GENERAL
LC/CAR/G.716
3 March 2003
ORIGINAL: ENGLISH

THE ADOPTION AND APPLICATION OF INFORMATION TECHNOLOGY IN THE CARIBBEAN AND ITS CONTRIBUTION TO SCIENTIFIC, TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENT

ADOPTION AND APPLICATION OF INFORMATION TECHNOLOGY IN THE CARIBBEAN AND ITS CONTRIBUTION TO SCIENTIFIC, TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENT

Introduction

When Alexander Graham Bell invented the telephone in 1876 the phrase "information technology" was not yet coined. Consequently other inventions and discoveries that could speed up communications, assist in information exchange and generate information did not feature in the language of information technology. Such instruments as the telex machine, typewriter, fax machines and calculators, though employed extensively in business, never got the recognition they deserved and were overshadowed by subsequent developments. Interestingly, the invention of radio and television with their mass appeal, though not initially business friendly, provided the breakthrough for the dawning of the information technology age.

So that, although information technology has now come to be synonymous with computer use, radio and television are also important components of the information technology age. It is radio and television, that whetted people's appetite for news and information, that allowed the computer to be in such demand when it broke into the information market. This notwithstanding, as an advanced technology, the computer does have particular unique features which contribute to its success and usefulness. Even now, computers have not shaken themselves of the television, as teleconferencing and power-point presentations continue to use television technology, an improvement on the early use of the television screen as the monitor for the computer. The point is made here to illustrate that most technologies are cumulative, building upon what existed before. Hence the resident knowledge base in the society becomes important for technological development.[1]

It is generally accepted that technology has become the driving force in modern economic growth. The activities leading to the growth, however, can take different forms, but their dependence on technology is unmistakable. It is not uncommon to refer to the services sector as the engine of growth. However, what is clear is that regardless of the sector, technology is the driver. Tourism would not be as developed as it is now and a major economic driver for many countries if the jet aircraft had not been developed. International banking would not be a success if telex, the facsimile and computers had not been developed. Agriculture would not be as efficient as it is today, without the invention of machinery and equipment such as the tractor and the combine-harvester.[2]

This paper will focus primarily on the computer and its use in product delivery, or as a tool for achieving success in scientific, technological or human resource development. The paper will not focus on the development of the technology in the subregion but rather on its use in the above-mentioned areas. It is, important, though, to

---

[1] De Gregori, Thomas. A Theory of Technology. Continuity and change in human development. The Iowa State University Press. Ames. 1989. P 30.

[2] A great change has started. The Economist. March 1979.

discuss how new technologies have their impact and what conditions are favourable for their success. This paper will take a historical perspective in order to compare information technology with other technologies in the region.

The success of a technology

Just as the "Green Revolution" did not bring benefits to all farmers, or reduce hunger and poverty worldwide, so too the information revolution continues to leave a sizable portion of world population behind. That was true of the inventions during the first and second industrial revolutions and it is already being observed in this third revolution, as the information age is coming to be known. Because of gaps in socio-economic development, education and income levels, and because of language and geographical barriers, not all countries and individuals have equal access to the new advances in information technology. For example, what does information technology mean to indigenous people in remote and poverty-stricken areas? In its 1998 World report, the World Bank noted that poor countries and poor communities will fall behind more rapidly than ever before with the rapid development of information technologies (IT). "As we are enthusiastic about the information superhighway, there are villages and slums without telephones, electricity or safe water, and there are primary schools without pencils, paper and books. For poor people the promise of the new information age, that of knowledge for all, remains as remote as a distant star."[3]

The World Bank report also notes that the share of high-technology goods in international trade has doubled over the past two decades. However, the trading of these goods and services is highly concentrated in the industrialised countries. Knowledge-based products now make up more than half of the gross domestic product (GDP) of Organization for Economic Cooperation and Development (OECD) countries. In today's IT and knowledge-based economic system, the globalisation of trade, finance and information flows is intensifying competition. Being able to gain access to the information highway is the key to success in the world market. Lack of infrastructural and governmental resources, and heavy debt burdens have made it almost impossible for developing countries to reduce poverty through IT.

Research has suggested that there are a number of preconditions that would determine whether a technology would bring about increased economic growth through its application. A first precondition to the success of the technology is a general increase in knowledge in the society. The peculiar situation in most developing countries is that technologies used are not endogenous. That means the technology was not developed to solve a local problem or increase efficiency in a local activity, which is usually the driving force behind technology development.[4] It has been suggested that in a situation of general increase of knowledge the required critical mass of knowledge necessary to develop the technology is resident in the population and the inner workings of the technology is generally understood. Since that situation does not, as a rule, exist in most

[3] World Bank Report, 1998

[4] De Gregori, Thomas R. A Theory of Technology – Continuity and Change in Human Development. The Iowa State University Press. 1985 p. 34

developing countries because of the disjointed approach to technology transfer and technological adaptation, what obtains is primarily imitative technological applications.[5]

Sakiko Fukuda-Parr, Director, United Nations Development Programme (UNDP), New York, in posing the question as to which path – indigenous or modern – should be taken for technology development, notes that it should not be a case of either one or the other. She acknowledges that the advent of technological innovation can threaten indigenous methods and knowledge, but also that the bunker mentality of rejecting all innovation does not help either tradition or people. The way forward should be to mix the benefits of modern scientific methods with indigenous knowledge to create innovative technology that can solve problems in people's daily lives.[6] However, to achieve that objective, itself requires sustained effort and investment in adoptive technological research.

