THE NEED FOR THE DEVELOPMENT OF A CURRICULUM FOR TECHNOLOGY EDUCATION IN TRINIDAD AND TOBAGO

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The technological environment in Trinidad and Tobago is one in which the conventional, established technologies in the petroleum, iron and steel, and urea industries exist alongside the agricultural and light manufacturing sectors which are characterized by the under-development and under-utilization of technology. While the products of technology impact in varying degrees upon the lives of all citizens, many are untouched by and insensitive to the process of technology. Ali (1990) describes the Caribbean as a whole as "technologically illiterate and scientifically backward" (p. 4). This implies that the majority of Caribbean people lack the skills and competencies needed to control existing technologies and to devise new ones to improve the quality of their lives. This paper will argue that there is a need for technology education for all students in Trinidad and Tobago, as opposed to mere technical/vocational training for some. The aims of this technology education must be to produce Trinidadians and Tobagonians who possess technological literacy, technological awareness as well as technological capability, and who view technology not as the prerogative of big business but as being within the reach of every citizen. Its role must be the promotion of national development goals through an improvement in the quality of life for all citizens. Enhanced human resource development, reduced unemployment levels and a more equitable distribution of wealth should be the outcome of technology education.

Nature of Technology and Technology Education

Technology may be defined as "a body of knowledge and the systematic application of resources to produce outcomes in response to human needs.

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and wants" (Savage & Sterry, 1990, p. 20). A Committee on Technology Education (1993) appointed by the Minister of Education for Trinidad and Tobago adopted as the definition of technology "the systematic application of knowledge and resources to satisfy needs and wants and extend human capabilities" (p. 2). It should be noted here that to define technology as a body of knowledge is not to deny that it is in fact an activity, or that it is a construct of processes for the achievement of human needs, for problem solution, for designing, for testing and for evaluating technological products.

De Vries (1987) outlined the following five general characteristics of technology:

(1) technology is a human activity
(2) technology is closely related to science
(3) the three "Pillars" of technology are matter, energy and information
(4) technology encompasses the skill of designing, using and maintaining technical products
(5) there is a mutual influence between society and technology.

Technology education is the study of technology and its effect on individuals, society, and civilization. It provides the citizen with background and understanding vital to his or her involvement at local, national, and international levels. The content of technology education is essential to the present and future society as the individual functions in a variety of roles. The aim of technology education is to prepare individuals to comprehend and contribute to a technologically-based society. The Trinidad and Tobago Committee on Technology Studies (1993) defines technology education as "a comprehensive action-based programme concerned with the nature of technology, its impact on individuals, society and the environment, and which develops proficiencies in technological design, problem-solving, research and evaluation" (p. 2).

Any attempt at curriculum development for technology education must be based on a sound conceptualization of technology itself. In view of the nature of technology and the Trinidad and Tobago context, a program
of technology education should aim to produce citizens who possess technological literacy, awareness and capability, through:

1. a knowledge and understanding of technology (history, principles, processes, methods, materials, tools, etc.);
2. an ability to use design, research and problem-solving skills for the use and creation of technology to satisfy human wants and needs and extend human capabilities;
3. an understanding of and appreciation for the link between technology and other disciplines;
4. a sensitivity to values issues in technology;
5. a willingness to assess critically the technological needs of a rapidly changing society, and to participate in the discussion about how to meet these needs;
6. an ability to think, create, and exercise rigour as well as imaginative insight;
7. an awareness of the concept of appropriateness as it applies to the technologies of their own and other cultures.

De Vries' (1987) five characteristics of technology may be used to provide some direction in the choice of content of a technology education curriculum, that would facilitate the development of technological literacy, technological awareness and technological capability.

The first characteristic suggests that technology education should include a historical perspective. Students should acquire an appreciation of the fact that technology is as old as mankind and should gain some understanding of the stages of technological development. De Vries (1991) affirms that

Technology is a process that goes from the past via the present to the future. Technology education should stimulate pupils to be part of this process - to learn about the past of technology, to study what we have now and to think about what new developments can take place.

