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

FAIR USE POLICY

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

19459

Workshop on Incubators of Entrepreneurship
and Strategies to Stimulate Innovation
among Small and Medium Enterprises in Europe

Organized by UNIDO in Co-operation with
Research Area of Trieste
Trieste, Italy, 27-30 November, 1990

TECHNOLOGY INCUBATION CENTERS FOR INNOVATION AND ENTREPRENEURSHIP DEVELOPMENT

Rustam Lalkaka 1/

Contents

1/ Mr. Rustam Lalkaka is Senior Advisor on Technology Transfer at Northwestern University's International Business Development Programme, Evanston and Consultant to the United Nations Industrial Development Organization (UNIDO), Vienna.

TECHNOLOGY INCUBATION CENTERS FOR INNOVATION AND ENTREPRENEURSHIP DEVELOPMENT

Introduction

The technological revolution of the 1980's is being followed by rapid political and economic transformations. In Eastern Europe, for instance, economic forces have led to political democratization; this, in turn, must open the way to technological innovation, entrepreneurship and new forms of economic enterprise. The painful transition from rigid bureaucratic coordination of all activities towards economic decentralization calls for hard work in the countries concerned and the cooperation of the international community.

Relationships between the First World of western democracies, the Second World of former socialist countries and the Third World of developing countries are changing fast. Moreover, the differentiation between north and south, east and west is becoming blurred. In these conditions, all need to explore innovative patterns of technical and economic cooperation.

The United Nations development system, with its experience of institution building and global field net-work, can help provide the international expertise and skills formation for these purposes to all countries needing such assistance. The United Nations Industrial Development Organization (UNIDO) can, for instance, be the mechanism to facilitate the networking of ideas, of individuals and of organizations. Over the last decade, the United Nations Development Programme (UNDP) has supported over 1000 projects on entrepreneurship and small industry development, with $600 million in grant technical assistance. The World Bank provides loans for such development which average $300 million annually. The United Nations Fund for Science and Technology for Development (UNFSTD) is currently assisting a number of countries in examining the feasibility of adapting the technology incubation center (TIC) concept to their specific needs and conditions.

break-throughs. A great deal of innovation takes place at the artisan and shop-floor levels. The first industrial revolution was triggered by tinkerers and artisans; then science followed. Indeed, only in the twentieth century has science been deliberately used for public good and commercial gain.

Conditions vary of course from country to country. The newly industrializing countries such as Korea and Singapore have practically overcome obstacles to innovation and are now significant players in world markets. The large countries like China, India and Brazil have the manpower and natural resources for their development, but they also have equally large domestic problems. The tiny island countries such as Jamaica, Cyprus, Malta, lack internal markets and must, more than others, look outward to export-let growth. Finally, there are countries in Africa where economic instability, lack of technical manpower, low incomes and small markets make technological innovation even more difficult.

Obstacles to the Innovation Process

While the EMEs of east and central Europe have had a good technical education system and a strong heavy industry base, they have hitherto lacked the open, democratic systems needed for the innovation process. The command economy had put a premium on the fulfillment of central plans, thus stifling any entrepreneurial propensities. Further, the effort to force product innovation or upgrade quality from the top down had no chance of success in a system of controlled prices and excess demand.

Today, the transition from the past legacies towards market-oriented sytems requires urgent efforts in many directions: changes in ownership patterns through extensive privatization of small and large entreprises; the freeing of state controlled prices and wages together with the removal of subsidies; the convertibility of national currencies; the reform of personal and corporate tax structures; the creation of financial markets

including stock exchanges, mutual funds and venture capital: and the integration of local economies with those of western Europe.

The problems of these countries are compounded by internal instability and unfavourable external economic conditions: budget deficits and rising inflation: disruption of traditional supplies of raw materials and components: and the carry over of officials who still have the mentality and methods of the former socialist regime.

Bariers in the EMEs: Specific obstacles to the technological innovation process are at the economic, political/legislative, organiztional and cultural/social levels. These include:

Economic
- Scarce financial resources
- Poor infrastructure and support services
- Inadequate attention to advanced technologies
- Widespread unemployment and inflation
- Difficulties in attracting foreign know-how and investment

Political
- Slow progress of legislative reforms
- Gross regional economic imbalances
- Complexities of privatization
- Legacy of past bureaucratic system
- Political instability

Organizational
- Obsolete organizational structures
- Lack of work spaces for budding entreprenurs
- Inadequate management and accounting skills
- Poor understanding of market dynamics
- Lack of experience on emerging mechanisms for linking university-research and productive sectors.

Cultural
- Behaviour patterns of dependency
- Differing attitudes to wealth, bankruptcy
- Lack of incentive for hard work
- Entrepreneurial skills directed to speculative or commercial activities
- Isolation from international scientific community.