It is understood that information flows are at the very core of the globalisation process, and that countries and corporations project power by promoting their own culture and values on a global basis. This suggests that the countries that are better positioned to thrive in the new economy are those that can rely on widespread access to communication networks for their companies and citizens; the existence of an educated labour force and consumers; and the availability of institutions that promote knowledge creation and dissemination. Technological development then itself becomes an ongoing activity which provides the impetus for better technologies. Employment and wealth are therefore created both in the development of the technology and in the trading of the technology. That general understanding contributes to the success of the application of the technology. Against this background, developing countries seem to be at a significant disadvantage vis-à-vis industrialised countries.

A second condition is the ability to fund research and development to applied knowledge. Development has always been "knowledge-based". However, this fact has not always been adequately understood, articulated or integrated into development strategy. The diffusion of advances in information and communication technology requires that assumptions of development be revisited and adjusted, lest development approaches become part of the problem rather than part of the solution. Knowledge-based development provides a framework for linking the application of information and communication technology to the achievement of development objectives. The need to fund research and development to make technologies applicable is a key component of the success package. Besides making sure that technologies remain relevant, it provides the catalyst for innovation. Such research and development funding and capability provide for small business development, which are not big enough to develop technology but which, through application, develop appropriate methodologies for increasing efficiency or solving problems. In that case, both the benefits of technological development and technological application and adaptation will filter into the society,

---

[5] De Gregori, Thomas R. A Theory of Technology – Continuity and Change in Human Development. The Iowa State University Press. 1985. P34.

[6] Development Magazine, August 2001

opening up opportunities for trade, delivery of services, consultancies and technical assistance. Wealth then accrues to these pioneers!

Scientists in developing countries, however, have a major challenge. They not only work under adverse conditions, but also need to achieve more to win recognition than those who work under better conditions in developed countries. Often they watch their work go unnoticed, regardless of its quality. A *New Scientist* editorial (1 November 1997), for example, reveals that for manuscript publication, editors of reputed international journals select articles from Harvard over those from Hyderabad, even though both manuscripts may be of comparable quality.[7] Technology also tends, unfortunately, to exacerbate this inequality and further marginalises the scientists and the work done in developing countries. It is important for researchers to know what is happening around the world and to publicise their own work. Information is key to the growth of knowledge, and dissemination of information is crucial for scientific enterprise. Today, there are thousands of journals but many of them are just too expensive for libraries in poorer countries to acquire. In a recent informal survey conducted by the ECLAC Science and Technology Unit on assessing the use of IT in the Caribbean, while all respondents noted that scientific information was sought from journals that have on-line sites, only one indicated that on-line subscriptions were paid for access to the relevant sites.[8]

A third is the need to keep knowledge increasing. The pool of knowledge must always grow at a faster rate than the population itself increases. The innovative ideas that come out of research and development exercises must be made available to the society to build upon. This then creates a dynamism that would provide greater opportunities for wealth creation through linkages between developers, users, and promoters, including tertiary institutions and trade organizations. The more one knows, the more one is likely to understand how a technology works. The more one understands how a technology works the more likely it is that one can make changes to the technology; and the more knowledge that is available on the technology, the more likely that the technology will be employed and traded. This is the technology cycle that keeps a country ahead of the pack.

Generally, these conditions do not exist in most developing countries and the Caribbean region is no exception. In this era of information, some two billion people worldwide still do not have access to electricity, the basic technology of the industrial age. Global technological innovation is highly concentrated in the high-income OECD countries. According to the World Bank, by 1995 low-income economies averaged less than 2.6 telephone lines per 100 inhabitants and less than two computers per 1,000 inhabitants, in contrast to a teledensity of 54.6 per 100 and 199 computers per 1,000 inhabitants in high-income economies. The annual wages for many developing countries is less than the cost of a cheap computer. In a survey on the "Utilisation of Information Technology by Households, 2001" conducted by the National Institute of Higher Education, Research, Science and Technology (NIHERST) in Trinidad and Tobago, it was determined that only 12.7% of households in that country had a home computer. For

[7] New Scientist. November 1997
[8] September 2002

purposes of comparison, more than 30% of the households in a number of OECD countries were equipped with computers by 1997 and more than half (54%) of the households in Australia had computers in May 2000. Affordability was cited as the major constraint in 56.3% of all households without computers. The influence of education level is also a significant contributor to development since the level of education is often correlated to digital literacy, to social capital, i.e. social networking among peers, and also to income. The table below shows distribution of computer users by highest level of education and age, as obtained by the NIHERST survey.