(p.1)

Technological literacy includes some knowledge of past technologies, particularly those that are indigenous to the societies in which the curricula are to be used. In the developing countries, it is particularly
important that students gain an appreciation of technologies developed by their own societies, in order to dispel the common notion that worthwhile technology usually comes from the developed world. An evaluation of indigenous technologies in light of general technological principles would not only help students appreciate the need for the generation of local technologies to meet local needs, but would also help to instill in them respect for their heritage and develop a sense of national identity.

The second characteristic, the relatedness of technology to science, implies that the curriculum be so organized that students gain an understanding of the dynamic mutually supporting relationship that exists between science and technology. The scientific principles by which technological objects or systems work should be elucidated, wherever it is feasible to do so, but it has already been suggested that the technological experiences of the child should not be limited to those whose underlying scientific principles he understands. In this way, school technology would reflect real life technology which, it has already been pointed out, is not merely an application of science. While students should come to a realization of the relationship between science and technology, one essential difference between the two should not be ignored. Science is primarily concerned with "what is," technology is concerned with "how to." Technology concerns the application of knowledge to the solution of problems. Science, on the other hand, is concerned with the nature of the universe, and its activities are guided by hypotheses derived from theory. The two, science and technology, are interdependent yet distinct, and for this reason the UNESCO conference, Project 2000+, held in Paris in July 1993, in its recommendations for the achievement of scientific and technological literacy for all, recommended that the two subjects should represent separate curriculum areas.

The third characteristic recognizes that all technical systems involve matter, energy and information. Students need to be made familiar with basic science concepts relevant to the nature and properties of materials and to energy transformation. In addition, all students need to acquire a basic understanding of computer technology, information processing and the working of complex systems.

The fourth characteristic relates directly to the development of technological capability. The emphasis here is on design for problem solving. The
design process for technology should involve: (a) the recognition and re-definition of the problem; (b) brainstorming for the generation of possible solutions; (c) implementation of one or more of the solutions; (d) evaluation of the effectiveness of the solution using appropriate criteria; and (e) modification and refining or a repetition of stages (b) to (c) of the cycle. Thus conceived, the design process provides an avenue for a thorough integration of cognitive and manipulative skills.

Making technology education realistic demands that students acquire some appreciation that in real life technological processes, a large number of skills other than design and manufacturing capability are involved. Exposure to such aspects as financial control, customer relations, assembly line management, and so forth, ought to form part of the students’ experiences in technology education. In this regard, the question of links between technology education programmes and industry needs to be given careful consideration. Such links could profitably involve students in visits to industry and allow some measure of teacher involvement in industry, as part of teacher education programmes for technology education.

The development of manipulative skills must not be neglected, however, the emphasis should be on broad, flexible, transferable ones which are applicable to varied technological processes. The aim of skill development here is not to produce specialist craftsmen to fit into narrow slots in the labour market, but to allow all pupils, regardless of future occupational choice, to acquire a level of comfort in the use of machines and tools. The skill is subordinate to the overall design process and not an end in itself. While design is central to technological activity, the repair and maintenance of technological objects is an aspect of technological capability that should not be neglected.

The fifth characteristic of technology has to do with the relationship between technology and society. Technological activity is heavily value-laden. Students need to be aware that the decision to use one technology over another is always value-based. The development of technological awareness in students requires that they be led to consider the multifaceted ways in which technology impacts on society. The production of technological objects or systems and their use by man has political and economic outcomes. The impact of technology on the environment and the way in which technology has challenged traditional norms and ethical
positions are issues for inclusion in the curriculum for technology education.

The foregoing represent the broad areas that appear to be necessary components of a balanced programme of technology education. Such a programme differs vastly from the technical/vocational programmes now being offered in the Senior Comprehensive schools, in that it would contribute to general education rather than merely to equip the student with skills thought to be relevant to the workplace. Additionally, technology education seems more likely to result in the development of positive attitudes to technology, without which technological skills will not impact on the quality of life of the citizens of Trinidad and Tobago.