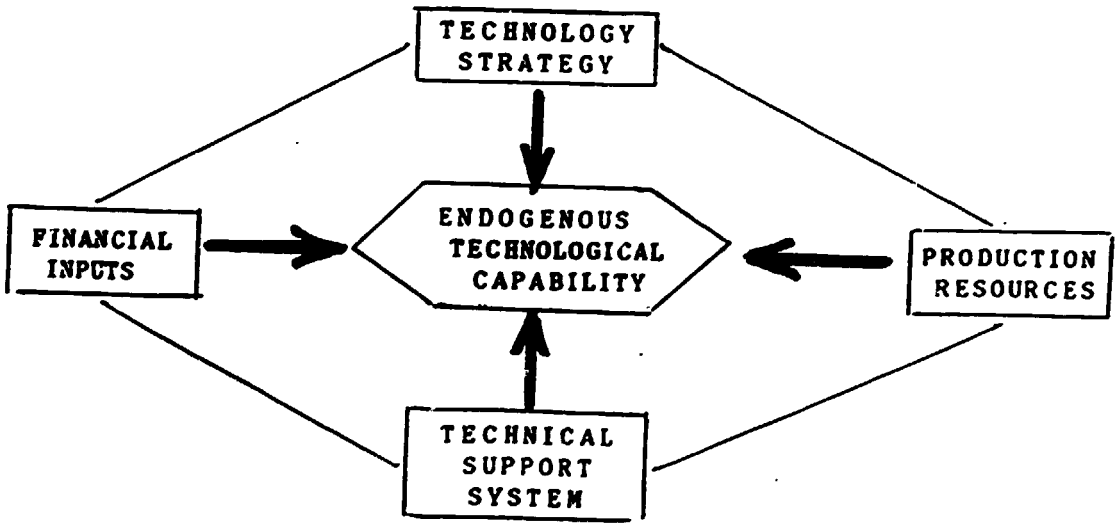
Planners and researchers, at both federal and provincial levels, are now exploring some of the emerging arrangements to re-vitalize their national technology establishments.

Building National Capabilities

The economic and organizational reforms in the EMEs have received clear priority. But now the stage is set to tackle the important task of technological transformation.

The re-vitalization of endogenous capabilities for technology acquisition, absorption and innovation requires national action in four areas, namely, explicit technology strategy (including an innovation strategy), production resources (particularly technical human resources), the technical support system, and the needed financial resources.

Fig. 1 - Strengthening National Capabilities



The technology and innovation policies should be derived from the national social and economic development plan, which must be directed to improving conditions and opportunities for the mass of the people. A critical area of action is to strengthen the technical infrastructure such as consultancy services, telecommunications, repair and maintenance facilities and a total quality management system. The financial resources needed must come primarily from within the nation, with catalytic inputs from external sources.

The Government agencies that have played a dominant role in economic activity in former socialist countries are not generally inclined towards taking risk and so tend to have a dampening effect on entrepreneurship. New ways of stimulating innovation and pushing new product ideas promptly to the market place therefore have to be devised.

At the recent conference organized by the German Technology Incubator Association (ADT) on "Entrepreneurship, Technology and Innovation - Cooperation Between East and West Europe", Berling, 4-6 November, 1990, participants from the former socialist countries explained their plans to establish a variety of technology innovation and incubation activities. Such technology centres have already been started in the former DDR, Poland and Hungary, while Czechoslovakia, Bulgaria and Rumania are in the planning stage.

Emerging Arrangements

One of the most remarkable phenomenon of this last decade has been the important role played by small and medium entreprises (SMEs) in national economies. In the United States, for instance, the large companies lost 4-5 million jobs in the period 1974-84, but there was a net growth of 24 million jobs. The SMEs created the bulk of these new jobs. The SMEs produce three times more innovations than the large corporations. Approximately one-fifth of these new jobs were in high-technology companies.

Similar results can be achieved in the former socialist countries. At the Third Beijing International Conference on Technology Innovation in May this year, all participants agreed - including the Chinese - that the way to stimulate growth of entrepreneurial SMEs is for the government to create the enabling economic policy, tax and incentive environment; then the government must get out of the way, leaving to private entreprise the tasks of creating jobs and wealth.

New arrangements for bridging the gap between research, university and productive sectors and promoting small/medium entreprises include the establishment of:

- R&D marketing/liaison groups in each research laboratory and technical university;
- Foundations for matching grants to stimulate private industry-university-research projects;
- Technology sourcing and brokerage mechanisms to help match the needs of firms in developing countries with availability of know-how at home and abroad on proven processes and products;
- Computer-based information systems for exchanges among countries on know-how available or needed, training and trading opportunities;
- Research Commercialization Corporations run as a business;
- Data-bases of available research facilities and personnel;
- Seed and venture capital mechanisms;
- Systems for standardization, testing, metrology and total quality management;

- Executive training and university curricula for the management of technology;

- Sub-contracting of supplies and components;

- Special work spaces such as technology parks and incubators.

It is in this context that the U.N. development system is examining the business incubation modality, suitably adapted to local conditions, as one possible option.

The Technology Incubation Center (TIC)

Business incubators are in simple terms facilities that provide shared facilities such as rental space, office services, management, marketing and consulting assistance. Entrepreneurs are assisted in preparing business plans and taking the various steps needed to start up their business.

The incubator provides the supportive environment for monitoring business activities during the initial preparation and through actual operational stages; this increases the chances of nurturing successful entreprises. Furthermore, by sharing office facilities the initial cost of launching a new entreprise are considerably reduced and made more affordable to a larger group of potential entrepreneurs. There is both cooperation among tenants to tackle common problems as well as competition in their specific market niche. At a successful incubator, the tenants are likely to receive a greater degree of acceptability from financing and other institutions.

Recent surveys of U.S. business incubators indicate that the services most often provided are: general counselling, word-processing, security, conference room, typing, photo-copying, and receptionist.

