to nuclear power would require building so many nuclear reactors and recycling so much plutonium that "such a prospect cannot sanely be greeted with equanimity", and that fusion power is a long distance, unproven technology. That leaves the solar options, which Hayes defines as wind, falling water, biomass and direct sunlight.

Though Hayes is quick to acknowledge that most solar technologies are hard put to compete economically with conventional fuels at current prices, he argues that many alternative power sources have environmental costs and hidden subsidies which are not usually included in economic comparisons. As those costs are not internalised and as oil and gas prices spiral upwards, solar energy will become increasingly attractive, Hayes suggests.

Straightforward comparisons between solar power and conventional fuels also neglect an important factor: solar energy is not just more of the same. "Most energy decisions are based on the naive assumption that competing sources are neutral and interchangeable", Hayes notes, but solar technol-

**Energy: The Solar Prospect* (Worldwatch Institute, 1776 Mass Avenue NW, Washington DC 20036, \$2).