Chapter 3

New Technological Aids

(a) Remote Sensing

Remote sensing is a technique for acquiring information about objects, areas of phenomena by means of sensors mounted on space craft or aircraft. Although of great value to weather forecasting and other meteorological tasks, especially in the tropics, one aspect, that of meteorological phenomena, is not considered here. For it is a specialised field undertaken mainly by national meteorological services in co-ordination with the World Meteorological Organisation (WMO). Remote sensing by aeroplanes and satellites differ only in practicalities, not in principle. Aircraft imagery is available at specified times with excellent resolution for specific coverages; while satellite imagery is bound by the track of the spacecraft, both in terms of timing and coverage. Aircraft imagery has been available for many purposes (e.g. mapping), while satellite imagery is still in the experimental stages. Geophysical data can also be obtained from low flying aircraft. Remote sensing may be applied to various aspects of this expanded programme:

(i) Agriculture/Forestry:	Classification of crops Areal extent of crops Crop Disease Stress due to lack of water
(ii) Land Use:	Identification of land uses Changes in land use
(iii) Cartography:	Hill shading Aeronautical charts
(iv) Geology:	Geological mapping mineral exploration

(v) Water:
- Soil moisture
- Sea and lake levels
- Snow cover
- Coastal turbidity
- Sediment flow
- Fish finding
- Thermal pollution

Remote sensing provides considerable opportunities for scientific co-operation in the Commonwealth because of:

(i) the wide disparity in its development in the different nations of the Commonwealth;

(ii) the modular nature of the technique, allowing nations to adopt the technology at grades suitable to their financial and developmental levels; and

(iii) its benefits to countries with either large land areas and/or highly dispersed populations such as Australia, India, New Zealand and Canada. These countries have developed remote sensing techniques over the last 10 years and used them extensively. However it is important to distinguish between data required in quasi-real time (e.g. crop monitoring), which are very expensive, with the existing systems in LANDSAT 5, and data which are not time-dependant (e.g. geological), which exist in archives on previous satellites. Simple equipment and images, at near reproduction costs, are all that is required to make a start on historical information. Remote sensing by satellites is still experimental, and there is therefore considerable opportunity for scientific development without the need for expensive installations.

Indeed, with its wide coverage of tropical areas, Commonwealth nations could contribute in a number of special ways: using existing facilities in member countries towards training at any required level; conducting in-depth workshops (4–6 weeks duration) on particular topics such as the use of microwaves and conventional aerial surveys; developing end-to-end experiments involving the identification of a specific application goal and its attainment by the collection and analysis of data; through Commonwealth co-operation, acquiring hardware for obtaining and analysing data from the newer satellites, and, because of high costs, in hiring aeroplanes for specific surveys.

In the short term remote sensing activities could include:

— training and education (e.g. basic matter and energy relationships; remote sensing capabilities in various parts of the electromagnetic spectrum; multi-stage sampling techniques; photo-interpretation; digital data processing);

— workshops (e.g. photo-interpretation techniques, digital processing of data, data use and application);

— end-to-end experiments (e.g. thematic map for use by planners/ decision makers);

— establishment of small national or subregional centres; and

— solving of particular tasks.

Based on these short-term activities, discussions on larger co-operative ventures could take place with a view to their establishment in the medium-term. Such activities may include airborne surveys and ship-borne earth stations. Long-term activities could include the establishment of regional centres and earth stations. Remote sensing is an economical way to provide the smaller nations with information for national planning and economic advancement.

For the larger nations, positive co-operative efforts in remote sensing should keep them in the technological race, and provide a wider source of data for the improvement of their own science. Some equipment is needed, such as interpretative devices (e.g. densitometer, additive colour viewer, microfische camera system, aerial film drier, mobile photo-processing), radiometers and chlorophyllscanners, and in ground-truth data collection. The equipment needed is relatively cheap however.

