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# Technology transfer or incubation?: Technology business incubators and science and technology parks in the Philippines

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*The paper is based on an assessment of the Technology Business Incubator (TBI)/Science and Technology (S&T) park scheme in the Philippines, carried out in the mid 1990s, when the scheme had been in operation some five years. In the enthusiasm to launch the scheme, little attention had been paid to establishing precisely what is meant by the terms 'TBI' and 'S&T park'. Nor was it determined whether the scheme existed to transfer technology, incubate new businesses, or both. There was an overall goal that TBIs and S&T parks should facilitate the contribution of technology to the economic and social resurgence of the country, but precisely how they would do this was never established. Nor were intermediate targets identified which would have allowed monitoring of the technological and business progress of tenants. Consequently, monitoring was confined to financial and administrative matters. In these circumstances, uncertainty plagued the implementation of the scheme so that what was achieved and what was contributed to the overall objective was more attributable to the determination of individuals than to ambitious and often conflicting policies.*

THE WORLD'S first planned industrial park was launched in Manchester in the UK in 1896, but not until after World War II did industrial parks become common in the United States. There have been many derivatives since: "....whatever the name, the presumption is that the industrial park is a project which has been planned and developed as an optimal environment for industrial occupants" (Barr 1983). Integration of commercial functions with the industrial activities traditionally associated with industrial parks seems to have grown from the 1970s, encouraged, in part, by technological change (Joseph, 1989a). Working conditions required for research or information handling could be similar to a residential environment. Commercial property developers have reflected these changes in the way they plan and market industrial parks. National, regional and state governments, together with universities and research institutions, have also taken a greater interest in the shaping of industrial parks (Congress of the United States, 1984).

This paper is based on an assessment of one nation's policy to encourage the growth of small firms through the exploitation of new technology in specialised property developments. The assessment was carried out by the authors for the United Nations Development Programme in the mid-1990s (Department of Science 1995). The paper considers the policy of the Philippines government to encourage the growth of small

firms by means of technology business incubators (TBIs) and science and technology (S&T) parks. In particular, it considers the consequences of the uncritical adoption of policy measures from overseas and of their implementation in the harshest of economic environments.

**Technology business incubators**

Both technology business incubators and science and technology parks have been derived from the general concept of the industrial park (Macdonald 1987; OECD, 1987 pages 5-7). Terms differ among nations, and even among regions, but some categorisation is possible. The terms 'small business incubators', 'enterprise centre', 'business technology centre', 'technology business incubator' and 'innovation centre' are often used synonymously. In general, though, such incubators and centres have a number of common characteristics in that they:

* group a number of businesses in one facility under the guidance of an experienced business person
* provide low-cost, expandable space
* give firms access to a business-consulting network offering low-cost services for product development, marketing, financing, and so on
* provide a forum in which firms can assist each other (Australian Department of Industry, Technology and Commerce, 1989a).

The availability of in-house managerial and consultancy advice is crucial and distinguishes incubators from similar shared accommodation. In practice, of course, incubators may also be able to accommodate some technology-based companies. However, the term 'technology business incubator' is appropriate for incubators which are specifically accommodating companies where technology development is a central component of the business plan. Thus, the following definition emerges:

**Technology business incubators** are converted or purpose-built industrial buildings which offer accommodation and a supportive, growth-oriented environment for newly-formed companies which have technology development as a core component in their business plan.

Some of the services a TBI can provide, in addition to those offered by other incubators, are:

- programmes for improving the scientific and engineering training of entrepreneurs
- information networks incorporating skilled workers and advisers from local universities, schools and businesses
- technical and management training
- evaluation, consulting and referral
- information gathering and dissemination (such as guest speakers and site visits)

- specialist advice on financing technology development
- patenting and commercialisation advice (Congress of the United States, 1984, pages 5-6)

In the TBI, emphasis is placed on addressing not just the business development problems facing all new companies, but on problems associated with technology. The TBI recognises that technology development can pose special problems for new firms. The initial focus of the incubators created in the United States from the 1970s was on small business in general, but the concept broadened to incorporate special support for technology and other policy objectives, such as employment generation (Congress of the United States, 1984, page 15). Assessments of the success of TBIs have been hampered by the fact that job generation and enterprise development are difficult to measure in the short term. While there is some agreement that incubators as a whole "appear to be an effective and an innovative way of helping entrepreneurs at the beginning of their businesses", it is still too early to judge their overall worth as an economic development tool (Congressof the United States, 1984, page 17) This conclusion is in some conflict with the impression prevalent in the Philippines of the success of incubators overseas.

> "Experience in other countries with business incubators showed that 90% of those nurtured in the incubator were successful against 20% successful businesses who were not incubated." (Tiong-Aquino, 1990a, page 5).

**Science and technology parks**

While incubators and TBIs focus on new enterprise development, S&T parks aim to establish concentrations of firms or industries in a particular area and are associated with technology transfer objectives. The terms 'research park', 'science park' and 'technology park' are frequently used interchangeably and distinctions easily become blurred. The International Association of Science Parks defines a science park as a property-based initiative which:

- has formal operational links with one or more universities, research centres, or other institutions of higher education
- is designed to encourage the formation and growth of knowledge-based industries and other organisations normally resident on site
- has a management function which is actively engaged in the transfer of technology and business skills to tenant organisations (Australian Department of Industry, Technology and Commerce, 1989b, page 7).

Criteria for S&T parks vary a good deal (Joseph, 1992). Most important seem to be the activities permitted (for example, research only or some light manufacturing), links with the university, and the extent to which interaction with the university is promoted. Crucial characteristics of an S&T park would seem to be a high-quality, low-density physical environment on a park-like setting, location within a reasonable distance of a

university or research institute, and encouragement of the formation and growth of a range of research, new technology or knowledge-based enterprises. Thus, the following definition emerges:

> A **science and technology park** is a collection of high technology industrial companies concerned with both research and manufacturing, located in attractive, well-landscaped surroundings, and situated within a reasonable catchment area of a scientific university or a major research institute (Australian Department of Industry, Technology and Commerce, 1989b, page 17).