Age Group (yrs)	Highest Level of education				
	Total	Primary	Secondary	Technical	University
All ages	1033	158	519	110	246
<10	97	97	0	0	0
10-14	126	47	79	0	0
15-19	171	0	153	3	15
20-24	124	0	52	19	53
25-29	97	0	48	16	33
30-39	168	2	84	29	53
40-49	150	5	58	29	58
50 and over	86	7	37	14	28
Not stated	14	0	8	0	6

Source: Utilisation of Information Technology by Households, 2001. NIHERST, Trinidad and Tobago. January 2002.

It can be observed that half (50.2 %) of the total computer users had attained a secondary level education, whereas 23.8 percent had acquired education at university level. The highest level of education for 15.3 percent of the users was up to the primary school level.[9]

It is also significant to note that in the Human Development Report 2001, published by UNDP, a Technology Achievement Index (TAI), which represents a composite measure of technological progress that ranks countries on a comparative global scale, unsurprisingly shows that no developing country was among the list of leaders in this area. Costa Rica, ranked at no. 36 out of 72 was identified as a potential leader, with Trinidad and Tobago and Jamaica, ranked 41 and 49, respectively, as the only Caribbean countries identified as dynamic adopters. All the other Caribbean countries were placed in the "Other" category, which, it should be noted, was even below that of "Marginalised."[10] Based on the above, knowledge cannot be generated, disseminated or applied to effect wholesome change rapidly. It is rapid change in wealth creation that distinguishes the impact of technology from the impact of market and institutional change, features of early economic growth before the industrial revolutions.

[9] Utilisation of Information Technology by Households, 2001. NIHERST, Trinidad and Tobago. January 2002.

[10] Measuring Technology Achievement of Nations and the Capacity to Participate in the Network Age. M. Desai, S. Fukuda Parr, C. Johansson and F. Sagasti. The index was developed for the Human Development Report 2001 – Making New Technologies Work for Human Development published by OUP for UNDP.

Examining the three above points in general it can be observed that given that the Caribbean is not a generator of technology, most technologies applied in the subregion are usually without any specific prior determined strategic purpose. True, a number of agencies in the subregion are subsidiaries of larger overseas concerns and profit from the directives of these parent companies. The introduction of technologies in these cases are driven more by the need of the parent company to micro-manage the subsidiary than to make the subsidiary more efficient. For example, a technology that depends on a reliable supply of energy would incur additional cost to the parent company because of the need to invest in standby generators where the local electricity supply is unreliable, as is the case in Guyana. That the subregion is not a generator of technology also makes the introduction and application of the technology costly, wasteful and detrimental in some cases because of the lack of knowledge of the inner workings of the technologies and the latent effects of the technology. For example, the introduction of Irish potato into the subregion did serious damage to tomato production since it increased the incidence of fuserium wilt. Equally as well, in the case of e-commerce, it is now possible to introduce seeds into the region without proper field trials or quarantine. The implications are indeed frightening. Richard Critchfield has suggested that when technological change comes too fast it can produce consequences that could cause upheavals in the society.[11] V.S. Naipaul, too, shares that position. [12]

Another major problem in underdeveloped countries and the Caribbean is the financial capability to fund research and development in the area of applied technologies. Since most technologies were developed outside of the subregion it is not enough to just apply the technology because it works elsewhere. There is the need to breakdown the technology into its component parts and integrate it into the entire fabric of the society in which it is to operate. Research and development would facilitate and ensure the best conditions under which the technology should be introduced or not. It is not uncommon to hear persons speaking of the speed of their computers or the capacity of the computer and wanting to get the latest and fastest in the business. Upon very close examination it is seen, though, that the majority of computers in the subregion are simply used as word processing machines and their capabilities hardly utilized on a continuous basis. True, the cost of computers are decreasing. However it can be argued that the price paid for capacity that is not used, when added, can amount to a substantive sum in the subregion. Research and Development work would help to keep a sufficiently good stock of optimal use machines in service. Just as the airline industries have increased the efficiency of turbo-props to service areas where a jet would be too costly, a good R&D programme in IT (hardware) would serve to provide that kind of service. This is similar to the early concept of the Volkswagen® motor vehicle designed in Germany, and more recently the K-car® series in the United States of America that were targeted at specific groups of the population.