A distinction needs to be made between a strict business incubation center and the technology incubation center (TIC). The TIC is also called an "innovation center" in some countries. The business incubator provides a variety of office facilities and services to help small businesses survive. The TIC provides, in addition, access to technical advice and facilities through its close association with engineering universities and research laboratories. Its mission is to assist the innovator take his concept through development and proto-type stages, on to commercial utilization. In these respects the TIC is also quite different from the traditional industrial estate.

Different Patterns: The technology business incubator provides not one model but a variety of options. It has the advantage of being adaptable in various ways: for instance, it can be modified to suit different purposes such as reviving depressed areas or promoting hi-tech businesses; to different funding sources - public or strictly commercial and variations in between; adaptable to different linkages with realtors, universities or state administrations; to different stipulations with regard to entrance and exit of tenants, the extent and type of shared facilities, and so on., Above all, the incubator has the characteristics of self-help (rather than subsidized government support) and of the 'mentoring' environment. These flexibilities lend themselves to tailor-making the incubator for varying needs and conditions in different countries.

In some countries, old warehouses and derelict buildings have been converted to provide space for a variety of small and medium-sized enterprises. Some incubators have been set up as purely private concerns, while most have been partnerships between government and the private sector. The staff running the incubation center is generally small (4-6 persons). A suggested organization for a TIC is shown on the next page (Fig. 2).

An important task of the TIC management is to organize a tenant selection procedure, based on questionnaires, interviews, induction courses, and business plans. As seen in Figure 3, a large number of prospective tenants may apply but only a few chosen.