The identification of national, regional or Commonwealth needs in remote sensing is a major task:

(i) LANDSAT 4 & 5: Twenty Commonwealth nations besides others are not totally visible from the new LANDSAT satellites (Table 3; Page 45), and they are mainly located in the Caribbean, West African, East and Central Africa, and the South Pacific regions.

(ii) National laboratories for photo-interpretation: About 35 Commonwealth nations appear to have no permanent national interpretation facilities, although some do have facilities which have been provided for specific projects, or users.

(iii) Training: About 10 Commonwealth nations appear to have national facilities for training, and these have considerable scope for co-operative use.

In the past, major donor agencies have contributed to the development of remote sensing in the less advanced nations. Moreover the technologically innovative countries are particularly willing to fund such projects; for example, the USA in connection with its space programmes and through USAID; the European Economic Community in connection with European Space Agency (ESA) through European Development

Fund (EDF); Canada through the Canadian International Development Agency (CIDA). The possibility for co-operation in remote sensing exists between New Zealand and the Pacific Islands. Remote sensing is particularly appropriate for Commonwealth co-operation and mutually beneficial to nations, regardless of their size and state of technological development.

The Council should consider supporting a remote sensing programme for the short-term, and establishing a Task Force to review present and future Commonwealth activities in remote sensing. The objectives of this Task Force should be:

(i) to review available techniques, capabilities and infrastructures of Commonwealth nations to obtain and analyse remotely-sensed data;

(ii) to formulate a plan of action for an integrated Commonwealth approach, beneficial to all nations but particularly the small states for remote sensing and data transmission and analysis, using both aircraft and satellite carriers;

(iii) to examine within this plan of action, existing arrangements and new mechanisms for the training of technicians and scientists in remote sensing, especially on a regional basis;

(iv) to commission a study in the short-term on the use of available remote sensing data, and based on the expert papers submitted, make politicians and scientists more aware of the potentials and advantages of this programme;

(v) to establish in the short-term regional networks for information exchange on new developments in remote sensing analysis and application; and

(vi) to investigate the feasibility of developing aircraft-borne remote sensing capability, with palletised equipment, for deployment and use by a number of Commonwealth nations.

This initiative would diversify remote sensing capability on a global basis, and enhance the scope of basic sciences in each participating nation. It would reinforce the Council's previous interest in land use, coastal management and environmental planning, and should not involve substantial additional funds if undertaken on a network and cooperative basis.

We recommend that the Council allocates the following sums for developing projects in the remote sensing programme:

	Levels of Programme Development		
	£ (*Priority A1*) *Initial*	£ (*Priority A2*) *Minimal*	£ (*Priority A3*) *Desirable*
Projects:			
• Task force	60,000	60,000	60,000
• Commissioned study and Project Groups/ Networks	250,000	500,000	1,000,000
• Aircraft Remote Sensing Capability	–	–	–
Five-year total: (£)	310,000	560,000	1,060,000
Sum per annum: (£)	62,000	112,000	212,000

Table 3: Landsat Coverage for Commonwealth Countries

Country	*Receiving station and Average Detail*	*Location of Receiving Station*	*Receiving station in Commonwealth Country or Not*
Antigua and Barbuda	Partly visible to Greenbelt, Maryland for Landsat 1, 2 & 3. Not visible for Landsat D & D.	Maryland, USA	No
Australia	Totally visible from Alice Springs, Australia	In Australia	Yes
Bahamas	Totally visible from Greenbelt, Maryland	In US	No
Bangladesh	Totally visible from Hyderabad, India	In India	Yes
Barbados	Not visible	—	—
Belize	Visible from Greenbelt for Landsat 1, 2 and 3 and not visible for Landsat D & D.	In US	No
Botswana	Totally visible from Johannesburg	In South Africa	No