A result of the above two problems is the insufficient generation of knowledge to a larger section of the population. That lack of knowledge about the technology makes

---

[11] Critchfield, Richard. Science and the Villager. Foreign Affairs. Volume 61. Number 1. Fall 1982.
[12] Naipaul, V.S. A Bend in the River. Knopf. New York. 1989.

the population easy prey to advertising gimmicks and pressures. Because the knowledge of the technology itself provides an opportunity for business, those who possess the technology may sometimes be unwilling to share the information. In today's IT and knowledge-based economic system, the globalisation of trade, finance and information flows are intensifying competition. Because of this, being able to gain access to the information superhighway is key to success in the world market. As information technology spreads into every aspect of life, those who have access to IT knowledge have more sources of information and ways to gain support. Social exclusion has become a very real possibility for the already marginalised people in developing countries and as IT becomes a dominant communication channel, the poorer classes in developing countries may be further deprived of opportunities to express opinions and participate in social development. The technology, though, offers the opportunity to address the problem of skewed development, but it needs to be well thought out and applied as a policy priority. The fact is, developed countries not only steer the development of information technology, but also own a much larger part of the technology through patent and intellectual property legislation. The data show that over 60% of all internationally recognised patents are held by multinational companies in Europe and the United States of America[13] and that 80% of the patents in developing countries are owned by citizens of developed countries.[14] The ratio of research and development expenditures in high-income countries to that of low-income countries is 218:1[15]. Most developing countries are therefore unable to participate in this capital and knowledge-intensive industry. The Caribbean is no exception.

In addition, the cost for developing countries to gain access to IT is higher than for developed countries. This is due to the fact that in order for poor countries to set aside resources for IT development, given the general lack of resources, they may need to cut spending on other items such as public services. The harsh and adverse impact of reduced government services on poor people is direct and immediate whereas the benefits of IT investment may take some time to be realised.

The use of the new technology

A quick snapshot of the Yellow Pages of the Trinidad and Tobago Telecommunications Services Company shows approximately 23 pages being devoted to listings for computer suppliers and other IT related businesses ranging from computer sales and services to Internet development, providers, software suppliers, schools and consultants. The cost of a fully loaded computer for average household use ranges between US$800 to US$3,000 for state-of-the-art systems. The NIHERST survey of 2001 showed that of the households with computers, 54.8% reported a gross monthly income of US$1,000 and over and 29.2% had monthly incomes between US$320 and US$999. The modal household income group with computers (19.9%) was over US $1,200, whereas only 5.1% of households with a gross monthly income of less than US$320 had a home computer. Affordability was cited as the major constraint in 56.3%

[13] Oxfam International, 1999
[14] UNDP Human Development Report, 1999.
[15] World Bank Report, 1998.

of all households without computers. With regard to use of computers in the workplace, 59.8% were employed with the private sector and 29.7% with government. No figures were obtained for the situation in other Caribbean countries. If however, the correlation between average gross monthly income and the ability to purchase a home computer is consistent, then the figures for the smaller and less developed economies than Trinidad and Tobago may reveal even more limited access to computers by households.

Of the households surveyed, only 11.8% were engaged in software development and 20.2% accessed distance learning/education compared with other activities such as games (78.4%), Microsoft Office (66.0%), e-mail (62.4%) and web searches 61.5%). By value of e-commerce transactions, 42.2% of the households spent less than US$100, while 35.6% spent between US$100 and US$500 over the six month period ending May/June 2001. Of those households with Internet access, 19.5% reported e-commerce transactions, mainly in the purchase of computer hardware/software, electronic goods and books and magazines.[16]

Based on the above, it is debatable whether the subregion maximizes the use of its current stock of computers and accessories. That position may well be because of the manner and the areas in which the computer were introduced in the region. The introduction of computers in the region may have been ***firstly*** as improved typewriters, where the majority of computers were used as word processors to replace the electric typewriter. Computers were not introduced on a large scale into the scientific or research institutions until much later, when they had already been in general use in the secretarial pool. That is so because the breakthrough of computers in the subregion coincided with the development of the desktop machines. At this time, the business sector remains the largest user of the technology followed by private home owners, since the technology is perceived both as a business machine and as a play-station.

In the ***second instance***, computers were used for faster calculations. As with most advanced technologies, there is a time lag between developer user and non-developer and users of the technology, in terms of its real potential. For the most part the computer was seen by most in the subregion as a normal progression from the electric typewriter which itself had replaced the manual typewriter. Here, as with the typewriters, the speed of the particular operation was of importance and not necessarily the versatility through the many possible applications of the technology. However, as the technology became better known, its potential and other capabilities were realised and employed.

Thirdly, the computer was used for greater versatility in applications. As with all technologies, there will be those who would be more adept and more inquisitive and therefore explore beyond the usual limitations. However, the number of those individuals were very small. In addition both technological activity and even business activities had not matured to the extent that the capabilities of the computer would be effectively utilized. This will require further knowledge of the technology, additional training and

[16] Utilisation of Information Technology by Households, 2001. NIHERST, Trinidad and Tobago. January 2002.

investment in human resource development. Invariably, however, much of that had to come from outside of the region initially.