Fig. 2 - TIC ORGANIZATION CHART

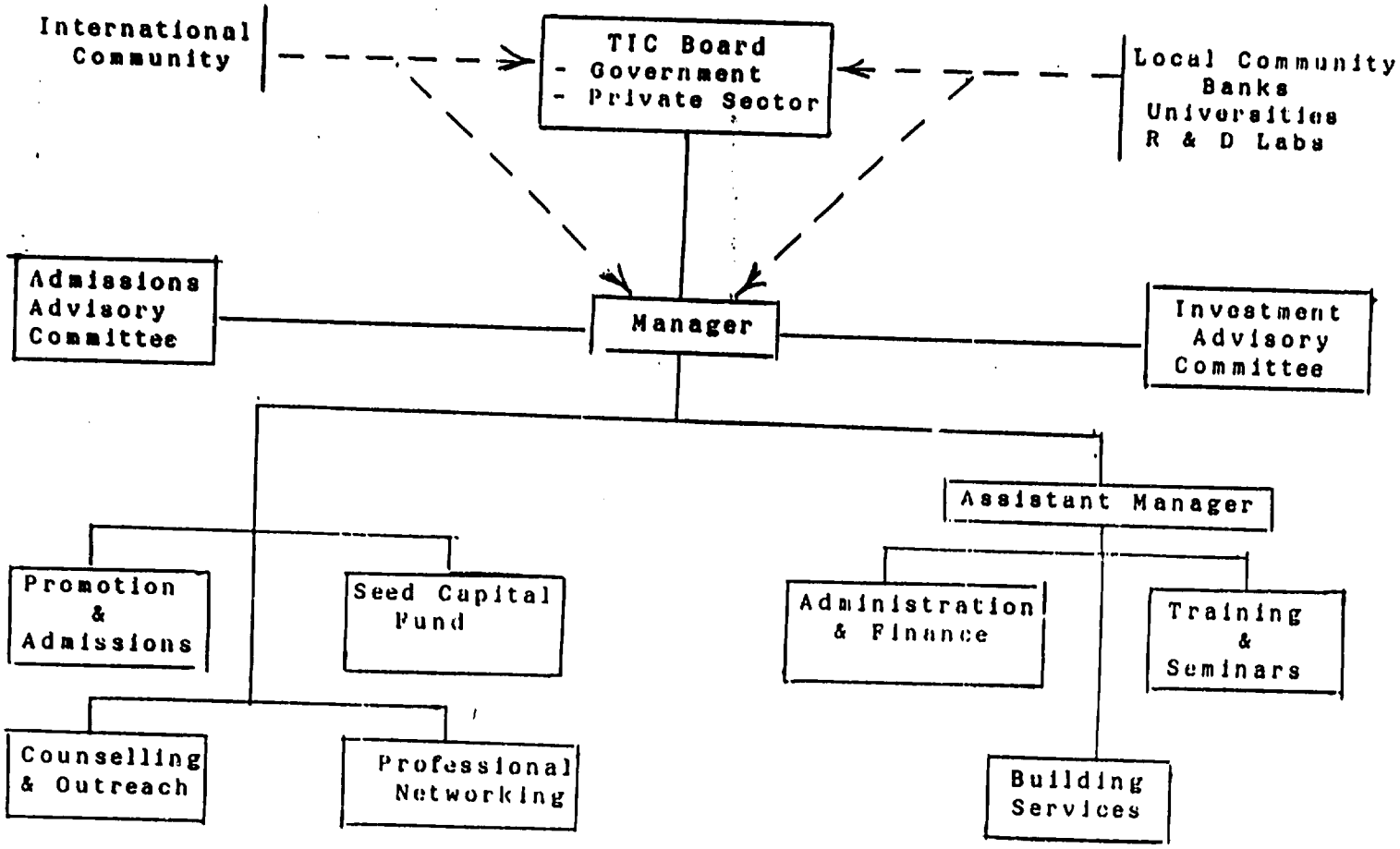
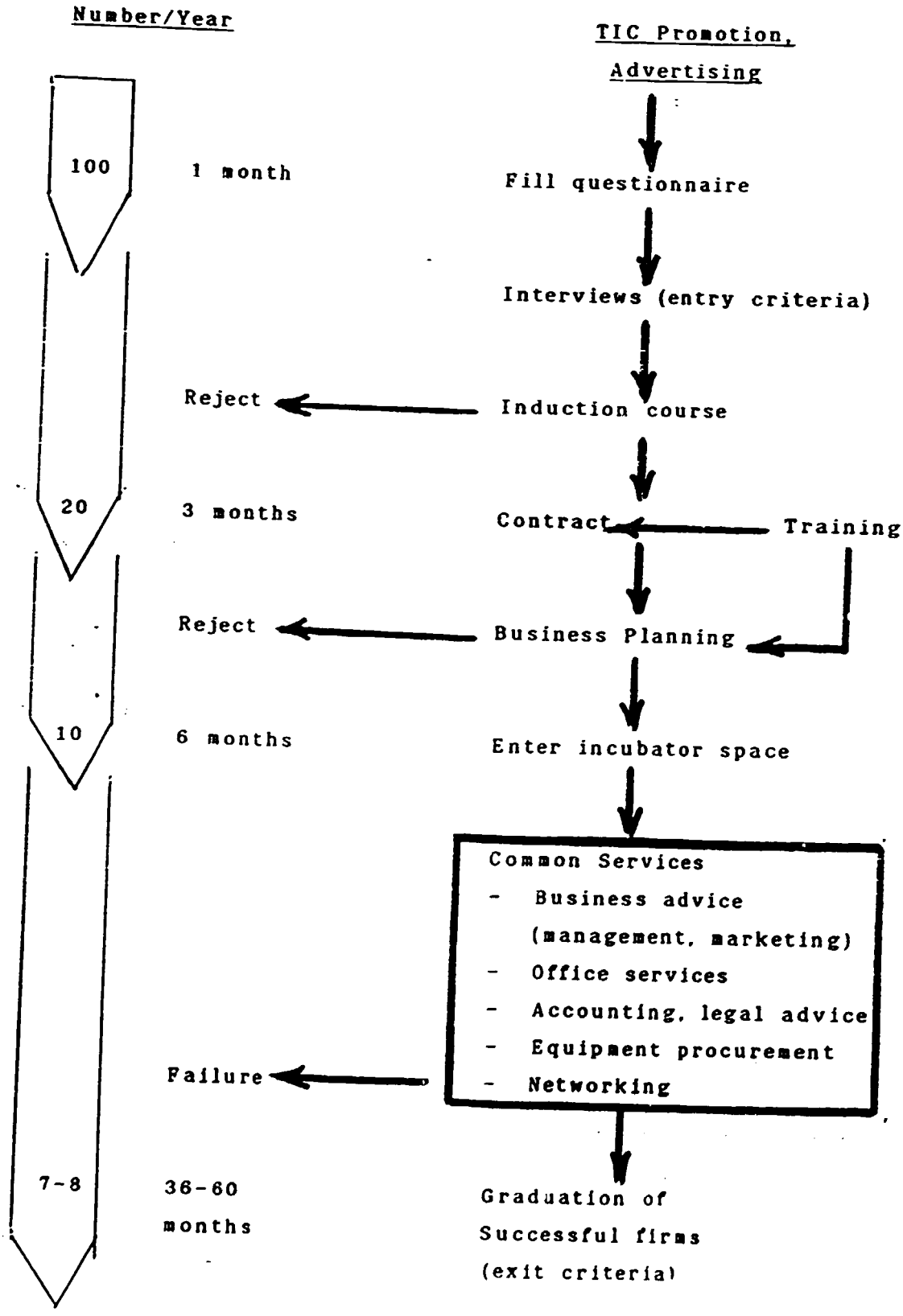


Fig 3 - TIC - TENANT SELECTION PROCEDURE



TIC Policies: Generally, tenants are expected to graduate and leave after a specified period of nurturing, ranging from three to five years. These entry and exit requirements make it possible for space to be made available to new, aspiring entrepreneurs. Graduates from an incubator could move to an industrial estate where they could continue to have access to consultancy services provided by the incubator. Incubators can thus contribute to social and economic development by creating jobs and by generating a return on investments for management in the form of rental income, royalties from new products, equity in tenant companies and consulting fees.

Regardless of the modality adopted, a common feature of successful incubators in the industrialized countries is that they have significantly reduced the failure rate of new businesses in the small and medium-scale sector. The incubator itself has to be run as a business, albeit a non-for-profit business. The initial costs of land and building need public support, but the running costs can usually be met from rentals and services in 2-3 years after start up.

The number of incubators in the U.S. has grown from about 100 in 1983 to around 400 today and most are less than four years old. There are another 200 in Europe, Canada and Australia. Of the U.S. incubators, three-quarters are public-private-university, not-for-profit, partnerships while the balance are private, for-profit. The median size is around 2,000 sq.m. with 15-20 tenants each.

