OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

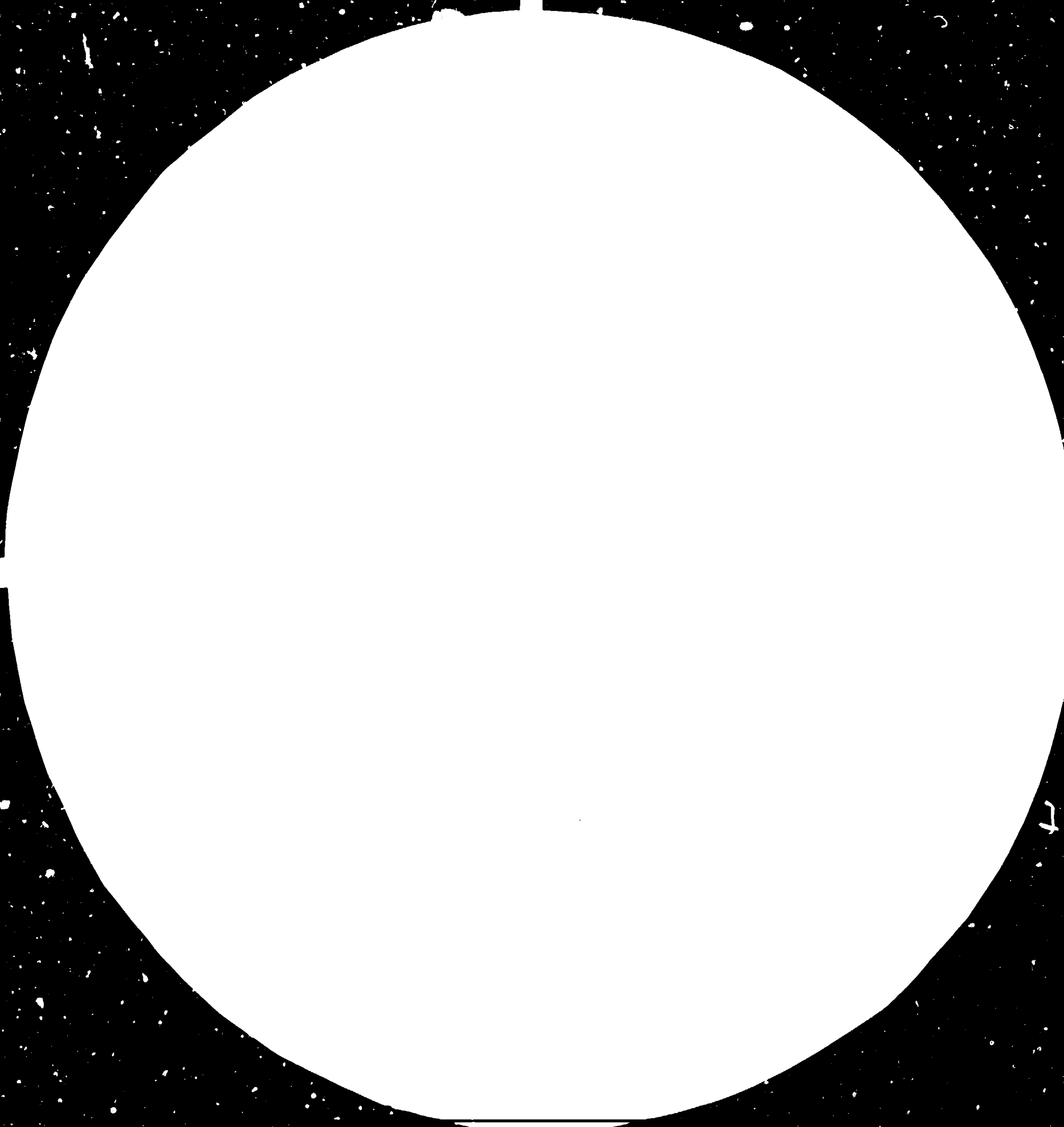
Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

