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Application Of Space-Age Technology For Developing Countries And Education

Technology transfer and the multitude of benefits derived from space exploration is a prime factor in solving the problems of developing countries. The responsibility of developing countries in their own development process begins with a planning strategy and knowledge of the technology available to aid them in this process. The industrialized countries must understand the needs and goals of the developing countries and be ready to respond to their requests. This is a global responsibility to all mankind. The role of satellites in the development process is critical. Three categories of satellites - communications, meteorological, and earth resources - are described and the benefits of each are discussed. Cooperation among developing countries regarding the use of space and its benefits is at least as important as the links between industrialized countries and the less developed countries.

INTRODUCTION

Technology and economic development are benefits gained from space exploration. They can be applied to all mankind and can solve global problems which have no frontiers. Space research is a natural way to unite mankind.

An assumption is that developing nations can benefit even more from using new space technology than industrialized nations. The industrialized nations can improve services they already have, but the less developed countries (LDC's) can now have access to services not previously available or improve minimal services.

Space technology by itself is not a solution to the problems facing LDC's. The development of science and technology, however, can be considered a catalyst for broader technological and economic development of an LDC. Having the new technology they can better deal with such common problems as illiteracy, isolation and the lack of and organization of information. Unfortunately, governments are slow to identify science and technology as a critical input in the development process.

Development - Development is defined as a continuing process of the liberation of peoples and societies as they assert their autonomy and self-reliance. Thus, national pride is a key factor. Development is the unfolding of people's social imagination in defining goals and inventing ways to approach them. This universally accepted maxim can be applied to a developing country: give a man a fish and you feed him for a day; teach him how to fish and you feed him for life.

It can be said that space research has, in fact, stimulated development in the following ways:

- _ influence on other sciences, creation of new sciences,
- _ technology transfer and spin-offs,
- _ increased interest in education, science and technology,
- _ use of spacecraft and satellites for transmission of TV, radio, telephone signals; data transfer; remote sensing; meteorology; cartography; navigation prediction and notification of natural disasters,
- _ increased self-confidence of scientists through the prestige that their work is being used by their country for economic, political and commercial purposes.
- _ access to education

Profile of LDC's - In order to help identify their wants and needs here is a profile of developing countries: A large percentage of people live below the poverty level, often in dreadful conditions. Other aspects are: Malnutrition is common because there is often not enough food, safe drinking water is rare; disease is wide-spread and health services are spread thinly; when work is available, the salary is low and work conditions are frequently intolerable; insecurity is constant; there is no health or life insurance or social security for retirement; life expectancy is short, there is a high birth rate and centers of high population density; and, the illiteracy rate is high because educational facilities are outdated or inadequate and teachers are poorly paid and lack proper skills.

How will the wants and needs of the LDC's be satisfied? This is a key question and it is where the whole subject of technology transfer comes in. Indeed, it will create many new ones. One limiting factor in the ability of LDC's to adapt the new technology is the state of their indigenous science and technology capabilities. Here, let's describe science as understanding nature and technology as utilizing this understanding.

DUAL RESPONSIBILITY IN DEVELOPMENT

Development should be understood in two ways. First, the LDC's must understand how the new technology can help them to provide solutions. Second, the responsibility falls on those who possess the technology- the industrialized nations- must be aware of the existing problems in the LDC's.

Role of the LDC - Planning is the key process in understanding how new technology can provide solutions to a country's problems. A suggested long-range plan of action for the LDC's could be as follows: Create a committee with local groups of well qualified scientists and experts; discuss the use of technologies that are appropriate to the local economic and social conditions (i.e. those not too sophisticated); include technologies that will serve the poorest segment of the population; and, establish educational programs that will protect the indigenous culture. Issues to be considered in designing a national policy would be the current state as well as the potential of the country's higher educational facilities; identification of space research problems to which the country can make a significant contribution; cooperation with other developing nations.

In order to tap the technology available from the industrialized countries, the LDC's must meet certain criteria:

1. Gain knowledge of what is available and its source.
2. Understanding of its usefulness and applicability to their local needs and goals.
3. Knowledge of terms and conditions under which technology is available so that we can do cost/benefit assessment of its contribution to economic and social goals.
3. Existence of educational and scientific infrastructure to link needs and goals to external sources of information.
4. existing channels to transfer technology - often this is the industrial and educational sectors. Frequently, recipients of technology choose the first available source without seeking alternate and perhaps better and/or cheaper sources of similar technical information.