Governments have sought to provide a physical and management environment on S&T parks appropriate to high technology firms. Typical features include the physical attractiveness of the park, infrastructure (such as roads and telecommunications), and other incentives (such as low rent, new buildings and tax breaks). Technology transfer considerations have often influenced the design and location of S&T parks. In that S&T parks are to transfer technology from universities and research institutes to business, they are seen as facilitating the commercialisation of technology. For this reason, it is not uncommon for TBIs to be associated with S&T parks. However, while TBIs have an essential enterprise development role, S&T parks focus on technology transfer. By concentrating in a designated area a number of technology-based firms which will develop skills, jobs and technology, S&T parks are supposed not just to promote the growth of these firms, but also to generate economic growth in the whole region, or whole nation (Russell and Ross, 1989)

Unlike TBIs, S&T parks have proved a popular policy instrument almost everywhere (Castells and Hall, 1994). Developed and developing countries alike have incorporated S&T parks into arrays of measures to promote economic development (Joseph, 1989b). The United States has the longest tradition of S&T parks and the Stanford Research Park in Silicon Valley is often presented as the classic example of the genre. This is peculiar in that the growth of Stanford Research Park since the 1940s has essentially been the consequence of the development of high technology industry in the area rather than the cause of this development (Macdonald, 1987). There are a great many S&T parks in the United States, but failure rates have been high (Minshall,1983). and even the most successful examples have often not developed the expected linkages between university and firm (Massey, Quintas and Wield, 1992).

In Europe, the Sophia-Antipolis Research Park in France and Cambridge Science Park in the UK are often presented as success stories. Yet, these are exceptional and there are serious doubts about the role and effectiveness of the S&T park (Quintas, Wield and Massey, 1992). While S&T parks may provide a focal point for technology development and job generation in some cases, it seems unlikely that they can supply all the ingredients necessary to sustain an environment as innovative and dynamic as that of Silicon Valley (Joseph, 1994). This cautious conclusion is at some variance with Philippine enthusiasm for S&T parks, based - ironically - on overseas experience.

> "Science and technology parks have played significant roles in the utilization and commercialization of technological innovations in developed countries. The same is observed among the tigers of Asia. Realizing the wealth of knowledge and

> information in the University, it can bridge the gap between technology generation and utilization." (Tiong-Aquino, 1990, page1).

**Intervention with science and technology**

The current Philippines government takes an interventionist approach towards the economy. Among the forms intervention takes, science and technology are prominent (see Sharif, 1997), the argument being simply that highly protected industry has little competitive incentive to introduce new technology and that competitive industry has.

> "A more open economy prods entrepreneurs to improve productivity, use least-cost components, newer technologies, and advanced managerial knowhow if they are to compete with imports." (National Economic and Development Authority 1992, page 4).

Elsewhere, such an argument would recommend reliance on market forces, but interest in developing countries is in making the market work at all and policy often works in tandem with market forces. What research and development there is in the Philippines is overwhelmingly in the public sector. This has traditionally been directed towards basic and academic endeavour rather than industrial innovation, towards the creation of information rather than its application. Thus, some intervention is required in the science and technology sector itself before this sector can be used to intervene in selected industries. The mobilisation of national science and technology resources is something new for the Philippines.

> ".... Science and Technology has remained a poor cousin of all policy or program instruments used by government in its development programs. While the role of S&T in national development has always been recognized, this policy recognition until recently has not been translated into meaningful programs and working relations between industry and the S&T agencies." (Economic Development Foundation, n.d., pages 19-20).

Since the political changes of 1986, there has been increasing determination to revitalise the Philippine science and technology base and to mobilise it in the service of Philippine industry. Increasingly, legislation has reflected these pressures: for example, the Foreign Investments Act of 1991 encourages technology transfer to the country, and other legislation of that year provides a range of incentives to independent inventors. The new determination is also evident in the growing industrial awareness of S&T activities, and in the mounting pressure on publicly-funded S&T to serve the needs of industry - "casting aside of the gilded 'ivory tower' facade in R&D activities opening these to the real world" (Perez and Brinas 1993). It has been apparent in the re-structuring of much of the Department of Science and Technology (DOST) (Tiong-Aquino, 1990a, attachment 1, pages 1-2), and particularly in the formation of the Science and Technology Co-ordinating Council (STCC) in 1989. The STCC comprises representatives from the

private sector, government and the universities, and has the key role in formulating technology policy for government adoption (Tan 1995).

The TBI/S&T park scheme is but a sub-module of a much greater programme, which is itself part of a master plan - the Science and Technology Master Plan (STMP) of 1990 - outlining the role that science and technology are expected to play in the economic development of the country. STMP is quite uncompromising in its declaration of what this role is to be:

> "Through intensive infusion of S&T in production, the country can attain the status of a newly industrializing country (NIC) by the year 2000." (Philippines Department of Science and Technology, 1990, page 2).

**Science and technology: demand and supply**

STMP, which emerged from the recommendations of the Presidential Task Force for Science and Technology, has three strategies: technology transfer to modernise the production sectors, upgrading R&D capability, and development of the S&T infrastructure. These are reflected in the DOST Corporate Plan for 1994-98 (Philippines Department, 1995a, pages 7-8), as long term strategies by which the goal of the Science and Technology Agenda for National Development (STAND), an offshoot of STMP, is to be achieved. In the medium term, the strategies to be employed to reach the overall goal - the Philippines attaining the status of a newly industrialising country by the year 2000 - are:

- utilisation of emerging technologies
- increasing private sector participation
- networking
- manpower development
- review of policies affecting science and technology
- technological dynamism and monitoring.

In 1993, STAND selected 22 goods and services on which superior technology should be concentrated for the Philippines to gain and maintain competitive advantage (National Economic and Development Authority, 1992, page 3). From these 22, seven goods and services were chosen, using criteria that include availability and access to superior technology to take the lead in the export drive. These 'export winners' are:

- computer software
- fashion accessories
- marine products
- fruits
- gifts, toys and housewares
- furniture
- metals fabrication.

These seem to be but the first seven of a list of 13 export winners attributed to STAND in the medium-term S&T direction of DOST (Philippines Department of Science and Technology, 1995a, pages 7-8). The goods services on this curtailed list were identified not only as export winners, but also as:

> ".... areas where critical technology inputs are required..... areas which the S&T community will work on to serve the needs of the target industries and client sectors." (Philippines Department of Science and Technology, 1995a, page 11).