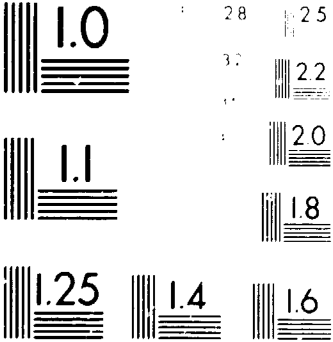
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





MICROCOPY RESOLUTION TEST CHART

13291

Distr.
LIMITED

ID/WG.412/5
10 January 1984

ENGLISH

United Nations Industrial Development Organization

Seminar/Workshop on "Technology Transfer, Management and Development and the Implications of Newly-Emerging Advanced Technologies"

Port-of-Spain, Trinidad and Tobago, 8 - 12 November 1983

FINANCING NEW TECHNOLOGICAL DEVELOPMENTS*

by

Euric Bobb**
and
Terrence W. Farrell**

* This document has been reproduced without formal editing.

** Central Bank of Trinidad and Tobago, Port-of-Spain, Republic of Trinidad and Tobago.

V.84-80317

Whether they arise out of long, intensive research and development by large corporations or the serendipity of single genius, new scientific and technological developments and their commercial exploitation usually require considerable risk capital if they are to be successful. This paper attempts to explore some of the issues which arise in the financing of such developments and suggests possible approaches to their financing in the context of a small, resource-poor economy like Trinidad and Tobago. Section 1 considers, in broad outline, the question of appropriate science and technology policy, strategy and tactics in developing economies like Trinidad and Tobago. Section 2 analyses the nature of the risks associated with scientific and technological developments. Section 3 examines the financing strategies used in various developed countries in respect of the commercialization of technology and outlines approaches that Trinidad and Tobago and other Caribbean countries might usefully take. Section 4 summarises and concludes the discussion.

1. Science and Technology Policy

Technological progress has usually been the basis of increases in productivity and output in industry. It is however, also the case that the basic technologies utilised in the industries which have dominated economies in this century -- motor cars, iron and steel, chemicals -- were developed in the 19th century and early 20th century. Such innovation as has taken place has been largely in the direction of process innovations based on more sophisticated engineering.

In the post-war period however, basic scientific research began to spawn the seeds of new industries. The integrated circuit replaced the transistor -- a pre-World-War II development -- and has led to the development of the micro-electronics industry which in turn has caused the development of microprocessors and the modern third and fourth generation computers. Micro-processors have in turn stimulated the transformation of medical electronics and telecommunications, and their applications in business and industry have altered the way in which production is carried out in several industries from garments to assembly. Robotics for example, is a direct outgrowth of the micro-electronics 'revolution in minaiture'.

Quietly and almost unobtrusively, the science of biology was also undergoing significant change as a result of basic scientific research. Combined with the engineering and chemical sciences, biology evolved into biotechnology and genetic engineering techniques, which involve essentially the manipulation of existing micro-organisms to create new or modified organisms which are capable of performing a different or enhanced range of functions. These technologies have implications for diverse fields including agriculture, petrochemicals, petroleum production and certain manufacturing processes.

Although the existing mix of industries in the modern world still largely reflects earlier scientific and technological developments, this is beginning to change and the process of economic transformation is quite rapid since new discoveries and innovations operate synergistically leading to exponential growth of new processes, new products and new economic activities. Indeed it has been suggested, not without foundation, that the series of recessions which the Western industrial countries have been experiencing over the last decade reflect as much structural transformation towards a new scienfific and technological basis of industrial activity, as any of the other monetary, fiscal or exogenous factors - OPEC action - usually cited to explain the experience.

Given the pace of these new developments, it seems certain that unless the developing countries move actively to keep up with these developments, the 21st century will find them in the backwash of change and transformation. The gap between the rich and the poor countries will be even wider than at present and the pattern of economic, social, cultural and even political dependency will be reinforced. In short, the implications of these new developments and developing countries responses to them, are wide and serious. Science and technology policy is therefore not a catch-phrase or shibboleth, but an absolute imperative in the planning and policy-making of the developing countries, as much as it now is in the industrialised countries.