A rural incubator could provide a mechanism for promoting production, maintenance and marketing in agriculture and food processing, energy and metal-working industries. It could operate as an "incubator without walls", providing services needed by entrepreneurs in the agro-processing and artisan sectors. Such projects must be based on local participation and be capable of rapid replication in other areas.

To summarize, the technology incubation modality has significant potential for expanding the economic base and creating jobs in selected developing countries and EMEs. Chances of success can be improved by:

- Well-designed government policies and economic incentive packages for small enterprises;

- Involving the community, business, scientific and banking groups from the very outset, and finding a committed sponsor, a "champion";

- Overcoming the key constraint of funding for incubators and tenants;

- Starting prudently, and sustaining interest for the 3-5 years needed to determine whether the concept is workable;

- Designing the appropriate incubator structure and procedures, exit/entry policies, affordable space, training and entrepreneur inter-action; and

- Trained and motivated incubator manager.

U.N. Technical Assistance Initiatives

The objective of UNFSTD's programme is to stimulate innovation and entrepreneurship from the conception of a technical proposal through the development and demonstration phases. The vehicle for investigating the techno park/incubator option has been the conduct of feasibility exercises to adapt technology business incubation to local requirements. These projects are now underway in a dozen developing countries and are being planned in five others.

- Revitalizing the technical universities and research laboratories and introducing new courses in entrepreneurship development management of technology and business administration under open-market conditions;

- Reducing dependence on imported goods and services, especially those provided by existing industries which often operate well below their normal capacity. On the other hand, once economic prosperity increases, there could be a significant potential for foreign trade and investment;

- Improving the infrastructure and technical support services, in order to promote small entrepreneurial enterprises in manufacturing, services and farm activities;

- Creation of social conditions to reduce migration of personnel to the cities (or to foreign countries). While the incubator itself may not create large employment, it can have an important multiplier effect in the community;

- Promotion of an environment that would give greater impetus to the commercialization of local R&D as a means of solving national and regional problems, with some stress on the advanced technologies.

While technology incubators could undoubtedly promote these national objectives, they must be considered essentially as a micro-economic initiative which focusses on nurturing entrepreneurship at a local and regional level. The benefits in the medium to long-term are the creation of incomes through the mobilization of latent entrepreneurial and innovation capacities. It must be reiterated that the basic concept has to be adapted to suit social and economic endowments in each country. The operational requirements for an incubator in an urban area will be different from a rural setting or for a designated growth-pole where basic infrastructure is in the process of being established.

Technology Incubation Centers in Developing Countries

Typical UNFSTD-sponsored activities are briefly reviewed below:

Asia: The technology incubation scheme in China initiated by UNFSTD in close collaboration with the State Science and Technology Commission (SSTC) has already resulted in the establishment of a dozen incubators in cities such as Wuhan, Guangzhou, Tianjin and Shenzhen. This is a component of China's TORCH programme, which has the goals of creating 2,000 entrepreneurs in advanced technology fields and training 20,000 management personnel to handle such activities. The incubation activities are being supported by an initial SSTC budget of Rmby 3 million provided as loan or equity share and matched by funds from local sources.

The UNFSTD/European Commission-sponsored Feasibility Study for the programme in China proposes a holding company (termed China Technology Incubation Corporation) which would take a majority share in local incubators. Each technology incubator would be a separate semi-autonomous corporate entity. A manual of Best Practices for China's TIC managers has also been compiled and training courses have been run for both managers and prospective tenants.

In China as in Eastern Europe private ownership of small high-tech businesses is a recent phenomenon, and therefore the Chinese success with the incubation approach can be of special significance. It is interesting to note that even while the UNFSTD-sponsored studies were in progress, the Wuhan East Lake New Technological Innovators Center was already brought into operation. A young manager, Yang Niaw Quan, supported by the Hubei Province Authorities, has taken over on rental (Y45,000/yr for 600 sq. m.) an office-dormitory-garage complex vacated by the Peolple's Liberation Army - a new twist to the biblical injunction of turning swords into plough-shares!

- - - - - -

in Pune. These would be essentially regional initiatives with strong involvement of the scientific community and with local managements, broadly guided by a national advisory council. It is also suggested to start Business Consultancy Centers to give specialized advisory services to small enterprises.

The approach in the Philippines is similar: plans call for four initial incubators with broad government support. In Thailand, a more ambitious technology park is visualized, drawing upon the experiences of similar developments in Taiwan, Singapore and Malaysia.

Latin America and Caribbean: In Trinidad and Tobago, the first incubator -- INNOTECH -- has already been initiated as a limited liability company whose shareholders are the Caribbean Industrial Research Institute (CARIRI), the Development Finance Corporation (DFC), the Industrial Development Corporation (IDC), the Ministry of Planning and Mobilization, the University of the West Indies (UWI), and private sector financial institutions.

In Jamaica, St. Lucia and Guyana, the proposed incubation centers will help create small enterprises based on local natural resources. The incubator management is expected to provide advisory services to firms located in existing industrial estates. It is also planned to establish Small Enterprise Development Units to help entrepreneurs take advantage of local business opportunities and to facilitate access to credit sources.

UNDP/UNFSTD are currently assisting incubator-type developments at Morelos, Mexico, at the University of Santiago in Chile, and in Argentina.