Of these, three have been chosen to be the focus of the TBI/S&T park scheme: fruits, metals fabrication, and marine-based products. These same three are among fourteen export winners selected from 154 by the Department of Trade and Industry (DTI), using the criteria of high worldwide potential; low sensitivity to protectionist measures of importing countries; and minimum requirements for efficient infrastructure, production capability, and highly skilled labour (Philippines Department of Science and Technology, n.d., pages 24-5). In other words, the DTI would seem to support concentration on these particular industries because they do not require major new inputs, including new technology, while DOST support of the same industries is precisely because they do require new technology. This uncertainty over what are the technological requirements of industry is an admitted deficiency of STMP.

> "A major constraint in the formulation of the STMP is the inadequacy of baseline data. Consequently, the supply side of S&T is emphasised. However, the demand side of S&T will be included in future revisions of the Plan as more comprehensive technology assessment activities are undertaken." (Philippines Department of Science and Technology, 1990, page 1).

In other countries, the tradition of formulating S&T policy and programmes largely in terms of what science and technology are able to supply, rather than in terms of what industry can use, runs deep. The tradition is especially evident when the focus is on technology transfer. It is not unknown in the Philippines:

> "As the premier state university the UP [University of the Philippines] has generated technological research studies which are just waiting for industry to adopt." (Tiong-Aquino, 1990b, page 3).

Another DOST programme has compiled a list of 50 technologies which it describes as "ready for transfer" (Philippines Department of Science and Technology, 1990, page 66). The list is instructive for it contains a great many of the technologies with which TBI/S&T park tenants are involved. In practice, supply seems to have triumphed over demand. This is perhaps to be expected in the early days of a technology transfer scheme, before demand can be properly identified and supply has the opportunity to respond. It has advantages in that new technology can be made immediately available to industry, public sector S&T can be seen to be making its contribution to overall policy objectives, and industry can learn the value of technology transfer and can better express its demands for other technology. However, the disadvantage is obvious: it is simply that supply may

not be of the technology that industry needs. This matching, this closing of the gap between technology demand and technology supply, is never easy and may be made the harder to achieve by policy which also has other goals.

> "One major reason for the establishment of TBIs is not only to nurture start ups but also to encourage the commercialisation of new technologies which are considered vital to the economy." (AIMCON, 1995, page2).

**Definitions of TBIs and S&T parks in the Philippines**

Uncertainty over just what TBIs and S&T parks are is particularly evident in the Philippines. The separate listing of TBIs and science parks in the long and medium term plans of DOST suggests that they are different. In most other policy documents they are regarded as one and the same. The Comprehensive Technology Transfer and Commercialisation (CTTC) programme is an exception: it not only distinguishes between the two, but shows them to have different lead implementing agencies, technology business incubators being the responsibility of the Technology Application and Promotion Institute (TAPI), and science parks that of the Office of the Secretary of DOST (Philippines Department). The Technology Investment programme, submitted to DOST by the Economic Development Foundation and Alternative Development Initiatives Incorporated, ignores TBIs altogether and budgets only for science parks (Economic Development Foundation). Conversely, the Medium-Term Philippine Development Plan, formulated through the co-ordination efforts of the National Economic and Development Authority, includes technology business incubators among the means by which science and technology can contribute to national economic development, but not science parks National Economic and Development Authority 1992, pages 2-9).

Of all these programmes, only the CTTC programme attempts a definition of TBIs and science parks (Philippines Department of Science and Technology, 1990, page 72). It sees TBIs as rather different creatures from science parks.

> "Technology Business Incubators
>
> The Technology Business Incubators are established to assist in the transfer and commercialisation of technologies and investment in technologies with high economic impact and employment generating potential. They help ensure the survival and successful growth of new technology firms by providing them with appropriate marketing, financial, technical and management assistance.

Science Parks

Science parks are developed to facilitate the transfer of advanced technology; serve as the vehicle for university interaction with private industry; develop new knowledge-based industries and strengthen existing ones; and provide conducive environment for innovation and contract research."

The definitions presented in the DOST Annual Report for 1994 are clearly derived from those of the CTTC programme, but in each case the technology transfer function has been omitted (Philippines Department of Science of Technology, 1995c).

"Technology Business Incubators (TBI)

These are facilities established to assist new technology firms during their initial stages of operations. Assistance are made available to the firms, such as technical, financing, marketing and management."

"Science and Technology Parks

S&T parks serve as the vehicle for the universities to interact with private industry, develop new knowledge-based industries and provide conducive environment for innovations and contract researches."

None of these definitions is wrong, but all concentrate on how TBIs and S&T parks are meant to function and what they are meant to achieve rather than what they are. Consequently, there is some uncertainty over what might constitute a TBI site or an S&T park, and over what facilities they might be expected to offer.

**Current facilities**

In January 1990, TAPI was given the responsibility of implementing the feasibility programme for the establishment of technology business incubators in the Philippines, a collaborative project of DOST and development agencies of the United Nations. Seven locations were selected as suitable incubator sites. Outside the Bicutan area, where DOST and its research institutes have their headquarters in Manila, there were to have been five sites operational by 1994:

- the technology park at the Diliman campus of the University of the Philippines
- the science and technology park at the Los Banos campus of the University of the Philippines
- the Bohol TBI
- the Pangasinan TBI
- the Negros Occidental TBI.

By late 1995, there was no commercial activity at the last two of these: building construction at Pangasinan had started in November 1994, but negotiations with various international donors were still underway for the funding of construction at Negros Occidental. Four further sites had also been proposed for TBI operations:

- Central Luzon State University
- Agusan del Sur
- Visayas State College of Agriculture
- University of the Philippines (Visayas campus).

A feasibility study for the first of these was being conducted by TAPI, and pre-feasibility studies for the remaining three. TAPI was organising an increasing number of such feasibility studies as applications for assistance under the TBI/S&T scheme mounted.