One must understand that the effective recipients of technology in the LDC are: The government, universities, independent institutions, local companies, foreign owned affiliates, and consultants of various types. They must address three important issues. First, make sure to have an

effective technology transfer system. Second, to negotiate acceptable terms of transfer. Last, to facilitate assimilation of the technology into society. The above points are perhaps the most difficult yet the most important in the whole area of technology transfer.

Role of the Industrialized Nation - To assist LDC's in developing and implementing their own science and technology policies, the industrialized nations must take into consideration several issues. Some of these are:

- _ Willingness to receive requests for assistance in the development of indigenous research and development (R&D) institutions
- _ Establishment of appropriate engineering school programs for foreign students in the industrialized countries
- _ Development of adequate engineering schools and business management schools in the LDC's
- _ Formation of technology centers
- _ Creation of extension services in science and technology
- _ Encouragement of transnational corporations to cooperate in the diffusion of technology
- _ Provision of negotiation-simulation sessions
- _ Formation of dialogues on continuing problems
- _ Encouragement of international financial institutions to support R&D units in LDC's
- _ Creation of data banks
- _ Promotion of the establishment of groups of LDC's to discuss their common problems and form their own industrialization goals and structures.

In promoting the development of LDC's through the use of science and technology, the industrialized nations must help in the transformation of these countries into more productive industrial nations. Therefore, it is the responsibility of the industrialized nations to adjust to the industrial shifts among the LDC's. They must be prepared to incorporate into their international economic policies the "new" products the LDC's want and need to export to pay for the capital, management and technological services obtained.

The industrialized nations and more specifically the space powers should recognize that there is a large pool of talented and skilled scientists and engineers in the LDC's. They should participate in the establishment of space mission goals and in the marketing of space-derived products. Such cooperation between these scientists and engineers in the LDC's with their colleagues in the developed countries will be beneficial to all mankind in the long run.

Transnational corporations also have some responsibility in the development process of the LDC's in which they do business. Even if you ignore the humanitarian aspects of the issue and consider the subject from a purely profit-oriented angle, the approach is still the same:

- _ Work with local governments or private institutes
- _ Help train or retrain technicians
- _ Provide contract research opportunities
- _ Assist in the development of standards

- _ Provide scholarships for graduate students
- _ Provide scientists or adjunct professors advise on program development
- _ Finance the exchange of professors to see how graduate programs operate abroad
- _ Provide research and bench experience in company labs for graduate students and professors
- _ Engage local professors as consultants in R&D projects.

A recurring complaint by LDC's marketers is that large companies are only interested in selling their products in the LDC's. They will sell components and not the entire system if that is the only way they can make a sale. This deprives the user of its full benefit and wastes their often precious funds. The marketers will not check to see if there is enough local technical expertise to operate and maintain the equipment. They are out for the fast profit with little concern for the consumer.

However, part of the blame must go to the LDC's for falling prey to the slick salesmen of some of the transnational corporations. Besides the above reasons they should not have purchased equipment they could not use, they often have the tendency to buy the equipment or system with the cheapest price tag. This logistical error could easily turn out to be more expensive in the long-run since durability and maintenance costs must be figured into the total cost picture. Again, planning and knowing what is available are important factors to remember.

BRAIN DRAIN

A serious problem facing LDC's is related to employment of scientists and engineers - and most professionals - who have received training abroad. Once trained, they do not want to go back to their country of origin. The main reason is due to the fact that salaries are often much higher and employment opportunities greater in industrialized countries. Part of the responsibility for solving this problem lies with the engineering schools in the industrialized countries who need to prepare the foreign students to return home rather than stay in the host country.

The engineering schools can meet this responsibility by first doing field research in the LDC's to understand their needs and objectives for technological development. The universities can then offer appropriate training programs, relevant to the needs of the foreign students so as to prepare them to return rather than induce them to stay. Often, the technical training they receive is so sophisticated they have no chance of applying it at the developmental level of their home country.

Another means of encouraging engineers and technicians to return home by ensuring them immediate employment with transnational corporations doing business in their home country. They can be phased into these companies and jobs through summer employment or work-study situations.

THE ROLE OF SATELLITES IN LDC's

The country should evaluate the cost-effective trade-off of using satellite technology. In an LDC with minimal or no ground infrastructure for microwave or fiber optics communications facilities, it is a better choice in the long run to use satellite technology. However, the decision to switch

to satellites is sometimes difficult because of their large capital investment in ground facilities. The initial cost is less and the capability can be created in much less time than if ground services were set up.