Africa: As noted earlier, in adapting the business incubator concept for African Countries a number of special considerations have been kept in mind. The level of demand for the commercialization of R&D results is low, at least in the initial period. Apart from a few urban areas, the

population tends to be highly dispersed and the market size of most communities is small. This calls for sub-regional co-ordination of production activities and intra-country trade in goods and services. There are still insufficient numbers of trained personnel with the required skills in management and entrepreneurship.

In Gabon, the study proposes an "incubator-without-walls", that is, a management team at Libreville to provide outreach services to tenants who will work in their own premises. Initially, expatriate experts will be used for 2-3 years to train Gabonese personnel.

The Nigeria feasibility study has resulted in a business plan for the incubation center at Agege where the Lagos State Government has donated space to accommodate 35 tenants. The incubator will select tenants (1 out of 20 applicants) for technology-related, value-added products. A management team of 2 professionals and 13 support staff is visualized. The analyses indicate that the incubator can operate commercially and generate surplus after 2 years; but the establishment costs will have to be met by the Nigerian authorities and international agencies. Similar arrangements are underway in Zimbabwe and Cote d'Ivoire.

Eastern/central Europe: In the EMEs, the old economic structures have not yet been fully replaced by the new laws and systems needed for transformation to a market economy with the rigours of competition. After a half-century of socialism, the individual entrepreneurial spirit has barely survived. As noted earlier, management training is only now being intensified, public administration restructured, and new organizations such as commercial/development banks and capital markets being initiated.

The technology incubation concept was explained in Warsaw, Poland in September, 1989; the State Office for Science and Technology was quick to grasp its potential role in stimulating private entrepreneurs under Poland's emerging economic conditions, and requested UNFSTD support for a

feasibility excercise. In cooperation with the German Association of Technology and Business Incubation Centers (ADT), expert missions in November 1989 and March 1990 together with a training workshop at Poznan in October 1990, helped start the preparatory process.

As a consequence, Poland's first such undertaking, the Wielkopolska Innovation Center has been founded in Poznan with an initial capital of US$50,000 and support from the provincial councils, industry, economic and craftsman's chambers and the Economic Society of Wielkopolska. Others such as POSTEUR (the enterprise for promotion of technologies), the Poznan International Fair, Poznan Academy of Science and the Polish Chamber of Foreign Trade are Potential supporters. A donated building space is being sought from among several sites examined. Initially the Poznan incubator will have mixed tenants, including non-technology related activities, but plans to move to more focussed incubators in future.

It is clear that in the EME context, the technology incubation center will have to provide a variety of consulting and support services not presently available and also serve small businesses outside the center. Further, large state enterprises will have to be assisted in INTRAPRENEURING, that is, enabling their employees to set up new businesses under the corporate umbrella.

Similar technology-related business initiatives are underway at the University of Prague, Czech and Slovak Republic, in Hungary, Bulgaria and many cities in eastern Germany. In all cases, the incubation system may need to be linked to mechanisms for micro-loans to entrepreneurs as well as for advisory service to small business development.

Global network: Once these technology centers are operational, they could usefully be linked to each other, to others being planned in Turkey, Malta and Cyprus, as well as to the Europen (EBN), German (ADT), British and US (NBIA) networks. When incubators in other developing countries are fully in operation, UNFSTD/UNDP could help initiate a truly global technology business incubation network. The World Association of Industrial and Technology Research Organizations is currently planning such a global system.

Linkages to European Community: The single European market of 1992 offers to small/medium enterprises in the EMEs the opportunity of access to an enormous market of 320 million consumers. But this requires that the enterprises position themselves now to improve product quality and productivity, to move into knowledge - intensive activities which exploit the economies of scope (if not of scale).