The elements of a science and technology policy are now reasonably well understood. They are (i) the education system - primary, secondary and tertiary (ii) research and development institutions involved in basic and applied research, testing and experimental development - pilot plants, etc; (iii) specialised facilities for maintenance, modification and adaptation of hardware; (iv) consultancy and design, involving project identification and design, plant design and systems; (v) information on scientific and technological developments world-wide and the potential usefulness and/or application locally; dissemination of information to users of technology; (vi) financing, planning and management of all scientific and technology-related activities. A great deal can be said about each of these areas, but the critical focus is the development of an indigenous technological capability.

Small, open economies face serious problems in implementing a science and technology policy one of which is the problem of scale or numbers. They will not have the critical mass of scientists, engineers, technicians, information specialists and educators to compete across a broad range of activities at or near the leading edge of scientific and technological developments. In this regard therefore, the strategic response may well be to develop one cadre of non-specialised scientists and engineers to service the information function across a broad spectrum of activities and then identifying out a few activities which will become the focus of a second cadre of specialists to engage in adaptation, design and development. Other areas which the specialist cadre cannot address must be tackled by selective and controlled licensing, foreign investment, etc., which constitute the traditional modes of technology transfer.

Initially, at least, the focus of specialised R and D may be not basic and applied research leading to invention, but problem-oriented basic and applied research leading to innovations which could seek to carry out known processes more cheaply and efficiently, exploit some particular marketing advantage perceived by market research (e.g. energy-saving techniques, down-sizing, user-friendly products, user-safety, packaging, etc.), or find new applications for existing technologies or new uses for existing resources or products.

2. Risk

There are basically two kinds of risk to which science and technology development activities are exposed. Firstly, where research is open-ended i.e. is not goal-directed, a great deal of scientific and financial resources may be committed for extended periods of time to projects which may bear no fruit or where gestation may be too long for a small economy. Secondly, where research is goal-directed and/or market-oriented, there is the possibility that the new process or product may not find market acceptance or ay be overtaken by new technological developments or new products.

The first problem really is one of scale. In a large country with considerable human and financial resources a significant proportion of research can afford to be open-ended. Where human and financial resources are scarce, this is not feasible or desirable, hence the suggestion advanced earlier that R and D in small economies should, or rather must be selective and goal-directed. The issue can be cast in terms familiar to economists. The return (net present value) on investment in open-ended research and development is the discounted value of the net income stream from such investment.

$$V = \sum_{t=o}^{T} \frac{R - C}{(1+r)^t}$$

- where C_o is the initial investment cost of the project, C_t are the operating costs and R_t are the annual returns on investment. In an open-ended project, R_t is likely, under normal circumstances to be zero for a long time, though it may become quite large eventually if the research effort is successful. Moreover, T is likely to be extremely long and r - the appropriate social discount rate - will be high since capital resources are scarce. This means that the return, V, on the investment could be low when ranked relative other investments in R and D or elsewhere in the economy, even if the eventual returns are high. In developed economies, the social discount rate is much lower and the horizon, T, is likely to be shorter because of the adequacy, if not surplus of human and technical resources which may be committed to the project.

The second class of risk, which may be termed 'market risk' has three related aspects. The first is the risk associated with bridging the gap between knowledge and the development of a marketable product i.e. the risks associated with commercialisation. The second is the risks associated with competition from other firms which have developed similar new products or processes. The third is the risk of rapid obsolescence due to technological innovations which overtake the marketed product.

The experience of firms in the developed countries illustrate vividly all these aspects of risk, particularly in the area of microprocessors and computers. If commercialisation is successful, there may follow the development of a host of similar products produced by a large number of new small firms who have made marginal alterations to the product or process by engineering around the patent or by reverse engineering and subsequent modification. Initially, all the firms may be highly profitable and growth can be quite rapid. Ultimately however, the product or process becomes standardized and a 'shake-out' begins in which large firms take advantage of their size and scale and swallow the smaller firms or simply put them out of business through fierce price competition. The recent experience of a number of small personal computer manufacturers and the rapid ascendency of IBM in the personal computer market (within two years) is instructive. Even established medium-sized personal computer manufacturers like Apple Computers and Osbourne now face ultimate extinction or absorption.