In December 1990, the Bicutan technology business incubator was launched to incorporate all the TBI activity in the various research institutes on the Bicutan site. There were apparently 30 tenants there in 1990 (Tiong-Aquino, 1990a, page 2). DOST Annual Reports provide statistics, year by year, on the number of TBI tenants occupying the various parts of the Bicutan site:

1991 - 20 tenants
1992 - 28 tenants
1993 - 34 tenants 15 graduates
1994 - 24 tenants 21 graduates.

The draft of the TAPI Annual Report for 1995 states that there were then 23 tenants occupying TBI units at these institutes (TAPI 1995). Occupancy in 1994 was said to be 80%, but there appeared to be rather fewer tenants - perhaps 14 - on the Bicutan site the following year. There were then five tenants on the pilot TBI facility at UP Diliman, and eight of the ten available places in the new TBI building there were reserved. There were also two TBI tenants attached to the Forest Products Research and Development Institute at Los Banos, and a further 20 fishermen on the Bay had just been classified as TBIs by the Philippine Council for Aquatic and Marine Research and Development. Although there were various commercial property developments exploiting variations of the terms 'science', 'technology' and 'park' (AIMCON, 1995, page 4), the only S&T park operating under the S&T scheme was that at UP Los Banos, where two new buildings each housed a tenant.

**Performance**

Because it is so difficult to devise criteria appropriate to the activities of new technology companies, because no clear definition of TBIs and S&T parks has been established, and because it is uncertain whether their function is technology transfer or business incubation or both, all sorts of activity in all manner of places can be encompassed. In consequence, proposed expenditure threatened to overwhelm the budget and the TBI/S&T park scheme was losing direction and focus.

Much is expected of technology in the economic revival of the Philippines. Much is also expected of the TBI/S&T park scheme in realising the potential that technology has to offer. Either implicitly or explicitly, promises have been made that this particular means by which technology will contribute to economic revival will be made widely available. The Rapid Technology Development Bill, for example, promises a profusion of science parks in the country. These expectations are unrealistic, but without a pre-determined limit to the budget of the TBI/S&T park scheme, public servants were forced to consider seriously every one of these proposals. They faced an unenviable task. In such circumstances, public servants have no alternative but to fabricate their own criteria for suitable developments.

It is customary to assess a programme in terms of the original objectives of that programme. In the case of the TBI/S&T park scheme, the original objectives are somewhat broad:

> "The Project aims to propel the national effort of commercializing research and development results in science and technology through the stimulation of entrepreneurship in small and medium businesses." (Tiong-Aquino, 1990a, page 1).

The situation is rendered the more nebulous in that no intermediate targets were ever determined, nor were indicators identified which might have allowed measurement of the progress the new TBIs and S&T parks were making towards the ultimate objective. In the absence of all but financial and administrative performance measures, it is almost impossible to say whether the TBI/S&T park scheme has been performing as intended. All that can be said with total certainty is that there are tenants, that the tenants are involved in a range of technologies, and that some tenants have graduated.

While the definitions of TBIs and S&T parks may give rise to uncertainty, the objectives of the TBI activity in TAPI are a model of clarity (TAPI 1990, n.d. See also Tiong-Aquino, 1990a, page 2). The TAPI TBI site is to:

- provide a place where technology-based entrepreneurial ventures can be started
- transfer technologies developed by the DOST to potential entrepreneurs
- provide the appropriate common services and facilities to light manufacturing industries
- nurture the business start-ups into viable enterprises
- show to the DOST staff and potential entrepreneurs the use and application of technology in business.

As long as the starting of entrepreneurial ventures does not necessarily mean the starting of new firms - and other documentation makes clear that this was certainly not a condition for the acceptance of tenants - these objectives seem thoroughly satisfactory. They emphasise the primary technology transfer function of the scheme and place business viability in that context, as necessary for successful technology transfer. Moreover, they stress the importance of two matters which are neglected in much other documentation - what public sector research can learn from proximity to private sector

exploitation of technology, and the indirect public benefits that may be gained from demonstrating to other entrepreneurs what is happening on TBI sites.

Monitoring of TBI/S&T park activities is the responsibility of TAPI, though it is a responsibility acquired rather than given. Originally, TAPI's recommended remit was limited to conducting feasibility studies for the establishment of technology parks and incubators in selected areas, assisting in the development of proposals for financing the establishment of technology parks, and participation in administering technology incubators in the Bicutan complex. Monitoring was almost entirely concerned with financial and administrative matters. Monthly returns from site managers showed the rent levels of individual tenants and whether rents had been paid. There was no monitoring of technological or business progress. Yet, appropriate suggestions for monitoring - along with recommendations for business plan formats for both tenants and TAPI, model contracts, criteria for selecting and scoring tenants, and so on (Tiong-Aquino, 1990a, Attachments 4-6)) - had been made in 1990 (Tiong-Aquino, 1990a, page 33)). They have simply never been adopted. Quarterly monitoring forms, designed to assess the business performance of tenants, had been recommended in 1993. These sought information from managers of TBI sites on a number of indicators of tenant performance. The form proposed asked for an account of problems encountered, action recommended and action taken, though there was no specific request for information about technology transfer. Again, this monitoring system has never been implemented, it having been decided that site managers would be unable to cope.

There is also a more serious problem. Some TBI managers feared that monitoring would reveal those firms which have least need of technology transfer and least need of incubation to be the most successful. Those which technology transfer and incubation would benefit most would score badly. This is a valid observation, suggesting that care be taken over what is monitored and how monitoring is used in assessment.

**Tenants**

The criteria used for the selection of tenants were established for TAPI in 1990 and recommended for use by the other institutes on the Bicutan site. They are quite satisfactory for choosing individuals likely to benefit from assistance in setting up new businesses, but they have no technology dimension. Moreover, even the incubator function seems to have been ignored in the implementation of these criteria in that it seems that other, less formal, criteria are more significant in the selection of tenants. It is widely believed that applicants who are well-connected have a high chance of acceptance, even though their prospects for either incubation or technology transfer may be poor (Case Study A).

On many sites, there was some trouble attracting tenants, certainly tenants who would satisfy existing criteria. For example, two of the seven applicants for places on the science park at Los Banos were property developers. It may be that the survey results of the pre-feasibility study for the science park at Diliman, which indicated that more than half of industry respondents wanted to move there (Tiong-Aquino, 1990a, page 14), have encouraged the belief that effective promotion of the TBI/S&T park scheme was unnecessary.