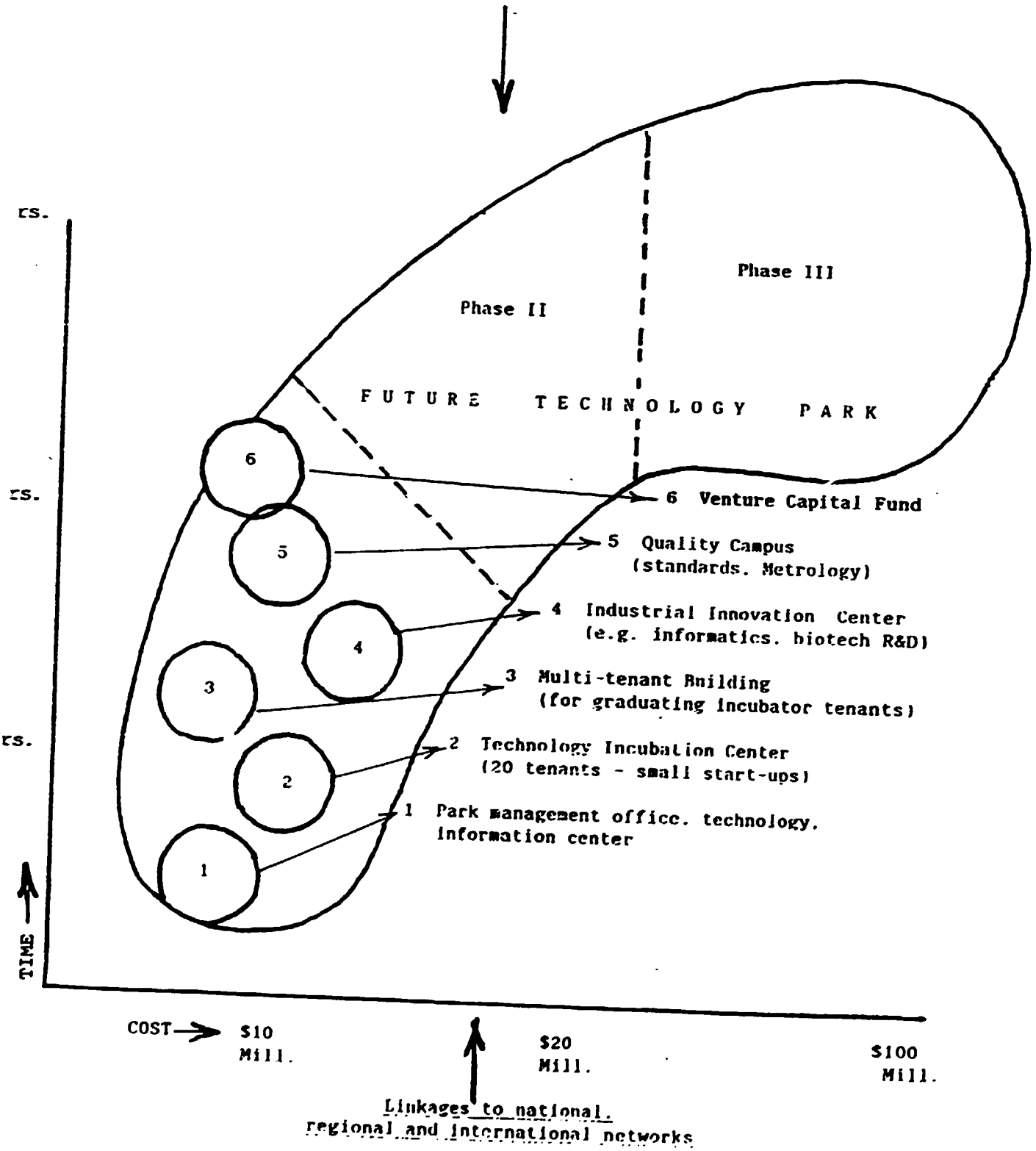
The EMEs also need to link into specific European Community schemes such as SPRINT which assists cross-border cooperation among advisory services ESPRIT and EUREKA which promote industrial and scientific co-operation, COMETT which provides training for adapting skills to the European environemnt, the BC-Net database which matches demands and offers, and EBN which assists some 50 business incubation centres.

Technology Parks

Countries such as Turkey, Malaysia and Thailand are being assisted to plan Technology Parks. While, as discussed earlier, the technology incubator is a micro-environment, the park is a larger, longer-term and more expensive undertaking. It is however possible - and often advisable - to start the park with the nucleus of an incubator, making full provision in the initial design for adding an innovation center, multi-tenant buildings for graduating incubator tenants, a venture capital facility and other technology-related activities in future (see figure 4 on next page). This approach is even more relevant for small countries such as Malta and Cyprus.

Park Characteristics: Generally, a technology park is a large planned tract of land (say 200 hectares) with multiple buildings, designed for a mix of technology-related activities. These usually include scientific research, design and development, manufacture of special products and technical support services. The park may have a limited or wide focus and it may (or may not) include an incubator and innovation center.

Fig. 4 - Linkages to University Government and Private Sectors



The park's mission is to catalyse the process of technology development and transfer by enabling laboratories and enterprises, private and state sponsored, to set up their operations in a pleasant environment where they can interact with each other and, importantly, with the researchers, faculty and facilities of technical universities and research laboratories in the neighbourhood. In this process, technology innovations and transfer are stimulated through information dissemination, new businesses are established, jobs created through sub-contracting, and the overall economic development of the region is promoted.

The tasks of the park management are to plan the roads, utilities and amenities for the overall estate, to attract tech-related organizations to locate there, and to support them through formal and informal networks with the surrounding community, particularly university research, venture capital, consulting, entrepreneurship development and other technology transfer agents. The tenants may either buy/lease land in the park and custom-build their own facilities, or rent building space from the management.

The bulk of the U.S. science and technology parks are university-private joint ventures or set up by state governments; only a small number are for-profit corporations. Starting with the Stanford Research Park (1952) and the North Carolina Research Triangle (1959), there has been a spurt in the establishment of technology parks in the 1980's. Today, there are well over 100 such facilities in the U.S. - and most of them either have or plan a technology business incubator.

In the developing country context, the Ressenslear Polytechnic Institute-sponsored park at Albany, New York, is of special interest as it is still in the development stage (established in 1983) and is located in upper New York state region which has experienced recent economic decline. An area of 1200 acres was available to RPI. Some 200 acres are now developed at a cost of about $5 million and occupied by 35 research,

manufacturing and service companies with 1000 employees. At RPI, five miles away from the park, an excellent Center for Industrial Innovation as well as Technology Incubator are located.

Hi-tech developments around San Jose, California (Silicon Valley) and around Boston, Mass. (Route 128) owe their success in large measure to the excellent technical universities and salubrious environment. While some development countries are talking of establishing their own Silicon Valley, they are better advised to start prudently (and plan ambitiously).

Success factors: In the U.S. experience, the important success factors for parks are:

- Location in proximity to good research capacity and strong technical education facilities which can provide the needed knowledge base, as well as prestige and image.