Fourthly, the computer was used for speed of business transactions, where globalisation had virtually thrust the use of the technology onto the region, without the necessary mechanisms that would allow end users to capitilize on its potential. Thus, there are still problems relating to the use of the technology in banking, commercial transactions and in government that create bottlenecks to the real time speed of the technology. In most cases changes in administrative structure that could facilitate the speed of the computer have not been effected in management styles and systems in the subregion.

The computer as a tool for development

The general consensus is that the use of computers can bring information to a larger number of persons in a population. In order, however, for information to be retrieved, the receiver also must have the technology to receive the message. Radio and television are modes of transmitting information, without the beneficiary actually owning either one. With the use of a computer as a medium of communication there almost always involves some personal investment by the receiver. Because this is not the case with radio or television, these media remain popular as messengers. Used properly the computer can also make a significant contribution to human resource development and to the transfer of technology. Its contribution to development in these specific areas will be examined, especially in the control of scientific and technological developments in the subregion.

Human resource development and education

In the Latin American and Caribbean region, many communities and classrooms lack computers and Internet connections, leaving young people ill-prepared for the opportunities and jobs generated by today's knowledge-based economy. This opportunity is especially critical for marginalised youth, for whom the digital divide is even wider. In light of the fact that 60% of the population in Latin America and the Caribbean is under the age of 30, with most of them living in poverty, there is a need to actively engage this sector in the development process and to mobilise its comparative technical advantage and capacities.[17] A study to assess the e-readiness capabilities of Caribbean Community (CARICOM) member States was conducted in June/August 2001 by the Commonwealth for Technical Cooperation (CFTC). The framework used in the exercise included *human capacity framework: e-enabled human capital.* The information requested under this issue were:

(a) The availability of e-professionals for e-business
(b) Skills and efficiency of the workforce

[17] Industrialisation Options for the Poorest Countries. Background Paper for Human Development Report, 2001. Howard Pack, The Department of Public Policy and Management, the Wharton School, University of Pennsylvania. November 2000.

(c) Levels of IT teaching in the education system
(d) E-literacy amongst citizens; and
(e) The institutional framework for fostering a culture of local creativity and information within the society.

Because human capital is the most important resource in this new era, the objective was to *inter alia:*

- determine the availability of personnel for e-business – both IT and management trained;
- what if anything the training and educational institutes were doing to address the need for a population that was prepared for the new technology;
- the level of IT literacy in the country amongst citizens; and
- whether or not governments provided the necessary infrastructure that would support creative thinking and information sharing using information technology.

The results of the survey revealed that the levels of IT training and teaching in the subregion's education system generally varied from "quite low" in Antigua and Barbuda to "fairly high" in Barbados where a full computerisation of the school network was being planned. In Barbados, IT teaching in schools and the Community College was limited, but in high demand and the e-literacy rate amongst citizens was "rising fast". Education in Barbados was said to be the largest item of government expenditure, with primary, secondary and tertiary education being free and universally available. The literacy rate was 97% in 1995. There were 79 primary schools, 21 secondary schools, and tertiary educational institutions including vocational schools in 1996. Computers were widely available to schools. The CARICOM survey noted that the skills and efficiency of the workforce in IT capability in Saint Lucia was about the same for other Organization of Eastern Caribbean States (OECS) countries, but with more extensive level of private training. The e-literacy amongst Saint Lucians was approximately 30% and rising. In Suriname there was a shortage of e-professionals because many of the trained persons migrated and IT was only just being introduced in schools. The e-literacy among citizens was estimated at 4 – 5%.[18] In Saint Lucia, The Star Newspaper, in a report dated Wednesday June 5, 2002, noted that the St. Lucia Electricity Services Limited (LUCELEC) was steadily coming closer to its goal of providing all schools island-wide, with a computer system. This was a target established a few years ago and, to date, the company had supplied over 60 computers to approximately 50 educational institutions across the island. The donations were usually a computer and printer package, with some schools also receiving a scanner.[19]

There is at present in the subregion a growing awareness that the use of computers can greatly improve the performance of both teachers and students. However, what is not clear is how best to design the programmes of introduction of computers, in the context of limited resources, for maximum benefit. In Trinidad and Tobago, for example, at the

[18] Country Framework Analysis for CARICOM States on their E-Readiness for Business. June/July 2001.
[19] The Mid Week Star, Saint Lucia. June 5, 2002.

primary school level, introduction of the use of the computer is not a formal part of the curriculum, but is dependent on the individual school principal's initiative.[20] Many teachers in the subregion are still computer illiterate. To compound the problem, the students are way ahead of the teachers especially in the primary and secondary schools, in terms of the mastery of the technology. That creates an antagonistic situation between teacher and student. In most cases computers have been introduced in schools that already perform better, due to better teachers who already own or use computers; the guidance of the better educated parent at home; and the financial status of the parent body of the school to provide needed tools for their children and the school in general. This is usually the case with the private schools but are also seen in the public schools that serve the elite of the society.