*Case Study A*

*Between 1991 and 1992, Habing Kamay was the single TBI tenant of the Philippine Textile Research Institute (PTRI), although actually housed in TAPI because PTRI had no experience in how to manage a TBI. The company's business was handloom weaving, on two looms rented from PTRI. Neither the entrepreneur nor her two employees had any familiarity with weaving and all had to be trained. The entrepreneur had no experience of this or any other business. With only two handlooms, it was never possible to generate profits sufficient to keep the business afloat. The entrepreneur had no patience with the business, and had difficulty making enough material even for neckties.*

*"It took days to come up with one metre - and then you have to sell it."*

*PTRI was determined to have a handweaving TBI even before the Bicutan feasibility study had been completed (Tiong-Aquino 1990). It seems that TAPI, too, very much encouraged the entrepreneur - then a TAPI employee - to embark on this venture, so much so that she was never asked to produce a business plan with her application and never did have a business plan. The business failed after a year and the entrepreneur, deep in debt, became a TAPI employee once again. The case exemplifies the very worst of the TBI scheme. The criteria for the selection of tenants were disregarded with the result that a tenant and a business were supported when neither had any chance of success. Remarkably, DOST continued to use Habing Kamay as a showcase TBI to promote the TBI/S&T park scheme and as an example for others to follow.*

**Management of TBI/S&T sites**

Each site of TBI or science park activity had a manager appointed by the host institute whose function was to assist the tenants in their incubation and technology transfer, as well as to see to their more mundane practical requirements. Whether the purpose of TBI/S&T parks is incubation or technology transfer, this is an absolutely essential position, critical to the success of these ventures. While it was evident that some of these managers were devoting massive effort to trying to help their tenants, it was not clear that they were always qualified for this particularly difficult task. Most had little commercial experience themselves, and all had many other responsibilities. The Bicutan feasibility study anticipated this problem and emphasised the need for a full-time management team (Tiong-Aquino, 1990a, page 30). This recommendation, too, has never been accepted. The United Nations Development Programme (UNDP) also stressed the need for management guidance in the TBI/S&T park scheme (UNDP, n.d.), but to no avail. In response to their unenviable position, some TBI site managers seemed to have withdrawn themselves from the task altogether: some even denied that they were site managers, and some tenants had no idea who their manager was. Table 1 gives an impression of tenant

satisfaction with the assistance received from site managers. One particularly enthusiastic and hard-working manager has raised the average considerably, but the figures still give grounds for concern.

**Table 1. Tenant Opinion of Performance of TBI/S&T Park Site Managers (n = 14)**

| | no idea | L | M | H |
|---|---|---|---|---|
| Time devoted | 1 | 8 | 5 | 0 |
| Motivation to help tenants | | 5 | 7 | 1 |
| Response time | | 6 | 7 | 0 |
| Technical competence | | 2 | 9 | 2 |
| Business acumen | | 5 | 6 | 0 |
| Communication skills | | 3 | 3 | 1 |

L - low, M - medium, H - high

*Source*: From Villaverde (1995).

The tenants of a TBI site and the tenants of an S&T park cannot be expected to succeed without expert management of these facilities. Where tenants require guidance in business and in technology transfer, they must be able to depend on the site manager. This they could not do. It is unreasonable to expect those individuals charged with the management of TBI/S&T park facilities either to pick up the necessary expertise through learning on the job, or to manage these facilities in conjunction with other tasks. Full-time professional management was required.

**Manpower**

Salary differentials between the public and the private sector in the Philippines pose an institutional constraint on the TBI/S&T park scheme, though this is not necessarily a barrier to the flow of technology. Salaries can easily be four times greater in commerce and industry than in the public sector. This means that, given the opportunity, there is a huge incentive for scientists and engineers in the research institutes and universities to leave for the private sector. The TBI/S&T park scheme seemed to provide this opportunity. Several of the best engineers at the Metals Industry Research and Development Center (MIRDC), having worked alongside Altair, the very first TBI tenant, have left to join the company (Case Study B). UP Los Banos hoped to take advantage of this desire to work in industry: perhaps its major reason for involvement in

the science park was to provide staff, who might otherwise have left altogether, with the opportunity to work commercially while retaining their academic posts.

*Case Study B*

*Altair International Tool Company was originally set up in MIRDC in September 1987 on a programme run by MIRDC's Industrial Assistance Division to assist small firms in businesses related to metals with time-share facilities and small space leasing. The company was established by Armscorp, one of the country's largest arms manufacturers, and uses investment casting technology to make hand guns, some of which are exported to the United States. This 'lost wax' technology brings large savings in raw materials and manufacturing costs. The technology is Japanese; it was brought to the Philippines (along with much equipment) by the Japan International Co-operation Agency, and developed by MIRDC.* When the TBI/S&T park scheme was launched in 1990, Altair was re-classified as a TBI tenant for some years until it left the site. The company is successful and much of its success would appear to be attributable to the technology it has adopted. Not only do other TBI tenants in MIRDC use the same investment casting process, but other companies in Altair's industry have come to use the technology, either through MIRDC or through Altair.

> *"Philippine businessmen will not take on, or even adapt, new technology unless they see it first."*

*Though there must be doubts about the wisdom of using Japanese aid to manufacture arms, the Altair case shows technology transfer taking place precisely as intended - at least in the CTTC programme. Technology transfer schemes are not easy to implement and take time to be effective. Where one is* working well, it may be disruptive to impose a new label, new criteria, and new responsibilities.

Contact between people facilitates the transfer of tacit information, the sort of information which comes from experience rather than instruction, and which is essential for innovation. Institutional and market means of information transfer are often poor at handling such information. When people work in close proximity, they exchange information, and there is some evidence in Table 8 that technology was being transferred in just this way at Bicutan. Transfer is the more successful when individuals - as human containers of information - actually move to another job or location and take their information with them (Macdonald, 1995). More effective still is a two-way movement of individuals so that the source of technology is constantly replenished with new information (Macdonald, 1992). And most effective of all is movement of people within

a network of producers, suppliers, customers and research institutions. Though the TBI/S&T park scheme seems to encourage some flow of technological information to and from tenants and hosts, it seems that the movement of people is in only one direction - from the public sector to the private.