3. Financing Strategies and Options

In some of the developed countries, the financing of R and D expenditure is undertaken mainly by large corporations, with government support in the form of tax concessions for R and D expenditure. In others, the government itself does a great deal of the funding. In France, for example, the government proposes to increase R and D spending by 17.8 per cent per annum over the 1982-1985 period, such that government R and D spending will reach 2.5 per cent of GNP by 1985.

Given the nature of R and D activity -- high capital costs in some instances, long gestation and uncertain outcomes -- it seems that the government must be heavily involved in the financing of this aspect of technology development. But governments in developing countries simply cannot afford to commit a large proportion of their expenditures to the R and D effort where there are urgent competing claims such as the provision of basic needs and welfare services, infrastructure development and some industrial development. It is for this reason the R and D programme must be highly selective so as to avoid funding open-ended projects here the risks are inherently high.

Market risk poses a different financing problem. In the U.S.A., venture capital firms have developed to assist in the commercialisation of new products and processes. These venture capital firms, some of which are subsidiaries of large corporations and banks, some of which are public and private small business investment companies and the others private partnerships, source funds from wealthy individuals, endowments, institutional investors and pension funds, inter alia. (Recent changes in U.S. legislation allows pension funds to fund venture capital firms). Of the total investment made by venture capital firms in the U.S.A. in 1980, US $118 million come from corporations, US $112 million from individuals, US $99 million from endowments, US $85 million from insurance companies and US $53 million from foreign investors. The total funds sourced by venture capital firms in 1980 in the U.S.A. is estimated at between US $700 million and US $1 billion. In 1980, there were an estimated 500 venture capital firms in the U.S.A., with a capital estimated at US $4.8 billion. In 1980 145 new companies were seeded. In 1981, the venture capital pool was estimated at US $6 billion.

The rapid growth of the venture capital industry has given some commentators cause for concern. Returns on venture capital have been extremely high and this has naturally attracted investors. The high returns are made despite the fact that 20 per cent of seeded companies fail and 40 per cent do moderately well through upward mergers. Another 20 per cent remain as small, private businesses. However, the 20 per cent of new firms which are successful are spectacularly successful, and the returns made on investment in these more than compensate for the modest returns made on the others. An important factor in this regard is that once a new seeded enterprise takes off, large corporations are willing to buy it and will pay a premium for the shares. Investors such as the venture capitalists who have got in on the ground floor therefore sometimes make exceptionally large capital gains.

Some of the companies which were originally funded by venture capital firms are now virtually household names in the U.S.A. -- Genentech, Apple, Cetus, Federal Express, Applicon, Zylog and Intel.

Venture capital firms in the U.S.A. do not only provide finance. They have recognised that, particularly in high technology areas, the scientists and engineers who wish to develop and market as new product often do not have managerial and marketing skills. The venture capital firms, some of which have at their disposal scientists and engineers who can evaluate the feasibility of the project, provide or assess the business plan of the new enterprise, supply or find the managerial and marketing expertise and make technical inputs as well. There is a period during which the venture capital firms nurse the new enterprises until they are technically and managerially viable.

The venture capital industry in the U.S.A. has been the envy of other countries. In the U.K. for example, there are a large number of financial intermediaries which aid small businesses and provide development capital. However, venture capital firms per se were estimated to number about two dozen (24) in 1982, compared to the almost 600 venture capital firms in the U.S.A. Some of these U.K. firms have links with American venture vapital firms.