The performance of students in science and technology in the subregion is generally accepted to be below what is desirable for development. A number of studies have identified the problem as being due in some part to the fact that the majority of persons who choose to enter the teaching profession are themselves weak in the science subjects.[21] To adopt, innovate and fully optimize the use of ICT as an instrument of development, a country would need more than digital literacy. It would need a technological and scientific base. The table below summarizes the availability of technicians and scientists (per million population) in different regions of the world.[22] Outside the OECD countries, Eastern Europe and Transition Economies seem to have the most technical and scientific human capital. The Caribbean and Latin America, while not the least well off, are far behind in terms of technicians and scientists.

Region	**Technicians per million people**	**Scientists per million people**
OECD	1326.1	2649.1
Eastern Europe and Transition Economies	577.2	1841.3
East Asia	235.8	1026
Latin America and the Caribbean	205.4	656.6
Middle East	177.8	521
Sub-Saharan Africa	76.1	324.3
South Asia	59.5	161

Another serious problem lies with the fact that there are no agreed standards by which the technological function of IT is measured. In the developed countries there are standardized technology assessment programmes that provide training for both teachers and students and measurement of the progress of both. This is an elaborate system usually administered by the National Science and Technology institutions, such as the

[20] Based on discussion with official of the Training Unit, Ministry of Education, Government of Trinidad and Tobago. November 2002.
[21] See Rationale for CCST/OAS project on Science Mathematics and Integrated Learning Experience (SMILE) implemented jointly with the University of the Virgin Islands. 1998.
[22] World Bank, World Development Report, 2000

National Science Foundation of the United States, Academy of Sciences of France, and the National Science and Technology Council of Canada. These programmes try to ensure that the teacher is always ahead of the student and provide for resource materials on a continuous basis for both teacher and student. An observation from a teacher training progamme that was conducted in the United States Virgin Islands in 2001 suggested that while many teachers may willingly accept the training, they do not automatically incorporate the new information in their activities on a continuous basis. A possible reason is that it involves additional work, both in terms of preparation and delivery.[23] Based on that observation it is suggested that the initial introduction of computers in schools should be first to provide support to the teachers, with a well-trained resource person being responsible for the unit. Only when there is a good mastery and acceptance of the use of the technology should the students be incorporated into the programme.

Where funding is not a problem, information technology is used as a means of improving the teachers' skills in both delivery and content. In the more prosperous Caribbean countries where all teachers, regardless of assignment, are required to be university graduates, a computer course is mandatory. This is augmented by regular training in not just the use of the computer, but in the application of the technology to improve professional skills. The technology is used in the preparation of lesson plans, teaching techniques, as well as improving the content base of the teacher on the topic to be addressed. A number of Caribbean countries have embarked on programmes to provide training to teachers in the use of the computer. However, because of the fact that these programmes are not supported by reliable and systematic software generated locally, much of the training is still centered on the downloading of foreign programmes.

The efforts of the governments of Barbados, Trinidad and Tobago, Bahamas and Jamaica, must be lauded in that a conscious effort was made to involve a number of capable institutions that would provide technical support to the school computeriation programmes in these islands. Barbados launched its Edutec 2000 progamme as a partnership between the Ministry of Education, the National Science Council and the Community College. In Trinidad and Tobago, NIHERST, and the University of the West Indies, St. Augustine campus, were instrumental in giving initial assistance to the school computer programme. In Bahamas, the Community College played a supporting role in the introduction of the programme by the Ministry of Education. Such collaboration ensures that resources outside of the Ministry are brought to bear on the programme and provide higher levels of sensitization. It should be noted that the existence of institutions of higher learning in these countries prove to be an added advantage that the smaller and less developed islands do not have.

Agriculture

The general educational level of most farmers in the subregion necessitates that farm visits by the Extension Officer remain the most effective means of technology

[23] Discussion with J. Keenan, Technology Resource Officer, Charles Emmanuel School, USVI. October 2002.

transfer and technical assistance. There are a few farmers that use IT to obtain information, but the number is small. All the Caribbean islands have Extension Services attached to Ministries of Agriculture. The officers of the Extension Service are to provide information to farmers and more recently to fishermen. Before the advent of radio and television, early extension work was solely through farm visits and demonstration plots. Around the late 1960s communications sections were added to the Extension branches and pamphlets and radio talks were produced. However, to the extent that a number of the practices advocated necessitate actual demonstrations, these had limited success.[24]