**Business incubation**

Fundamental to the purpose of any TBI/S&T park scheme is the idea that the proximity of tenants to management expertise will improve their chances of successful incubation, and their proximity to a source of technology will improve chances of successful technology transfer. Obviously, proximity alone is insufficient. If hosts have no management expertise, inadequate or inappropriate technology that is not matched to the technological demands of tenants, and if facilities are deficient, then the closeness of contact between tenants and hosts becomes quite irrelevant.

In fact, tenants in the TBI/S&T park scheme were not especially interested in being close to their hosts. What tenants wanted from the scheme, above all else, was cheap rent (AIMCON, 1995, page 10). This they achieved, and this was their major source of satisfaction with the scheme [Table 2]. This is not quite as utilitarian as it sounds. Premises are a sine qua non of any business, and some of these businesses would not have been able to set up at all without this concession.

**Table 2. Satisfaction of Tenant Expectations (n = 14)**

| | L | M | H |
|---|---|---|---|
| Cheap work space | 0 | 0 | 14 |
| Everything else the TBI site has to offer (average) | 5 | 3 | 0 |

*Source*: From Villaverde (1995).

Original rent levels were set arbitrarily, and very low. More recent rentals have some relation to equivalent commercial rates, and most sites were progressively increasing rentals so as to discourage tenants from outstaying their welcome. By late 1995, there were 21 graduates from the TBI sites at Bicutan, and several more from the pilot incubator at UP Diliman. By this measure, the TBI/S&T park scheme had already met with some success - if incubation is its purpose. However, it is less clear which of these were successful graduates - extinct companies were also regarded as graduates. It is also unclear whether these companies would have established themselves in the absence of the TBI/S&T park scheme; in other words, what the additionality of the scheme is. Some ventures would probably not have managed to start without the scheme, but neither the scheme's technology transfer function, nor its incubation function seem to be important in their nurturing. One highly successful company (Case Study C) is a tenant

because the new company could not raise venture capital in the Philippines. In other words, subsidised rent was substituting for venture capital. Another, a jewellery co-operative, occupied the Bicutan site because of the security it provides.

*Case Study C*

*There was only one tenant on the TBI at the Industrial Technology Development Institute (ITDI), C.S. Manrique and Associates, makers of decorative porcelain. The company's four founders had previously worked in middle and senior management positions for one of the largest porcelain companies in the Philippines, Pintar International Corporation, where they grew weary with prevailing management methods. Out on their own, they failed utterly to find the venture capital they required, heard about the TBI/S&T park scheme at a DOST seminar, and settled for cheap rent as a substitute. The company had been a TBI tenant for a year in 1995 and planned to remain on site for another year before moving out to its headquarters, 20 kilometres away. It employed 18 on its TBI site, was competently and efficiently run, and exported all its production. The case is an example of a highly successful company which also happened to be a TBI tenant, but which would probably not be in existence but for the TBI/S&T scheme. Although the company rented its machinery from ITDI, and the Institute tested the cadmium and lead levels of its glazes for the US market, there was little interaction with the Institute. Poor communications and the Institute's insistence that the company work only 8 hours a day - a provision derived from the model lease recommended in 1990 (Tiong-Aquino, 1990a, Attachment 4, page 5) and desperately inefficient when ovens had to be fired - made the TBI site an inappropriate location for such a business, but it was the best available and has been the making of the company.*

Many tenants were not start-up companies at all. Indeed, the criteria for the selection of tenants mitigated against the selection of those which were totally new to their business. Rather, tenants had typically already been in business some years (Table 3), and many were diversifications or subsidiaries of established larger firms. On some sites, tenant operations were more in the nature of experimental units whose main activities were located elsewhere. In fact, the vast majority of tenants seemed to have activities - often their major activities - elsewhere. In consequence, the operatives rather than the managers of tenant companies tended to be found on the TBI sites. As one Institute Director commented:

> "The tenants are in there when they need to be. They don't manufacture every day."

**Table 3. Years in Line of Business of TBI (n = 13)**

| | |
|---|---|
| less than 1 | 0 |
| 1-3 | 2 |
| 3-5 | 4 |
| more than 5 | 7 |

*Source*: From Villaverde (1995).

The explanation for this situation is quite straight forward: companies which are already in business were more likely to satisfy the tenant selection criteria than those which were start-ups, and the facilities offered to tenants on TBI sites were generally not conducive to the running of a business. The TBI/S&T park sites are supposed to provide the facilities essential for conducting business. Technology-intensive firms are perhaps especially dependent on such facilities in as much as they must interact with a wide variety of external activities. Where firms cannot supply all the required facilities themselves, they must rely on common services, and one of the attractions for tenants of TBI/S&T park locations is the common facilities they expect to find there. Those typically promised on TBI/S&T park sites in the Philippines are (Perez and Brinas, 1993, pages 6-7. See also Tiong-Aquino, 1990a, page 3):

- machinery and equipment
- office space
- conference rooms
- office equipment
- communication systems
- training facilities
- chemical/electrical equipment
- laboratory and testing facilities
- basic utilities
- audio-visual facilities
- promotional facilities.

In practice, very few of these facilities were available to tenants. Various feasibility studies go into vast detail about the facilities which must be provided (for example, costing the rental of overhead projectors at 10 pesos an hour) (Tiong-Aquino, 1990a, page 29), but the reality was that many tenants did not have easy access to something as basic for business as a telephone. A TBI site manager was quite specific:

"That was one of the problems - the TBIs were always looking for a phone."

Even the brand new TBI building at Diliman was constructed without access ports for telecommunications. At Bicutan, regular water shortage and a broken water tank

hampered many operations in both the TBIs and the institutes. On the science park at Los Banos, a biotechnology company made vaccines from water stored in plastic containers filled when water was available. The management of the science park had not considered installing a water tank. Whatever the advantages of science parks, they are likely to be nullified if high technology firms must collect what water they can in buckets on the floor. Similarly, whatever advantages there may be for tenants in their TBI locations - and there are real advantages - are brought to nought if they lack a telephone. One TBI tenant summed up the situation admirably:

"It would be impossible for anyone to run a business from a site like this."