Technology education is the area of the school curriculum that would allow students to experience the integratedness of propositional and practical knowledge. As outlined in this paper, technology education will be seen as a cognitively demanding subject, and this integration of the cognitive and the practical would serve to lift the status of technological activity in the minds of both students and parents. In addition to these attitudes towards technology, programmes of technology education would serve to develop those cognitive and affective skills that are regarded as the new skills of technology. Attention to such aspects of technological activity as financial control, assembly line management and customer relations would serve to foster the development of some of these affective skills.

Technical Education in Trinidad and Tobago: The Present Situation

The Draft Plan for Educational Development in Trinidad and Tobago 1968-1983 (1974) heralded an enormous expansion in the educational system. Whereas up to that time secondary school places were limited to a relatively small minority, the outline of the plan presented to Cabinet in March 1967, proposed that general education be provided for "all children up to age 14 in two stages, namely, primary followed by Junior Secondary" (p. 3). Further, the plan proposed that "specialised education and training for a selected entry at age 15 into academic and/or technical courses' (p. 3), be provided. These proposals did not only represent expansion in terms of increases in the clientele of secondary education
but, perhaps more significantly, they represented a broadening of the curriculum to include both academic and technical courses.

Eight years later, in the Education Plan 1985-1990 (1985), the Prime Minister proposed several modifications to that plan. The most consequential of these were:

(1) that the norm for secondary education should now be five years rather than three, and
(2) that technology in all its aspects be given a priority position.

The model of technical education that emerged from those proposals, and which is now in use in Trinidad and Tobago, is one in which junior secondary schools offer general technical courses, namely, Industrial Arts, Home Economics and Agricultural Science, while the senior comprehensive schools provide any of about eighteen specialized crafts, including such subjects as auto mechanics, masonry and beauty culture as well as pre-technician's courses like general electricity, metalwork, food and nutrition and principles of business. In the senior comprehensive schools, students who opt for either craft or pre-technician streams also pursue a core of academic subjects. Senior comprehensive students may also opt for a purely academic stream. At present, the Caribbean Examination Council (CXC) provides certification in three technology areas, namely, Building Technology, Electrical Technology and Mechanical Engineering Technology.

The 1985-1990 draft plan (1985) proposed the introduction of technology education as a component of general education for all students, both primary and secondary (p. 140). However, while the plan makes the distinction between technical/vocational education on the one hand, and technological education on the other, the specifics of the plan deal almost exclusively with technical/vocational training. No guidelines are provided on the content, structure or delivery of technological education, or studies as part of general education. What is heavily emphasized is technical/vocational education and training, not for general education but specifically as preparation for the world of work. More specific, though not detailed reference, is made to Technology Studies in the Task Force Report (1993), where it is included as one of the curriculum offerings for all pupils in the first three years of secondary schooling.
Given this lack of emphasis on technology education as distinct from technical/vocational education and training in the plan, this subject was almost certain to be a non-starter. As long as technical inputs into the curriculum are justified primarily by manpower concerns, the resulting curricula would be heavily skills-oriented and the interests of general education are in danger of being neglected.

If technology education is to help in the promotion of development goals for Trinidad and Tobago, its benefits must reach all students. It must develop technological literacy so that citizens are able to understand and participate fully in a technological environment. Countries such as Trinidad and Tobago are necessarily dependent, to a large extent, on the importation of foreign technology, but technology transfer is of greatest benefit to the recipient country when certain conditions exist in that country. One of these conditions is a high level of technological literacy, awareness and capability. Citizens need to be made aware of the social, ethical and economic implications of technology so that they are able to evaluate, select, control and monitor imported technologies.