Country	*Receiving station and Average Detail*	*Location of Receiving Station*	*Receiving station in Commonwealth Country or Not*
Great Britain	Totally visible from Kiruna and from Pucino	Kiruna in Sweden Fucino in Italy	No
Canada	Visible from Prince Albert, Fairbanks, Goldstone, Shoe Cove, Greenbelt	In US and Canada	Prince Albert and Shoe Cove Canada—Yes
Cyprus	Fucino (Totally visible)	Italy	No
Dominica	Not visible	—	—
Fiji	Not visible	—	—
The Gambia	Not visible	—	—
Ghana	Not visible	—	—
Grenada	Not visible	—	—
Guyana	Visible to Cuiaba	In Brazil	No
India	Totally visible from Hyderabad, India	In India	Yes
Jamaica	Visible to Greenbelt	Maryland, USA	No
Kenya	Partly visible to Johannesburg	In South Africa	No
Kiribati	Not visible	—	—
Lesotho	Totally visible to Johannesburg	In South Africa	No
Malawi	Totally visible to Johannesburg	In South Africa	No
Malaysia	Visible to Djarkarta Bangkok, Hyderabad (Partially)	Indonesia, Thailand and India	No No Yes
Maldives	Visible to Hyderabad	India	Yes
Malta	Totally visible to Fucino	In Italy	No

Country	*Receiving station and Average Detail*	*Location of Receiving Station*	*Receiving station in Commonwealth Country or Not*
Mauritius	Not visible	—	—
Nauru	—	—	—
New Zealand	Not visible	—	—
Nigeria	Partly visible to Fucino	In Italy	No
Papua New Guinea	Visible to Alice Springs	In Australia	Yes
St. Lucia	Not visible	—	—
St. Vincent	Not visible	—	—
Seychelles	Not visible	—	—
Sierra Leone	Not visible	—	—
Singapore	Visible to Djarkata, Bangkok	Indonesia and Thailand	No
Solomon Is	Not visible	—	—
Sri Lanka	Visible to Hyderabad	In India	Yes
Swaziland	Visible to Johannesburg	In South Africa	No
Tanzania	Partly visible to Johannesburg	In South Africa	No
Tonga	Not visible	—	—
Trinidad and Tobago	Not visible	—	—
Tuvalu	Not visible	—	—
Uganda	Not visible	—	—
Western Samoa	Not visible	—	—
Zambia	Visible to Johannesburg	In South Africa	No
Zimbabwe	Visible to Johannesburg	In South Africa	No

(b) Biotechnology (including Genetic Engineering)

Biotechnology has been defined by the European Federation of Biotechnology (in 1981), as 'the integrated use of biochemistry, microbiology and chemical engineering in order to achieve the technological application of the capacities of microbes and culture cells'. A recent offshoot of biotechnology is genetic engineering which, by gene splicing and recombinant DNA cloning, directly manipulates the genetic material itself. Biotechnology is a rapidly advancing area and, because of its significance to human welfare, is of considerable public and political interest. Some technological breakthroughs have already occurred: the development of new nitrogen-fixing plants; single-cell edible proteins; new crops resistant to pests; bacteria for use in waste recycling and pollution control; petrochemical substitutes; gene therapy to correct monogenic diseases such as sickle-cell anaemia; genetic screening for the isolation of genes responsible for birth defects; basic knowledge of immunological and molecular processes, including cancer.

The greatest beneficiaries of a Commonwealth programme in biotechnology will be agriculture, health and industry; and the major foci for research for the less advanced nations could be:

(i) Medicine	—	vaccines to eliminate tropical diseases such as malaria, trypanosomiasis, and hepatitis (long-term);
	—	epidemiology and diagnostic medicine (short- and medium-term);
(ii) Agriculture	—	biochemistry and genetics of plants (medium-term);
	—	plant breeding for increased grain yield, protein content, disease resistance and climatic or soil tolerance (long-term);
	—	micropropagation (short-term).
(iii) Animal Husbandry	—	vaccines to eliminate animal disease (long-term);
	—	production of animal growth hormones for increased meat yield (long-term);
	—	ova-transplantation (short-term).
(iv) Industry	—	production of bulk chemicals from sugar cane and lignocellulosic wastes (cane bagasse and rice straw) (short-term);

— lignin degradation to produce chemicals (long-term);

— microbial transformation of bulk chemicals into high value (long-term).