Table 4 gives some idea of the satisfaction of tenants with the facilities at the Bicutan site. Most tenants were thoroughly dissatisfied. Not a single tenant was highly satisfied with any of the facilities offered, and yet these facilities were supposed to have been carefully tailored to the specific needs of tenants. Table 5 presents an impression of the main obstacles tenants encountered. Poor facilities were easily the chief of these.

**Table 4. Satisfaction of Tenants with TBI Facilities (n = 14)**

| | L | M | H |
|---|---|---|---|
| equipment support/ maintenance | 9 | 4 | 0 |
| technical support | 8 | 6 | 0 |
| management support | 4 | 4 | 0 |
| communication facilities | 9 | 2 | 0 |
| instrument calibration | 0 | 3 | 0 |
| tooling assistance | 2 | 0 | 0 |

*Source*: From Villaverde (1995).

**Table 5. Obstacles Encountered by Tenants (n = 14)**

| | |
|---|---|
| Inadequate/inappropriate facilities/equipment | 10 |
| Lack of time/availability of TBI manager/staff | 9 |
| Lack of maintenance of equipment | 7 |
| Competition with host for use of equipment | 6 |
| Insufficient capital | 6 |
| Lack of marketing/promotion | 4 |
| Lack of market information | 3 |
| Lack of technical expertise in host agency | 3 |
| Lack of skill of tenant | 2 |

*Source*: From Villaverde (1995).

Adding to the obstacles faced by tenants were a whole host of constraints which reflected the institutional imperatives of hosts and their lack of familiarity with business. For example, the lease offered tenants at the Los Banos science park stipulated not only that they could not operate for more than eight hours a day, but also that they could not consort with other tenants. It is generally essential that new technology-based businesses work long and uncivilised hours, and that networks are formed through mixing with other science park tenants.

**Technology transfer**

Although tenants are very often working in the same technological fields as those of their hosts, there was very little evidence of technology transfer from hosts to tenants (Tables 6 and 7). Where there was technology transfer, informal contacts between individual tenants and individuals in the host organisation were important (Table 8). Most of the tenants had brought their technology with them and others made little use of any technology at all. A few used the technical services available on the hosts' premises and rented machinery from hosts. Often, though, this machinery was more appropriate for the experimental purposes for which it was originally intended than for commercial use. A great deal of the machinery available in host institutions was so old and so incompatible with other machinery that it had no use at all.

**Table 6. Source of Tenants' Technology (n = 14)**

| | |
|---|---|
| DOST R&D | 1 |
| Contract research with DOST | 1 |
| Elsewhere | 12 |

*Source*: From Villaverde (1995).

**Table 7. Participation of Host in Tenants' Innovations (n =14)**

| | |
|---|---|
| None | 6 |
| Low | 5 |
| Medium | 3 |
| High | 0 |

*Source*: From Villaverde (1995).

It is quite possible that hosts gained more from the technology - in the broadest sense - of their tenants than tenants gained from the technology of their hosts. Research institutions often acquired information from tenants which contributed to, or influenced, their own research. For instance, the Forest Products Research and Development Institute discovered a massive water pollution problem being caused by one of its TBIs, a company making paper. As the company was using the Institute's own machinery, and as the Institute had worked for years to overcome pollution problems associated with the process, this was totally unexpected. The explanation was that the company was using the machinery much more intensively and for coloured paper. The Institute started research immediately to overcome the problem. This reverse flow of technology - from tenant to host - is entirely beneficial and should not have been unexpected. Public sector research, even that which is applied and associated with technology transfer programmes, can easily become isolated from the daily realities of applying technology in business. Close working contact allows a flow of information - often tacit information and often through personal and informal channels - which might otherwise not take place.

**Table 8. Contributions to Tenants' Innovations (n = 14)**

| | |
|---|---|
| Previous experience/own experiments | 11 |
| Suggestions from end-user | 7 |
| Consultations outside host | 7 |
| Consultations with host | 7 |

*Source*: From Villaverde (1995).

*Case Study D*

*One of the tenants on the TBI of the Food and Nutrition Research Institute (FNRI), though the company was located in TAPI because of space shortage in FNRI, was a husband and wife company making squash noodles. The project was dear to the heart of FNRI, ostensibly being an extension of its long-term efforts to improve Filipino nutrition through the addition of vegetables to processed carbohydrates. FNRI undertook the training of the staff. The owners of the company, however, seemed unable to manage the trained staff: turnover was high and the original employment level of 12 dropped to 4. TAPI has no expertise in human resource training. The company produced seven 25 kilo bags of squash noodles a day using techniques developed by FNRI. Its machinery was rudimentary and the company's main use for the premises was as a noodle warehouse. TAPI regarded this as a showcase company, but perhaps unwisely. The deal struck between FNRI and the tenant gave the company a monopoly over squash noodles, presumably a case of private benefit at substantial public cost in as much as FNRI had long been trying to disseminate squash noodle manufacturing techniques as a public good.*

> *"Nutrition is hard to sell, so we have been very loose and very kind in our requirements and demands."*

*TAPI eventually curtailed this unfortunate arrangement, though with some reluctance. Because the owners had great trouble raising a bank loan, TAPI had* entered *into a joint venture with the company.*

**Technology transfer or incubation?**

Policy to encourage technology transfer and the incubation of new businesses runs the risk of confusing what are generally quite distinct, and sometimes conflicting, activities. Basically, it is hard enough to transfer technology from research laboratory to production

line without the added obstacle of the commercial recipient being new to business. The chances of successful technology transfer are much increased when the recipient is already highly experienced in business. In their emphasis on business experience and entrepreneurial credentials, the criteria established for the selection of TBI tenants seem to acknowledge this reality. So, too, does much of what has been written about the TBI/S&T scheme in stressing its technology transfer function.

> "Conceptually, the technology business incubator or TBI attempts to ..... complement sectoral needs by matching them with technology supply, thus shortening the gap between technology development and commercialisation." (Perez and Brinas, 1993, page 3).