But the U.K. bas taken other initiatives. In 1981, the Loan Guarantee Scheme was started. Its objective is to help provide capital for start-ups and expansion where lack of security would deter the commercial banks from lending. The banks take 20 per cent of the risk and the government guarantees 80 per cent for an insurance premium of 3 per cent paid quarterly in advance by the borrowers. The borrowing limit is L75,000 or about TT $300,000. Interest rates charged vary but are generally per cent above base rate with an arrangement fee of 1 per cent to a maximum of L500 (TT $2000). The total cost of funds to borrowers has been estimated at 4.5 per cent above base rate, so that the loans provided are in fact expensive.

Japan does not appear to have a venture capital industry along the lines of the U.S.A. However, there is considerable state support for and financing of new enterprises. The Japan Development Bank is apparently a key institution in this area, providing funds at below market rates, in contrast to the UK Loan Guarantee Scheme. Technology development accounted for 7.8 per cent of outstanding loans of the JDB at the end of FY 1980. Energy projects -- including alternative energy, conservation and diversification --accounted for another 8.8 per cent of outstanding loans.

For a small resource-poor economy like Trinidad and Tobago, the 'Japanese' approach of state-agency funding of new enterprises seems more appropriate. This is so for two basic reasons. Firstly, venture capital firms in the U.S.A. have the considerable advantage of being able to spread risk across a number of companies and perhaps over a number of industries or sectors. In fact, of the enterprises selected by a venture capital firm it may have sifted through many times more proposals from prospective entrepreneurs. In a tiny economy, such diversification is simply not possible. The areas for risk investment are necessarily more narrowly-defined.

Secondly, the venture capital firm approach presupposes an abundance of financial and managerial expertise which is needed to evaluate the new enterprise's business plan and to 'hold the hands' of the entrepreneur until the venture matures and can stand on its own. Financial and managerial expertise is scarce in small economies and these resources have to be concentrated rather than diluted if they are to be effective.

For these reasons the financing of new technological developments at the commercialisation stage must be done by a state- or para-statal agency which can tap resources from the private sector as well as the public sector, and which can concentrate within it a cadre of financial experts, scientists and managers. However, such an agency cannot operate along the lines of the traditional development bank since in the final analysis, it is supposed to be funding ventures which are so risky that they would not have attracted financing from traditional sources. In other words, the operating guidelines for such an institution must be much more flexible and the level of expertise considerably higher than exists in traditional development banks. It should be reiterated that the activities of such an institution will take place within the context of selective R and D as the foundation of the country's science and technology policy.

If such an institution is to attract funds on the scale required, then fiscal concessions must be made for investment in the institution. In the U.S.A. and the UK, fiscal concessions have greatly stimulated the flow of financial resources into new enterprises. These concessions include low capital gains taxes and capital transfer taxes and in the UK, the facility of applying relief on losses in such investments at the marginal tax bracket. Legislative and other restrictions which may now prevent potential sources of funds from investing must be removed. In this regard, the institutional investors -- insurance companies, pension funds, national insurance scheme -- are the obvious sources of funds for such an institution.

4. CONCLUSION

In the context of a selective R and D strategy as the suggested appropriate technology policy in economies like Trinidad and Tobago, the various aspects of risk confronting commercialisation were examined. The financing strategies of the U.S.A., UK and Japan were discussed. The 'venture capital industry' approach in the U.S.A. follows logically from the huge size of that economy, its richness in technical, financial and managerial resources and its free-wheeling, but not necessarily unstructured approach to investment in high risk areas. The Japanese approach relies on the close relations between government and industry and the para-statal approach to financing also follows logically from that relationship.

The parastatal approach was seen as appropriate for Trinidad and Tobago, not because of a close relationship between government and industry, though this is desirable, but because the technology policy strategy, small scale and scarcity of technical managerial and financial resources dictate a concentration of effort and organisation.

As we move toward the definition of our science and technology policy, hopefully in the context of a development plan, the organisation of the financing of information services, R and D activity and commercialisation will need to be carefully studied and elaborated. The 21st century is not around the corner, it is with us here today, and the issue of science and technology policy and the financing of new technological developments is a matter of urgency. The cost of failure to seize the time when the situation is still relatively fluid is to be lost forever in the backwash of the contemporary world.