However, large scale industries which involve the use of foreign technologies cannot be relied upon to reduce unemployment and produce a more equitable distribution of wealth. The costly dependence on foreign inputs together with the small market size do not allow for the achievement of economy of scale in such enterprises. It is to the development of our small business sector that we must look for such benefits. It is the small craftsmen, artisans and entrepreneurs who bring the greatest returns in employment generation per investment dollar. Technology education must provide students with technological capability to generate employment, but perhaps more importantly, it must develop creativity and heightened sensitivity to the possibilities for improved quality of life through the design and development of small-scale indigenous technologies. Technical/vocational training in schools is not meeting these needs. The reason is clear; technology education differs from technical/vocational training in a number of important ways summarized as follows:
<table>
<thead>
<tr>
<th>TECHNICAL/VOCATIONAL SUBJECTS</th>
<th>TECHNOLOGY EDUCATION</th>
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</thead>
<tbody>
<tr>
<td>1. Emphasizes specialized skills.</td>
<td>Emphasizes broad, flexible skills.</td>
</tr>
<tr>
<td>2. Concerned with vocational skills.</td>
<td>Concerned with the comprehensive skills and behaviours of adult life.</td>
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<tr>
<td>3. Concentrates on manual skills</td>
<td>Concentrates on the bases of the skills.</td>
</tr>
<tr>
<td>4. Little or no emphasis on ethical or social issues.</td>
<td>Has a strong people focus and thus ethical/values and social issues are emphasized.</td>
</tr>
<tr>
<td>5. Aims at technical capability.</td>
<td>Aims at technological capability, literacy and awareness, which emphasizes problem-solving, designing, making and evaluating as the central activities.</td>
</tr>
<tr>
<td>6. Necessarily incurs heavy capital and recurrent costs.</td>
<td>Does not necessarily require sophisticated tools or machinery and is suited to situations where resources are limited.</td>
</tr>
<tr>
<td>7. Limited to the technical skills of making and maintaining technological products.</td>
<td>Includes the full range of knowledge and skills involved in the making and using of technological products including finance, marketing, research, etc.</td>
</tr>
<tr>
<td>8. Not appropriate at the primary education level.</td>
<td>Includes primary education level.</td>
</tr>
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</table>

The fifth of these distinctions is by far the most important since designing and making for the solution of problems is the central activity of technology. Accordingly, this paper suggests that designing and making for problem-solving be placed at the centre of children’s learning experiences in technology so as to reflect the true nature of technology. Designing and making, however, must involve far more than manual skills. At its heart are the cognitive processes of problem-solving and evaluation based on a range of self-determined criteria. Its user-focus urges the learner to take the perspective of those who will be affected by the technology and thus produces valuable affective outcomes.
It is quite clear that technical and vocational training is very different from technology education. The difference becomes even more noticeable when one looks at the personal qualities which a technology education curriculum is capable of bringing about in the students. These include:

- ability to cope with technology and not be threatened by it;
- ability to appreciate the contributions made through technological developments;
- sensitivity to the advantages and disadvantages of technology;
- awareness of the need and value of technological literacy;
- awareness of the role of technology in future developments;
- awareness of sources of information about technology.

Technology education will empower the individual with a working knowledge of technology and a level of technological literacy to function in different roles:

- as a user of technology in the home, in recreation, in self-development, travel for daily routine, in work places and in hospitals; as a purchaser and consumer of technology ranging from motor cars to radios, televisions, computers, lawn mowers, refrigerators, boats, toys, games, household fixtures, smoke alarms, security alarms, microwave ovens, telephones, and countless others;

- as a decision-maker about which technology to acquire for use in the home, community, workplace, educational institutions, places of worship, and public office;

- as an employee or worker in the home, farm, factory, business, hospital, school, media center, public agency, and a broad spectrum of private and public institutions;

- as a planner for the future, whether it be a private project, a public enterprise, or an industry-business proposal.

Crucial to all this is the development of positive attitudes to technology. Technology education must remove the low status associated with technological work from the minds of students and make careers in technology attractive to them. The gender stereotyping associated with
technology must also be addressed, and girls as well as boys must see careers in technology as available options. The next section of the paper reports on a study of attitudes to technology among secondary school students in Trinidad who have been exposed to the present technical/vocational curriculum.

Attitudes to Technology of Technical/Vocational and Academic Stream Students

The Pupil’s Attitude to Technology (PATT) questionnaire was administered to 241 first year senior comprehensive school students. All students in the sample were either 15+ or 16+ years of age, and there were 135 males and 106 females. Of this number, 87 were enrolled in either specialized craft or pre-technician’s courses and 157 were purely academic.