However, this argument is accompanied by another:

> "The TBI is governed by the underlying precept that business entrants have higher chances of success when nurtured under a favourable, technology-oriented environment." (Perez and Brinas, 1993, page 3).

The idea has developed that business incubation is actually made the easier by the injection of new technology.

> "The aim of this project is to nurture potential entrepreneurs by technology transfer using DOST facilities to achieve commercial operation." (Tiong-Aquino, 1990a, page 5).

While new business entrants certainly do need nurturing, what they require in their nurturing are management guidance and business facilities. Technology is of much less importance, and a technology-oriented environment is not perhaps the most likely to provide appropriate management guidance.

A major advantage that tenants reap from their location on TBI/S&T park sites is credibility. For example, one survey of tenants found that they rated professional environment second in importance only to cheap rent (AIMCON, 1995, page 10). This is slowly coming to be recognised on such sites in other parts of the world, sites where it was originally supposed that the main advantage lay in technology transfer to nearby tenants (Macdonald, 1987). A new company, and especially a company exploiting a new technology, requires credibility in its industry, in its market, and among those who regulate the industry. Such credibility may take years to develop without assistance, during which time the innovation, and perhaps the company itself, may perish. Location in a research institute or on a university campus gives respectability to a company and does much to accelerate the process of credibility-building. One company brochure is typical in the advantage it takes of association with the University:

> "DSI offers you the technological breakthrough you need to be competitive. A locator at the University of the Philippines' Technology Business Incubator (TBI) facility of the DOST-funded UP Technology Park Project, DSI is engaged in researched [sic] and development in CAD/CAM technology."

If credibility is an important advantage that a TBI/S&T park site can bestow, it is all the more important that the environment of these sites is in keeping with the credibility sought. This aspect of the environment is sometimes deficient on TBI/S&T park sites in the Philippines. Research institutes have been encouraged both to launch TBIs and to make more efficient use of existing facilities. The result has sometimes been that TBIs are allotted to vacant space alongside old machinery for which there is no longer an institutional use. Such locations have all the credibility of a scrapyard. Other locations, especially those on the campuses of the University of the Philippines, are quite excellent. The TBIs on the pilot site at Diliman look and feel as if they are in business, as if they should be taken seriously.

Credibility, like technology, can flow in both directions. Both research institutes and the universities boost their reputations through association with private enterprise, at least in as much as they can parry accusations that their activities are remote from the real world and of no practical importance. The University of the Philippines at Diliman is quite explicit in its technology park brochure that an objective of the park is:

> ".....to project the University's image as a technology leader and as a center for innovative approaches to development."

More fundamentally, it is clear from both overseas evidence and that available in the Philippines that association with private enterprise increases research opportunities. As long as public sector research retains its scientific core competence, working with the private sector allows it to expand its research horizons, increase the relevance of its research, and offer an output which complements, but does not replace, academic publication.

## Conclusions

After just five years of operation, the TBI/S&T park scheme had become a substantial reality. There were many TBI tenants and the number of companies on science and technology parks was expected to grow steadily. This progress was a result of the massive drive and enthusiasm with which the scheme was launched. The scheme's problems were in part a consequence of this haste and enthusiasm. In the rush to become operational, it mattered less what was being created than that something was being created. Precise definitions of TBIs and of S&T parks were never agreed. And in the determination to contribute to the overall goal of rapid national development, no intermediate targets were ever established for the scheme. Consequently, monitoring of progress was always problematic, and was restricted to financial and administrative matters. Technological and business progress went unmeasured. Problems and opportunities in implementation have consequently remained unnoticed at the policy level. Failure to determine whether the TBI/S&T park scheme was to function through technology transfer or through incubation led to confusion and some loss of purpose with transfer of technology to firms unable to use it and the incubation of other firms

uninterested in new technology. Inevitably, this undermined the dissemination and demonstration function of the scheme.

Both hosts and administrators felt confident that the success of TBI/S&T park schemes in other countries could be repeated in the Philippines. Yet, where there has been success overseas, much of it is attributable to adaptation of schemes to local circumstances rather than to the unyielding imposition of a universal model. There has been some adaptation in the Philippines, but pragmatic, *ad hoc,* and operational adjustment during implementation rather than adaptation of the scheme itself. In its failure to take account of local infrastructural and manpower circumstances, the TBI/S&T park scheme sacrificed practical necessity to theoretical purity.

There is considerable evidence that the TBI/S&T park scheme produced benefits, but perhaps not entirely of the sort, and by the means, anticipated. New technology-based firms emerged, but so did new opportunities for the host universities and research institutes. Tenants found that they benefited more from low rent and the credibility of their hosts than from specific incubation assistance or from technology transfer. The TBI/S&T park scheme contributed little to the three sectors selected as export winners. Both the range of technologies available for transfer, and the number of companies able to make use of these technologies were necessarily limited. It was always optimistic to assume that these technologies and these firms would be in the fruit, metal fabrication and marine-based products sectors.

To some extent, policy expected too much of TBIs and science parks, and perhaps too much of technology generally. It was always unrealistic to assume that technology was the primary ingredient required to make firms in the Philippines internationally competitive, that this technology was already available in public sector research, and that it could readily be transferred to new companies while they were being incubated. The enthusiasm of policy overshadowed the reality that there is only so much that a TBI/S&T park scheme can achieve in even the most favourable of circumstances. Concentration on the grand objectives of policy and relative neglect of implementation issues and monitoring exposed the gulf between theory and reality. In theory, tenants had access to essential business facilities, leading edge technology was being transferred from the public sector, and new technology-based businesses were being nurtured. In practice, many tenants lacked a telephone, adequate management guidance was unavailable to them, and they had little use for the technology on offer. In practice, high technology companies had all the advantages of a science park, but no water. The reality is that established industry in the Philippines prefers to import its carrageen from Denmark and its fruit from New Zealand rather than expose itself to the irregularities of supply from local producers. The vast tuna industry, for example, lacks not technology (which it prefers to acquire abroad anyway) but cans. Industry in the Philippines does not anticipate a technological solution to such comprehensive infrastructural problems, certainly not one packaged and ready for transfer from public sector research. The TBI/S&T park scheme was presented as a technological solution when it could make only a technological contribution, and by far the major part of that long term and indirect.

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