Another problem with the use of advanced information technology in agriculture is that many farmers do not follow instructions, or they sometimes try to get more from the product than recommended. This is especially damaging with the use of pesticides where farmers either use too little or too much in an effort to conserve or to achieve maximum effect. In such cases a vicious cycle develops in that either the pest becomes resistant quickly in the case of too little or products become poisonous in the case of too much. One cannot, of course, blame the technology. These situations, however, reinforce the points made earlier in that for technology to be most effective it must be understood in its entirety. Not all persons need to be on the cutting edge of global technological advance. But every country needs the capacity to understand and adapt global technologies for local needs. It is often mistakenly assumed that technology transfer and diffusion are relatively easy and that developing countries, especially in the case of the agricultural sector, can simply import and apply knowledge from outside by obtaining equipment and seeds. But for farmers to use a new technology – to identify its potential benefits, to learn it, adapt it and use it – requires new skills and the ability to learn and develop new skills with ease[25]. For example, a study from Thailand shows that four years of education triples the chance that a farmer will use fertiliser effectively[26]. In the Caribbean, the proper use of fertilisers remains a problem, especially when applied on slopes, even notwithstanding the input of the Extension Services of the Ministries of Agriculture and WINBAN in the case of banana, after more than 25 years.[27] Furthermore, with today's rapidity of technological advance, the skill and knowledge required is the ability to adapt to new technology continuously. The recipient must have a sufficient level of knowledge and sophistication to adjust to the message. Unfortunately, learning by doing, reinforced by oral traditions, remain the maxim in the region.

Notwithstanding the above, farmers capable of understanding the technology can derive many benefits from its use. The number of extension officers is usually inadequate in the subregion and farm visits are not as regular as they should be. While information

---

[24] Discussion with Dr. Ranjit Singh of the Department of Agricultural Economics, UWI, St. Augustine on the Distance Learning Project (UWIDITE) as it relates to Agriculture, especially Agicultural Extension. October 2002.

[25] Measuring Technology Acheivement of nations and the Capacity to Participate in the Networl Age. M. Desai. S. Fukuda-Parr, C. Johansson and F. Sagasti. The index was developed for the Human Development Report 2001, Making New Technologies Work for Human Development published by OUP for UNDP.

[26] Lipton et al, 2001 (from 5 above)

[27] Observation and discussions with Rudolph St. Hill, Agricultural Extension Officer, Saint Lucia. November 2002.

on the agronomy of the crops or livestock that are produced in the subregion is available to farmers, most of the programmes are usually designed for either larger farms or in other ecological zones. There is need for adaptation of these programmes to local conditions, but the software and support systems are not readily available and without caution, some damage can also be done. For example, computerized programmes have been developed for the feeding of some animals. These programmes take into consideration several factors including temperature and breed of animal in determining feeding times and amounts. If one were to just replicate the programme and not be aware of these factors, wastage can occur, and efficiencies and even animal health can be compromised. The same applies for fertilizing and irrigation progammes that have been computerized. IT, though, can be useful in the maintenance of record and accounts, which are more generic and can involve the whole family in the farming business where the computer literate individual in the family can help keep the records. That then, should improve efficiency, provide better information for the Extension Officer to evaluate and eventually lead to increasing the efficiency of the operation.

At the level of the Extension Officer and Researcher, the use of IT can make a meaningful contribution. The Internet and the world wide web can provide useful information with the understanding that some of the information needs to be tested and adapted. In addition, given that a number of the islands do not have higher institutions for agriculture, a well structured training programme can be developed to provide the officers with information on a continuous basis. The Extension Unit of the University of the West Indies has begun to use some distance teaching methods and programmes to provide refresher courses to Extension Officers regionally and there is now in place the possibility of taking some courses without coming to St Augustine, in the degree programme. What is required is the development of IT friendly materials that can be shared in the subregion, to address problems in agronomy, pest control, soil and water conservation, etc. There is some awareness material on these, but there is need for material that can be used as training tools addressing the issues in a more in-depth manner.[28]

Industry

Cost of imported technology vs improvement in performance of firm or output?
A common complaint in developing countries is that cost of production is higher, or to put in economic terms, there is little comparative advantage in producing the product. This makes importing the product much more attractive and less risky. The bombardment of the media advertisements also help in slanting the argument in favour of importers. At present, industry in the region is well served with IT in terms of hardware as the reduced cost of both desktops and laptops have made them quite affordable. Also, most of the larger companies can and do purchase software developed primarily abroad to meet their needs. What is needed are software packages that are relevant, particularly to the Small and Medium-Size Enterprises (SMEs) that are being promoted in the subregion. This

[28] Report of the Twentieth Meeting of the Standing Committee of Ministers Responsible for Agriculture. CARICOM. Belize City. May 1997.

will not only increase the efficiency of operations but will also provide opportunities for SME creation within the IT industry.

While many of the SMEs may not generate sufficient business to warrant the investment in a computer, through a system of incubators, a number of small businesses can come together to share resources to help solve the problem. Early efforts at establishing incubators have not been successful in the subregion. These early efforts have generally focused on what is termed "hard technology" where training in product development was emphasized. Mistrust and the competition usually hampered cooperation among potential beneficiaries. If IT can now be used to promote management skills and information generation, areas where there is less perception of intellectual property theft, it may pave the way for a greater acceptance of the concept of incubators and build confidence even for product development collaboration.