The PATT questionnaire consists of an attitude scale and a concept scale, but in this study only the attitude scale was used. It consists of 60 Likert type items arranged into six subscales:

1. interest in technology
2. technology in the curriculum
3. gender-related aspects
4. difficulty of technology
5. technology careers
6. social consequences of technology

In addition to the items of the attitude scale, pupils were asked questions relating to the degree of technological activity in their homes as well as the nature of their parents’ occupations. There were six such questions and responses to these constituted the "home environment" variable. Pupils were also asked to indicate whether or not they took any technical subjects at school.

A previous study (Prime, 1992) which included this same sample yielded reliability data for this instrument. Cronbach’s alpha value, used as a measure of internal consistency was .863 for the total attitude scale and ranged from .45 to .71 for the six subscales. All students in the sample completed the questionnaire without difficulty. The language was understood by all. Teachers were of the opinion that the attitude scale
addressed relevant issues. Table 1 gives means and standard deviations for the total attitude score as well as for the six attitude subscale scores for males and females in the sample.

Table 1

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Male n = 135</th>
<th>Female n = 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub. 1</td>
<td>3.398</td>
<td>3.305</td>
</tr>
<tr>
<td>Sub. 2</td>
<td>3.116</td>
<td>3.074</td>
</tr>
<tr>
<td>Sub. 3</td>
<td>2.783</td>
<td>2.138</td>
</tr>
<tr>
<td>Sub. 4</td>
<td>2.752</td>
<td>2.865</td>
</tr>
<tr>
<td>Sub. 5</td>
<td>3.053</td>
<td>2.978</td>
</tr>
<tr>
<td>Sub. 6</td>
<td>2.990</td>
<td>.400</td>
</tr>
<tr>
<td>Total Attitude</td>
<td>3.015</td>
<td>3.056</td>
</tr>
</tbody>
</table>

The relationship between attitude scores and exposure to technical streams was investigated for the entire sample.

Table 2 gives correlation coefficients for these relationships.
Table 2

Pearson Product-Moment Correlations Between Total and Subscale Attitude Scores and Exposure to Technical Streams for Males and Females

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Males</td>
<td>.1541</td>
<td>-.0272</td>
<td>.1461</td>
<td>.0479</td>
<td>.1591</td>
<td>.0817</td>
<td>.1326</td>
</tr>
<tr>
<td>Females</td>
<td>.1426</td>
<td>.1175</td>
<td>.0620</td>
<td>.0634</td>
<td>.0663</td>
<td>.3342</td>
<td>.1574</td>
</tr>
</tbody>
</table>

(p. <.05)

Neither in the case of the females nor the males is the total attitude score significantly related to experience of technical subjects in school.

Analysis of variance was computed to investigate the effect of sex, home environment and exposure to technical subjects on total attitude scores. The variables were investigated for separate main effects as well as for any interaction effect. Table 3 is the analysis of variance table for these purposes:
Table 3

ANOVA Table for Sex and Exposure to Technical Subjects on Total Attitude Score

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Main effects</td>
<td>.942</td>
<td>4</td>
<td>.236</td>
<td>3.618</td>
<td>.009</td>
</tr>
<tr>
<td>2 Sex</td>
<td>.095</td>
<td>1</td>
<td>.095</td>
<td>1.459</td>
<td>.229</td>
</tr>
<tr>
<td>3 Exposure to technology at home (Home Environment)</td>
<td>.704</td>
<td>2</td>
<td>.352</td>
<td>5.408</td>
<td>.006</td>
</tr>
<tr>
<td>4</td>
<td>.247</td>
<td>1</td>
<td>.247</td>
<td>3.793</td>
<td>.052</td>
</tr>
<tr>
<td>2-Way Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Home and exposure to tech. subj.</td>
<td>.276</td>
<td>2</td>
<td>.138</td>
<td>2.117</td>
<td>.125</td>
</tr>
<tr>
<td>6 Sex and exposure to tech. subj.</td>
<td>.083</td>
<td>1</td>
<td>.083</td>
<td>1.275</td>
<td>.261</td>
</tr>
</tbody>
</table>

p < .05

These data suggest that neither sex nor exposure to technical subjects in schools significantly affects attitudes to technology. Neither is there an interaction effect of these two variables. A home environment with a strong technological element does, however, have a significant effect on the attitude of these pupils to technology.