- Top-quality real estate development with reasonably 'smart' buildings, near a good airport and other communication facilities;

- A pleasant climate, cultural activities and communication facilities to help attract key workers;

- In addition, the state must provide a good political - economic environment;

Once these prerequisites are available, venture capital and other support services follow.

The critical factors for failure of all such modalities are:

- The lack of political commitment to strengthening national technical capabilities;

- The paucity of initial funding;

- Inadequate appreciation and support from the local community, business, university and financing sources, and;

- Inappropriate location.

Location factors: In deciding upon the location of a technology park, the factors considered important by the promoters may be quite different from those of the tenants. Generally, the key considerations are as follows (in order of importance):

By Promoters	By Tenants
1. Near technical university	1. Affordable housing
2. Community atmosphere	2. Flexibility to expand
3. Favourable lease terms	3. Good public schools
4. Top-class scientific personnel	4. University graduates as employees
5. Attractive environment	5. University for continuing education

Finance for Innovation

Good economic conditions for innovation must include legislation on corporate and individual taxes (income and capital gains) which enables the entrepreneur to make money and to keep it. At the same time, the system should provide access to financial resources to help start and expand the business. Or an established enterprise may require finance to exploit an opportunity which needs greater development expenditures than provided for in the company budget.

Such risk money could come from:

- a government-sponsored foundation which provides matching grants to a business-university-research proposal,

- a technology development group, run on commercial lines, which provides project finance to help develop a specific product, process or service, on the basis of a negotiated levy on turnover when actual sales are generated. The enterprise does not part with equity nor pay interest on loans at a time when it can least afford to; but it shares the risks and rewards of the venture with the sponsor,

- the family and colleagues of the entrepreneur, or rich investors (so-called 'angels').

- a seed capital fund, which could be linked to a technology incubator or park, and provides small amounts (under say $100,000) as equity and/or loan,

- a national/regional development bank and commercial banks, together with loan guarantee schemes for small/medium enterprises.

- a venture capital mechanism.

Venture capital: This may well be the mechanism whose time has come in the EMEs. As defined here it is the commitment of capital and special skills to help carry a high-risk idea through to high reward. This has been more successful in the United States of America than elsewhere as it is rooted in several cultural and institutional factors which exist there: the entrepreneurial spirit which prompts people to leave stable jobs and

strike out on their own (a turnover of 25% a year among professionals in high-tech US firms is not uncommon); a constant exchange between university, industry and government which contributes to prompt flows of technology; the strong infrastructure of knowledge-related services; the tradition of financing ventures through a higher proportion of equity risk capital rather than debt; and the existence of highly liquid markets for equity shares. Over 300 venture capital partnerships are operating in the U.S., with some 2,000 professionals providing focussed help to nascent entrepreneurs together with $3 to 4 billion of financial disbursements each year.

Typically, venture capital would cover start-up finance through to the point of having a marketable product or service, and major funding to set up the manufacturing and marketing network; second round funding may be needed to expand the production and distribution systems, until the new firm can be listed on the stock market, generally over the counter. Then, the venture capitalist can exit with significant capital gains to deploy in new ventures. By the nature of its concentration in the high-tech, high-reward sector, this venture capital provides an enormous multiplier, as much as thirty times of sales turnover, together with significant exports and tax revenues as well as employment generation.

Employee stock options are often a part of the structure of entrepreneurial companies in the US. By giving company stock at very low prices to key employees, a greater sense of participation, devotion and hard work can be expected. The opportunities of equity ownership can be a powerful incentive, and this idea could also be tried in the privatization schemes in EMEs. Furthermore, frontier technologies are science-based and so also are the teaching and research at universities. It is therefore logical that high-tech ventures in the US are generally spawned close to the university environment.

Expatriate nationals: A significant trend is the realization in many developing countries that their scientists now settled abroad represent an enormous reservoir of knowledge which can be mobilized through schemes such as TOKTEN. When the talent and goodwill of the expatriate nationals can be combined with their financial resources, you have a powerful new mechanism to initiate high-tech ventures.

Conclusion

As economic development progresses, the needs for international technical cooperation also increase and become more sophisticated. Developing country governments recognize that the past neglect of technology has to be redressed, and therefore call for better access to the technical experience and know-how available in the industrialized countries.

The UN development system has now given high priority to the longer-term goals of environmental protection, technology upgrading and human development, together with the immediate task of poverty alleviation. Towards these objectives, a key role will be played by small and medium-sized businesses through technological innovation and entrepreneurship development.

Considerable experience is available on emerging arrangements for transfer of innovations promptly to the market place. Much can be gained by utilizing the multilateral and bilateral systems for (i) training of technology managers and potential entrepreneurs, both within their countries and through study tours abroad, (ii) providing international expertise to supplement local experience, (iii) networking of individuals and orgnaizations through practical low-cost information exchange arrangements, and (iv) establishing the needed technical support services to catalyze technological entrepreneurship and innovation.

A final word: There is a tendency in the EMEs and develping countries to organize numerous seminars on technology innovation modalities utilizing foreign experts, again and again. It is urged that once a knowledge-base and a certain momentum have been generated, the authorities should promptly establish an appropriate technology center or other arrangement. There is no substitute for learning by doing. Proceed prudently, by all means, but PROCEED!