Biotechnology is advancing very rapidly and research is not very expensive. It is appealing to governments, so much so that UNIDO is establishing international centres in India and Italy, with collaborating centres in several other nations. Recombinant DNA technology has excellent long-term prospects, and the Council should encourage individual scientists from the less advanced nations to learn new techniques in existing institutions.

The Council should urgently consider establishing a Biotechnology Advisory Committee comprising expert practising scientists with the following objectives:

(i) to review annually the advances made in potential substrates for microbiological processes, food and animal feeds, soil microbes for plant nutrition and health, nitrogen fixation, microbial insecticides, fuel and energy, waste treatment and utilisation, cellulose conversion, antibiotics and vaccines, and pure culture production techniques;

(ii) to promote and establish contact between scientists in Commonwealth and non-Commonwealth organisations;

(iii) to screen the application of all aspects of biotechnology in view of the very rapid and unpredictable nature of new advances;

(iv) to advise the Council on the need for training in specific techniques at appropriate regional institutions; and

(v) to identify important areas for the promotion of collaborative research, as appropriate.

In a rapidly advancing area such as biotechnology, the less advanced nations require a periodic review of advances. Such reviews will alert them of those new technological impacts that stimulate science and the education of young scientists; help them reach a balance between scientific research and science education; promote the training of scientists in the new techniques, either by visiting scientists from advanced laboratories or by exchange fellowships, so that scientists from the less advanced nations can visit more advanced laboratories or nations.

We recommend that the Council allocates funds to develop the following projects in the biotechnology area:

	Levels of Programme Development		
	£ *(Priority A1) Initial*	£ *(Priority A2) Minimal*	£ *(Priority A3) Desirable*
Projects:			
• Biotechnology Advisory Committee	50,000	100,000	100,000
• Implementation of recommendations	250,000	500,000	500,000
Five-year Totals: (£)	300,000	600,000	600,000
Sum per annum: (£)	60,000	120,000	120,000

(c) Microelectronics

The microelectronics revolution has been characterised by three major developments: miniaturisation of electronic circuitry or chips; the very large scale integration (VLSI) of extremely complex circuitry on a single chip; microprocessors, which are VLSI systems performing specific functions. It is a rapidly advancing field dominated by multinational corporations, particularly in the area of hardware. However not all research and development is occurring in the large-scale areas, and many more modest areas of development are being tackled by small groups. Commonwealth programmes could be developed in three areas:

(i) the fabrication of very large scale integrated (VLSI) circuits involving silicon systems and devices ('chips'), with emphasis on bulk production of 'uncommitted logic arrays' (ULA) which can be adapted for different applications;

(ii) the application of software engineering to develop expert systems (innovated or adapted), or intelligent knowledge-based systems (IKBS), for application in areas deficient in human expertise (e.g. medicine, agriculture, environmental studies); and

(iii) robotics, involving design or construction of software for remote control, special tools for computer architecture and hardware for sensing devices.

The proposed programme could establish links with industry to provide initial customer participation in design processes, and a research programme aimed at developing expert systems for use in areas of local interest to member nations (e.g. medicine, agricultural, etc).

The Council should consider establishing a Computer Advisory Committee to advise member nations, especially the small states, in the short-term, on specifications for a versatile, cheap, portable and standard Computer. The Council should urge member nations to seek expert advice on microcomputers. The development of a Commonwealth microcomputer is attractive, but it is difficult to improve on existing machines particularly since several nations have already specified educational microcomputers (e.g. United Kingdom, India, New Zealand). There is, nevertheless, a need for a cheap, versatile and portable school microcomputer. There is also considerable potential for adapting microcomputer hardware for specific purposes (e.g. medical diagnosis, agricultural economics and word processing).