Interpretation and Implications

Table 1 suggests that attitudes to technology for both males and females in this sample of Trinidadian senior secondary school students are fairly positive (means 3.015 and 3.056 respectively for overall attitudes). An
examination of the attitude subscale scores reveals: (1) that the mean scores on the difficulty subscale are lowest, suggesting that these students perceive technology as a difficult subject; (2) that their attitudes about the social consequences of technology are somewhat less positive than about the other aspects of technology, suggesting a degree of lack of appreciation of the social consequences of technology, and (3) the largest sex differences in attitudes to technology exist for the gender subscale. Males have a less positive attitude than females towards the involvement and capability of women in technological activity.

Further, while students in technical streams of these senior comprehensive schools did not have more positive overall attitudes to technology than their counterparts in the academic streams, Table 2 does reveal some significant differences in attitudes to various aspects of technology, as indicated by the subscales, between students in technical and academic streams. For example, boys in technical streams found technology more interesting, had more positive attitudes towards women in technology and were more positive about choosing careers in technology, than boys in academic streams. The only difference between the two groups of girls, suggested that girls in technical streams had more positive attitudes about the social consequences of technology. The results of the analysis of variance bears out the conclusion that neither sex alone, nor exposure to technical subjects alone, nor interaction between the two variables significantly affect attitudes to technology for these students. The variance in attitudes in the sample shown in Table 3 by a significant F-ratio for main effects (F = 3.618, p<.05) is accounted for by the differences in the home environments of the pupils in the sample.

All of the foregoing suggests that the exposure to technical subjects that these pupils now receive is not serving to improve their attitudes to technology. Of particular importance is the fact that even these students perceive technology as difficult; that girls doing technical subjects are not more positive about careers in technology that those who do not (r = .0663, p>.05), and that boys doing technical subjects do not view the social consequences of technology more positively than those in academic streams (r=.0817, p>.05).

It was stated earlier that the technical input into the curriculum in the senior secondary schools of Trinidad consists of training in specialized crafts and pre-technician’s courses such as metalwork, general electricity
and food and nutrition. Both of these streams, craft and pre-technician, place heavy emphasis on manual skill-training for the world of work. The results of this study suggest that these courses are not effective in developing positive attitudes to technology in the students who pursue them.

Towards the Development of a Balanced Curriculum for Technology Education

The inability of skills-based programmes of technical/vocational education and training to produce these outcomes is the most powerful argument in favour of curriculum change in Trinidad and Tobago, from the specialized craft and pre-technician courses now offered to technology education. It is instructive that in the present study it is exposure to technological activity in the home environment, as indicated by the significant F value in the analysis of variance, rather than enrolment in the technical/vocational streams at school that is related to the possession of positive attitudes to technology. The practice of technological activity in the home for the repair and design of equipment and the involvement of parents in technological occupations, have benefits which are immediate and obvious to the child. Such a child views technology as the means of solving real-life problems in real-life situations with real-life benefits. In this context, positive attitudes to technology are most likely to develop as the child sees the positive social and economic consequences of technology. Perhaps the absence of this element of "realness" in technical/vocational subjects at school is in part responsible for their ineffectiveness in improving attitudes to technology.

A programme of technology education, as opposed to technical/vocational education or training, that emphasizes design for problem-solving as the central activity of technology will incorporate this element of "realness." Children can be allowed to respond to problems that are real in their own lives and in the lives of the community in which they live. The repetition of design and evaluation and redesign is likely to lead to the development of such personal qualities as creativity, criticalness, problem-solving ability, imagination and enhanced self-esteem, as well as the practical manual skills.
Conclusion

This paper has advocated a change in the curriculum of the secondary schools in Trinidad and Tobago from technical/vocational subjects to technology education or technology studies, as it is sometimes referred to, on the grounds that this subject will contribute to the general education of students, and by providing them with positive attitudes to technology fit them to live productively in a technological environment. Such a programme will promote the achievement of both social and economic goals of development. It will demystify technology and put it at the service of the majority of Trinidadians and Tobagonians. The result might be an improved quality of life for all citizens.

References