Within the subregion there are businesses involved in computer repairs, Internet cafés, website development and limited activities in software modification. There is though, no link between areas of economic activity promoted by government and the IT industry. Such activities like agriculture, (to include livestock and fisheries), tourism, agro-processing, health, etc., remain outside of the concerns of the IT experts.

Media for general knowledge

It is a truism to say that the Internet has made many kinds of information more easily accessible to more people. One of the greatest challenges currently facing Caribbean territories is that of transforming their societies into learning societies. A society in which learning does not stop at any particular level of schooling but, rather, is continuous. Therefore any agent that can help achieve this goal is essential. The media is one of those agents.

The development and transformation of education in the subregion can no longer be left to the traditional partners of school, Ministries of Education and church. Education, in one way or another, impacts on the entire society. Therefore, it is necessary to have all stakeholders and sectors of the society involved in shaping, and if possible, the delivery of that education. The media forms an integral part of the society and its outreach ability is extensive. The media must therefore use that ability to play a vanguard role in transforming and developing education in the various territories. The regional media needs to re-prioritise its primary functions of, 'to entertain', 'to inform', 'to persuade' and 'to educate'. The function of 'to educate' seems to be the one least attended to. There is certainly the need to place greater emphasis on this particular function.[29]

Results of Surveys

The results of the CARICOM survey and other information coming out of the Caribbean reflect that some type of transition is taking place in the subregion's approach

[29] John Sealy, Communications Officer in the Ministry of Education, Human Resource Development, Youth & Sports, Government of Saint Lucia

to information and communication technology for development. In an article entitled "A framework to promote the ethical transfer of IT to developing countries" from "Computers and Ethics in the Cyberage", it is stated that developing countries should establish IT plans and policies which take into account social, cultural and ethical factors contributing towards agreed human goals. It also noted that IT transfer should be supported by education in computer literacy.

Government and policy makers know that access to information for people to build and apply knowledge is the common denominator for achieving efficient, equitable and sustainable development. This is the reason why some governments are in the process of drafting information technology policies. However, the very fact that they are disjointed means that the technology is still not yet understood to be treated as a holistic package in the development process.

Conclusions

It is clear that the introduction of information technology into society cannot be divorced from the general level of technological advancement of the society. (development of technology vs adoption of technology). It is also clear that in order to obtain maximum benefits from the introduction of the technology, the technology must be geared towards solving a particular problem or increasing efficiency in a particular operation. In order to obtain maximum benefit from IT, the following policy decisions must be taken:

1. There must be a link with the IT experts and the economic activity experts of the State so that a collective research agenda can be developed for problem solving.
2. There is need for support systems in IT in the subregion to research the needs and direct programmes.
3. While IT offers many benefits it can also pose challenges and problems if not properly understood and introduced.
4. Cost benefit analyses on specific aspects of the technology is also recommended.
5. Although generally perceived to be beneficial, it must be recognized that the imported cost of the technology can be high for developing countries, especially in terms of the supporting infrastructure that must be put in place, and the latent results from the technology.

IT can be used to boost human resource development but programmes must be systematic, well thought out and planned, properly implemented, and analysed and evaluated to ensure the desired results are achieved and that benefits accrue to all in the society. Information Technology can help the Caribbean achieve that goal, but without careful planning, it can also exacerbate the widening gap in our societies.

References

Bardowell, Merline., Taylor. Gladstone V. Technological Innovations and Adaptations in Jamaica. A Case Study. United Nations Educational, Scientific and Cultural Organisation (UNESCO). March 1990.

De Gregori, Thomas R. A Theory of Technology. Continuity and Change in Human Development. The Iowa State University Press. 1989.

De la Mothe, John., Foray, Dominique. Economics of Science, Technology and Innovation. Knowledge Management in the Innovation Process. Klewer Academic Publishers. 2001.

Internet Use in the Caribbean. ECLAC Survey. Preliminary Report and Analysis of Results. Caribbean Documentation Centre. June 1999.

John, Sandra. Informatuion Technology as a Tool for Sustainable Development in the Caribbean. ECLAC, Port of Spain. 1997.

Neelameghan, A. Information Systems and Services for Small and Medium Scale Industries in Developing Countries. UNESCO, Port of Spain. 1994.

Steil, Benn., Victor, David G., Nelson, Richard R. Technological Innovation and Economic Performance. Princeton University Press. Princeton and Oxford. 2002.

Utilisation of Information Technology by Households, 2001. National Institute of Higher Education, Research, Science and Technology NIHERST) Trinidad and Tobago. January 2002.

Wolf, Steven., Zilberman, David. Knowledge Generation and Technical Change. Institutional Innovation in Agriculture. Kluwer Academic Publishers. 2001