Three examples of the satellites' applications are:

Communications Satellites - These are used for: To collect and relay data; general purpose communications systems; in tracking; for search and rescue; special purpose information networks in medicine, business, education via internet; telemedicine; and, air and sea traffic management.

Meteorological Satellites - It is also the only choice for countries whose weather approaches from ocean areas without ground observation points. Minimal time is needed before information can be used. There is no cost for the satellite and only a small ground antenna is needed to receive data at unmanned stations (as in a jungle, ocean, mountain top) where a manned station is unfeasible to collect temperature, barometric pressure, wind velocity, rainfall, snowfall, etc. The information obtained in this category is even more valuable in LDC's where people often live in the vicinity of coastal areas and are directly influenced by flood and droughts.

Earth Resources Satellites - These are used to find probable locations of minerals such as copper, iron and uranium deposits. For example, they have provided land resource surveys and shown changing Gulf Stream boundaries used for shipping routes. They observe ocean temperatures used to guide fishermen to areas of high fish concentration. Also, they can provide information to do crop surveys, and crop yield estimates.

The following practical benefits gained from the use of satellites, broken down into several relevant categories are:

Communication - Telecommunications and information systems technology are indicators of the state of development and economic health of a country. It is important to national integration and development to have basic means of communication available to all the people in remote as well as urban areas. At minimum costs, most of the villages around the world can be inter-connected by telephones or any other communications system by means of a satellite system. The economic, social and political impact of communications development will be so profound that it is difficult to measure the cost benefits in financial terms in a short time.

Weather and Ecology - Besides the obvious benefits gained from weather forecasting, satellite information is helpful for issuing warnings for approaching storms, hurricanes, tornadoes, typhoons. Satellites can help assess flood damage, hydrological and climatological changes. Air and water pollution can be monitored as well as the erosion of land by wind and water causing loss of valuable topsoil.

Resource Survey - An important factor in any country's economic planning is the assessment of its natural resources. Through remote sensing data can be gathered on mineral, coal and oil deposits, forestry, fish and wildlife wealth, water supplies, and river flows.

Agriculture - Forecasts can be made concerning the weather, water tables, insect infestation, crop disease damage. Data from LANDSAT satellites has been useful in managing forests, doing crop surveys and in general agricultural development.

Education - Satellite TV educational programs can provide a classroom even in remote areas where a community TV can serve as a means of education for young and adults. This can bring basic information necessary for their survival and in matters concerning health, family planning and socio-economic developments.

Navigation - Navigation satellites are an indispensable aid to ship and plane navigators as they can pinpoint their exact location and route. Traffic control from space can aid safe and efficient use of conventional navigation systems.

TeleMedicine - Satellite TV is used in remote areas where local doctors and medical personnel communicate with complete medical facilities in patient diagnosis and treatment. Benefits in this area are also gleaned from space technology. For instance, bio-astronautics as a new science of life in space will have a great deal to contribute to our understanding of the human body and the control of disease. It is possible to conduct research in space and to manufacture pharmaceutical products in a weightless condition not possible or less expensively than on earth.

INTERNATIONAL COOPERATION

Within the LDC's there are degrees of development. However, they can recognize the similarity of their problems. There must be greater cooperation among the LDC's so that their efforts to use space technology in their development process will be mutually complementary and their efforts will not be duplicated. Such cooperation will also help defray the large initial financial expenditures. They can share cost of training personnel necessary to maintain the new equipment, and share repair facilities.

Although there are international organizations and governments coalitions dedicated to space research and technology transfer, there remains much room for increasing efficiency and effectiveness. Ideally, the activities of an effective international space agency would include actions to: Coordinate research and development, establish and maintain contacts with other institutions, advise and assist member governments, make international arrangements, process and distribute information and data, train experts and organize regular meetings, and public relations.

CONCLUSIONS

In addition to the transfer of technology to the LDC's there also exists the transfer of management skills. These are needed to manage the communications system, the new technology, and the increased data provided by the satellite networks. This complete transfer package is effective on a country's economy and development process. The active participation of developing countries in the space program is imperative.

The main justification for the space program is the profit derived from its services. Government subsidies may be needed to start an operation but they should not be needed to sustain it.

Some problems of developing countries have been identified. Also, some strategies are offered as to how they might be solved and some practical benefits derived from the use of satellites in the development process of LDC's have been suggested.

We are at the beginning of a new millennium for solving the problems of Earth by using space technology. Many of Earth's problems which have defied solutions for centuries can now be solved with newer knowledge and the adapted techniques that are developed through the exploration of space.

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