The Council should consider establishing, on a medium priority basis, special training courses in software development where its adaptation for local use appears important. The availability of cheap microcomputers facilitates the development of cheap software. Software development is a major technological challenge, particularly for various local needs, and is suitable even for small and disadvantaged states.

Microcomputers are important for schools and colleges in respect of both hardware and software development, and teaching aids. It is therefore important for young people to become familiar with microcomputers through mass education and literacy programmes in the Commonwealth.

Computer-aided Design (CAD) is the use of computers in systems design with interactive graphic capabilities, by its ability:

(i) to transform design data to basic binary blocks, which are the fundamentals of electronic systems;

(ii) to draw design graphics, which are the pictorial representation of the designs of products, etc; and

(iii) to give the designer capability to man-machine iterative interactiveness in 'real time' with the model under design.

The Council should consider giving medium priority to the conduct of periodic training courses of 1–2 weeks duration in computer-aided design, for scientists at the university and research levels. Computer-aided design could be used as a draughting tool for the design of domestic equipment, agricultural implements, leather products, textile products, wood products and food products in Commonwealth member nations. It is a rapidly changing technology characterised by expensive hardware and highly developed software. Hardware development is the domain of multinational corporations and we do not recommend that

Council should give it support. In view of its rapid advances, scientists in Commonwealth nations should be kept abreast of new technological developments in, and applications of, computer-aided design, especially at the university and research levels.

We recommend that the Council allocates funds for the establishment of the Computer Advisory Committee in this programme as follows:

— £50,000 over five years (£10,000 per annum) to initiate this project.

— £100,000 over five years (£20,000 per annum) to develop a minimal and desirable project.

(d) Epidemiology and Public Health

Recent progress in molecular biology is leading to new vaccines needing field trials and more specific diagnostic methods of great epidemiological value in the control of communicable diseases, while important new pathogens are being discovered. The communicable diseases are immensely important, being the principal cause of death and disability in the tropics. In the less advanced Commonwealth nations, the epidemiology of communicable diseases needs strengthening, and is perhaps the most cost-effective mechanism for improving human health and contributing to socio-economic development.

Communicable disease epidemiology provides an almost unique opportunity for scientific cooperation relevant to development that is mutually beneficial to both the less advanced and the more advanced nations. Expertise in the biological and molecular sciences is in the more advanced nations while opportunities for field studies and experience are in the less advanced nations. Communicable disease epidemiology comprises of four components:

(i) Determining the best methods for controlling endemic diseases (e.g. malaria);

(ii) Investigating outbreaks (e.g. typhoid, cholera);

(iii) Evaluating immunisation programmes and other control measures; and

(iv) Designing and operating surveillance systems.

In view of the World Health Organisation's specialist groups and regional networks on immunisation, tropical diseases research and diarrhoeal disease control, we recommend that the Council should not consider involvement in the epidemiology of communicable diseases.

Socio-economic development and industrialisation has led to an increasing prevalence of many non-communicable diseases in the less advanced nations, hitherto associated only with the more advanced nations. There has to be a greater understanding of the genesis of these diseases in the less advanced nations, and this requires the availability and integration of skills in epidemiology with those in biochemistry, food chemistry, surface chemistry and many other sciences. Epidemiological research could be beneficial to the planning and management of health services on emerging non-communicable diseases (e.g. cardiovascular diseases, new patterns of cancers, and other 'diseases of development'), occupational health, and of large-scale field testing of interventions against tropical diseases (e.g. schistosomal drugs, leprosy and malarial vaccines). However, in view of World Health Organisation's specialist groups and regional networks, the Council should not consider becoming involved in these areas of non-communicable diseases.